CIVIL AVIATION AUTHORITY
OF NEW ZEALAND

Advisory Circular
AC91-24

Revision 1

9 February 2021

Automatic Dependent Surveillance—Broadcast (ADS-B) Systems

General

Civil Aviation Authority (CAA) advisory circulars (ACs) contain guidance and information about standards, practices, and procedures that the Director has found to be an **acceptable means of compliance** with the associated rules and legislation.

However, the information in the AC does not replace the requirement for participants to comply with their own obligations under the Civil Aviation Rules, the Civil Aviation Act 1990 and other legislation.

An AC reflects the Director's view on the rules and legislation. It expresses CAA policy on the relevant matter, but is not intended to be definitive. Consideration will be given to other methods of compliance presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate AC.

An AC may also include **guidance material** generally, including guidance on best practice as well as guidance to facilitate compliance with the rule requirements. However, guidance material should not be regarded as an acceptable means of compliance.

An AC may also include **technical information** relevant to the standards or requirements.

Purpose

This AC provides information and guidance on ADS-B systems equipment requirements, accuracy parameters requirements; operational requirements, testing and installation requirements, procedures and information on the approvals process, and information relating to the operation of ADS-B technology.

Related Rules

This AC relates to Civil Aviation rule Parts 21, 43, and 91, and specifically to rules 43.46 and 91.257, 91.258. **Rules** refer to CAA rules, unless otherwise stated.

Change Notice

This version of the AC incorporates operational guidance on the use of ADS-B technology for operators.

Cancellation Notice

This AC cancels AC91-24 Revision 0, dated 24 July 2018. It also incorporates changes to Rule 91, under Amendment 32, which came into effect on 1 December 2020.

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Version History

History Log.

Revision No.	Effective Date	Summary of Changes
0	24 July 2018	Initial issue of this AC
0.1	1 December 2020	Incorporation of effects of ADS-B rule changes as part of amendment 32 of Part 91.
1	28 January 2021	Incorporation of operational guidance relating to ADS-B technology.

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1. Introduction

New Zealand will use Automatic Dependent Surveillance - Broadcast (ADS-B) as the main source of air traffic surveillance data when the current secondary surveillance system is decommissioned. This is in line with ICAO guidance and Standards and Recommended Practices (SARPs) and will improve the safety and efficiency of the air traffic management system.

The intention of this AC is to provide:

(a) an explanation of the mandate for ADS-B OUT;

(b) information on the certification process for installing ADS-B OUT on aircraft;

(c) guidance on equipment requirements for aircraft operating ADS-B systems in New Zealand; and

(d) guidance on performance requirements for ADS-B OUT systems.

Application to aircraft operating below flight level 245:

Note: The February 2021 rule amendments mandate the use of ADS-B OUT in all aircraft operating in controlled airspace from 31 December 2022.

These rule amendments also set the equipment and performance standards for existing and new ADS-B OUT systems in all aircraft in the New Zealand FIR.

2. Related Reading Material

FAA advisory circulars:

- AC 20-165B Airworthiness Approval of Automatic Dependent Surveillance - Broadcast Out Systems
- AC 20-172B ADS-B IN
- AC 90-114B Automatic Dependent Surveillance-Broadcast Operations

3. List of Acronyms and abbreviations

See also Part 1 of Civil Aviation Rules for other terms

ACAS	Airborne Collision Avoidance System
ANSP	Air Navigation Service Provider
ASSAP	Airborne Surveillance and Separation Assurance Processing
ATAS	ADS-B Traffic Advisory System
ATD	Acceptable Technical Data
ATM	Air Traffic Management
AWU	Aircraft Airworthiness Unit
ADS-B	Automatic Dependent Surveillance – Broadcast
CAA	Civil Aviation Authority of New Zealand
CAVS	CDTI Assisted Visual Separation
CDTI	Cockpit Display of Traffic Information
DAPs	Downlink Aircraft Parameters
ES	Extended Squitter
FAA	Federal Aviation Administration
FIR	Flight Information Region
FD	Fault Detection
FDE	Fault Detection and Exclusion
GNSS	Global Navigation Satellite System
ITP	In-Trail Procedure
MFD	Multifunction Display
NACp	Navigation Accuracy Category for Position
NACv	Navigation Accuracy Category for Velocity
ND	Navigational Display
NIC	Navigation Integrity Category
NUC	Navigation Uncertainty Category
OEM	Original Equipment Manufacturer
POA	Position Offset Applied

POB	Persons on Board
RTCA	Radio Technical Committee for Aeronautics
SA	Selective Availability
SB	Service Bulletin
SBAS	Satellite Based Augmentation System
SDA	System Design Assurance
SIL	Source Integrity Level
STC	Supplemental Type Certificate
TCAS	Traffic Collision Avoidance System
TIS-B	Traffic Information Services – Broadcast
TSAA	Traffic Situational Awareness with Alerts
TSO	Technical Standard Order
(E)TSO	(European) Technical Standard Order
UAT	Universal Access Transceiver
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VSA	Visual Separation on Approach

4. List of Definitions

See also Part 1 of Civil Aviation Rules for other terms

NACp specifies the accuracy of a reported aircraft's position, as defined in the FAA's TSO-C166b.

NACv specifies the accuracy of a reported aircraft's velocity, as defined in TSO-C166b.

NIC specifies an integrity containment radius around an aircraft's reported position, as defined in TSO-C166b.

SIL indicates the probability of the reported horizontal position exceeding the containment radius defined by the NIC on a per sample or per hour basis, as defined in TSO-C166b.

SDA indicates the probability of an aircraft malfunction causing false or misleading information to be transmitted, as defined in TSO-C166b.

NUC is a codified parameter used to report the maximum position error, which might not be detected with a predefined probability. NUC originates in a position-determining system and is transmitted by aircraft ADS-B systems complying with TSO-C166 initial.

Note: *NUC is only relevant to TSO-C166 initial issue devices. The NUC is a mathematical combination of the NACp, NACv, NIC, SIL, and SDA.*

Position source refers to the equipment installed on board an aircraft used to process and provide aircraft position (for example: latitude, longitude, and velocity) information.

5. Background

5.1 New Zealand's ADS-B OUT mandate

As the surveillance radar network comes out of service, ADS-B OUT will be the main source of information used for air traffic management, a safety-critical service. For that reason, it is essential that ADS-B OUT systems on aircraft meet performance requirements to ensure the surveillance data received by the ANSP are accurate and complete.

5.2 Mode A/C transponders in transponder mandatory airspace outside controlled airspace

Aircraft operating in transponder mandatory airspace (including special use airspace) outside of controlled airspace do not need to be equipped with ADS-B OUT. However, those aircraft must be equipped with and be operating a Mode A/C transponder as a minimum in accordance with rules 91.247 and 91.541.

5.3 Traffic Awareness Beacon System (TABS)

TABS is similar to ADS-B and incorporates some ADS-B elements. While TABS meets TSO-C199()[1], TABS is not compliant with ADS-B rules for ground-based surveillance in New Zealand as it does not meet all of the ADS-B, nor transponder requirements set in the rules.

TABS was developed to support voluntary equipage in aircraft exempt from ADS-B in U.S. Airspace, as it allowed those aircraft to be seen by aircraft equipped with TAS, TCAS I, TCAS II and/or ADS-B IN.

Within New Zealand FIR the use of mode A/C transponders within transponder mandatory special use airspace, as designated under rule Part 71, are used to provide additional visibility outside of controlled airspace.

TSO-C199

TSO-C199 contains the system requirements for a TABS system, including the position source. The TSO allows for both external GNSS and Class B GNSS sources. Even though these TSO-C199 Class B position sources do not meet a full GPS dedicated TSO, they may be suitable for position sources for some aircraft. Refer to Section 7.2.2.

[1] The double bracket "()" indicates any revision of this document.

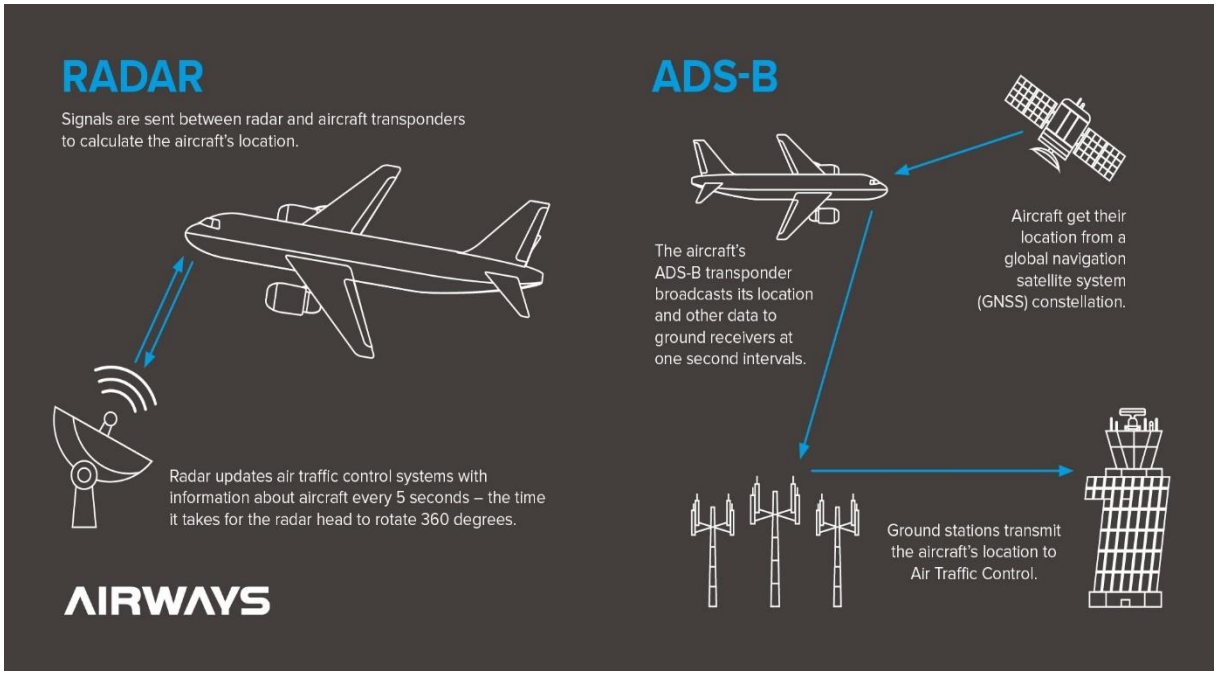
6. ADS-B description

6.1 ADS- B System

ADS-B is a surveillance technology incorporating both air and ground aspects. Compared to the current secondary surveillance radar system, ADS-B provides air traffic control (ATC) services with a more accurate and frequent picture of the aircraft's position.

Using ADS-B OUT equipment on board, the aircraft broadcasts its identification, position, altitude, velocity, and other information, described as ADS-B OUT functionality. The ground portion comprises a network of ADS-B ground stations which receive these broadcasts and direct them to the ANSP for presentation on a controller's display.

Figure 1: How ADS-B works



In addition, aircraft equipped with an ADS-B IN receiver can receive these ADS-B OUT broadcasts and display the information to improve the pilot's situational awareness of other traffic.

ADS-B is automatic as it does not rely on external interrogation, and is dependent as it relies on GNSS as its position source. It is a broadcast transmission system as it provides surveillance information to both ATC and other airspace users.

6.2 ADS-B Frequencies

ADS-B systems come in two distinct frequencies: 1090 and 978 megahertz (MHz).

1090 MHz ADS-B

ADS-B on the 1090MHz frequency is an evolution of standard transponder technology. This is the same frequency as Mode A, C and S transponders use. ADS-B systems in this case use Extended Squitter (ES), which is part of the Mode S transponder, in addition to the normal Mode A and C parameters. 1090MHz ADS-B OUT systems are covered by (E)TSO-C166().

978 MHz ADS-B

UAT systems are not supported in New Zealand, and transmission on 978MHz is specifically prohibited by rule 91.257A(a)(2). ADS-B on 978MHz is used in the United States. While these systems are typically in addition to the normal aircraft transponder, they can also be contained within the same unit. These 978MHz systems are known as Universal Access Transceivers (UAT). UAT Systems are covered by (E)TSO-C154().

Note: *most 1090MHz ADS-B IN receivers also receive 978MHz UAT signals and this capability is acceptable. If a 1090MHz ADS-B system can also transmit on 978MHz, however, this transmission must be disabled.*

6.3 ADS-B Avionics Operating Modes

ADS-B systems are able to both transmit and receive, which is referred to as ADS-B OUT and ADS-B IN.

ADS-B OUT

ADS-B OUT is the transmission from the aircraft containing relevant surveillance data, such as position, heading, airspeed, aircraft type and identification. ADS-B OUT is mandated in controlled airspace by rule 91.255.

ADS-B IN

ADS-B IN is the reception of ADS-B OUT data by a system within the aircraft. ADS-B IN is not a requirement under the rules. However, equipping with ADS-B IN will achieve greater benefit of the technology by improved traffic situational awareness and is therefore recommended.

7. ADS-B OUT Systems

An ADS-B OUT system includes:

- an ADS-B OUT transponder; and
- a compatible GNSS position source; or
- an all-in-one system comprising a transponder with an in-built GNSS position course or dedicated “blind” GNSS. **Note:** the GNSS in these systems is not to be used for navigation.

ADS-B OUT systems installed in aircraft operating in the New Zealand FIR must meet the performance criteria as described in rule Part 43, rule 91.257, and NTC 91.258.

The New Zealand implementation of ADS-B OUT is based on 1090MHz Mode S ES equipment.

7.1 Transponder standards

Transponders that are certified against the following TSOs meet the New Zealand performance requirements for ADS-B OUT transponders:

- TSO-C166 initial issue or can demonstrate equivalent performance
- TSO-C166a or can demonstrate equivalent performance
- TSO-C166b or equivalent

Note: *Any ADS-B system installed after 31 December 2018 must meet the TSO-C166b requirements. TSO-C166 and TSO-C166a are only accepted on systems installed prior to this date.*

Under NTC 91.258 clause 3, ADS-B OUT transponders that operate in controlled airspace must have an output power suitable for the aircraft operation per TSO-C112() and TSO-C166().

The power output requirements can be summarised as follows:

- output power is not to be less than 18.5 dBW (70 W) for an aircraft that operates at an altitude below 15000 ft and have a normal cruising speed less than 175 kt true airspeed (TAS):
- output power is not to be less than 21.0 dBW (125 W) for an aircraft that operates at an altitude above 15000 ft or have a normal cruising speed greater than 175 kt TAS:
- output power is not to be greater than 27.0 dBW (500 W)

7.2 ADS-B OUT Position Source

An ADS-B position source must meet certain performance criteria to be suitable. Based on the system performance requirement, as set out in NTC 91.258, GPS is the only currently approved GNSS position source for ADS-B OUT.

For ADS-B in New Zealand, the GPS position source equipment must be certified according to, or demonstrate performance equivalent to, the relevant TSO. The following GNSS certifications meet the requirements for ADS-B OUT position sources. All include fault detection and exclusion (FDE) capability (see note below).

- TSO - C145 ()
- TSO - C146 ()
- TSO – C196 ()

Note:

- *The position source for ADS-B OUT can be the same GNSS unit used for the aircraft navigation, but it does not have to be. If the position source and the transponder are different, the combination must be compatible and must transmit data that is compliant with the rule.*
- *GPS units fitted in accordance with CAA AC43-14 Appendix 4 are not permitted as an ADS-B OUT position source, as the GPS position integrity cannot be guaranteed. GPS units installed in accordance with AC43-14 Appendix 4 can only be used for situational awareness.*

7.2.1 TSO-C129

TSO-C129 was the first TSO to apply to GPS equipment providing aviation navigation data. This standard predated the current operating environment and did not anticipate ADS-B as a surveillance technology. As a result, operators of TSO-C129 GPS equipment need to ensure that they understand the functionality and limitations of their equipment.

Selective Availability (SA) was an intentional timing delay in the GPS satellite signal to degrade accuracy for the standard civilian GPS signal. Early TSO-C129 GPS (described as “SA ON”) receivers expect SA to be present in the GPS satellite signals. As SA ON equipment may report a worse accuracy than the device has actually determined, they may not meet ADS-B OUT accuracy requirements for ADS-B OUT. SA-aware receivers which can distinguish whether SA is on or not should be suitable.

Fault Detection (FD) and Fault Detection and Exclusion (FDE) TSO-C129 GPS receivers include FD functionality. These receivers can detect corrupted or otherwise inaccurate data from any one of

the satellites from which it is receiving data. An FD receiver will at that point stop providing a navigation solution based on GPS.

FDE is the next generation of technology. It enables the receiver to identify and exclude inaccurate satellite data and, provided it still has access to a sufficient number of satellites, will continue to provide a navigation solution.

Whilst FD-only GNSS receivers will amend the reported integrity on the ADS-B OUT message, when a fault is detected the navigation solution is no longer valid and the integrity no longer will meet the required performance. ATC may ask you to alter your flight path to ensure sufficient separation based on the lesser degree of position accuracy reported.

Although a FD-only TSO-C129 GNSS can be used as an ADS-B position source, it may not be the best solution for the intended operation, as navigational use of these devices may be limited to VFR only. TSO-C129 GNSS receivers that have FDE do not have this limitation.

7.2.2 TSO-C199 or Non-TSO Position sources

Notice of Requirement NTC 91.258 revision 2 includes paragraph 2(g)(5) which relates to position sources that do not meet the GPS equipment TSOs mentioned in sections 6.2 and 6.2.1. However, if approved for use by the Director, these are suitable to be used as a position source for ADS-B, when in combination with a TSO-C112() transponder, and produce a TSO-C166b compliant ADS-B system.

Refer to section 7.9 of this AC for more information on position sources approved by the Director.

7.3 Integration

Transponder and Position Source

Installing a certified ADS-B OUT transponder and a separate certified GNSS positon source does not guarantee that the combination will be compatible and result in the transmission of ADS-B compliant data. There are known instances of TSO-certified transponders and GNSS receivers that are not compatible and do not produce compliant ADS-B data.

CAA recommends that operators use proven combinations based on previously certified STCs or modifications, OEM recommended combinations, and the FAA approved combination list. If you install an unproven combination, you are required under rule Part 21 to provide a full engineering evaluation to demonstrate that the transponder and position source are compatible, and the output meets the performance criteria in NTC 91.258 clauses 2(g) and (3).

As with all ADS-B OUT systems installed after 20 July 2018, a functional test must be carried out to ensure the system produces compliant data.

Note: *Inclusion on the FAA approved combination list does not mean this system is fully compliant with New Zealand requirements, as there are differences between FAA and CAA requirements and the FAA approved equipment list may include UAT based systems.*

Other Equipment

ADS-B OUT systems report both barometric and geometric altitude. Barometric or pressure altitude is the same as that displayed on the aircraft altimeter, whereas geometric altitude is calculated by GPS as the height of the aircraft above the earth ellipsoid. These two altitudes are not the same, but allow for applications that require one or the other as an altitude source, as well as providing a means of verifying correct pressure altitude reporting from aircraft.

Barometric altitude is also required, as an ANSP will only use barometric altitude for vertical separation. New Zealand Civil Aviation ADS-B requirements do not alter any existing regulatory guidance regarding the barometric altitude accuracy or resolution.

7.4 Antenna diversity requirements

There is no requirement in the CAA rules for transponder antenna diversity (i.e. bottom and top mounted antennae) in order to operate an ADS-B OUT system.

However, antenna diversity may be required for utilising airfield ground movements or in accordance with system installation requirements. Operators may wish to consider antenna diversity to counter aircraft shielding during turns that could affect the reception of ADS-B OUT signals for the ground system and ADS-B IN operators.

Operators that operate their aircraft in foreign countries may also require a diversity system, especially in those countries that utilize space-based ADS-B receivers, such as Canada.

7.5 Multiple Transponder Requirement

CAA rules for ADS-B OUT do not require multiple transponders. Operators may choose to fit more than one transponder for redundancy.

Note: *Certificated operators may require multiple transponders when operating a PBN specification that requires surveillance.*

7.6 ADS-B Only Transmitters

While actual ADS-B data is automatically broadcast and does not rely on the signal interrogation and reply operation of a transponder, ADS-B OUT functionality is normally enabled as part of a Mode S transponder's ES capability.

To provide the required message sets, transponders need to broadcast ADS-B OUT and Modes A/C and Mode S functionality. These message set elements are detailed in NTC 91.258.

ADS-B OUT transmitters are available that transmit ADS-B data only (i.e. do not transmit Mode A/C nor Mode S data). These ADS-B transmitters are not an acceptable ADS-B OUT solution, as they cannot be detected by ACAS systems.

Transponders that also transmit Modes A, C and S data would continue to function if the aircraft lost its GPS signal. In that situation, air traffic controllers may still be able to see the aircraft if it was within secondary surveillance radar range, which would not be case for ADS-B only systems.

7.7 Non-Compliant Data

As ADS-B OUT will be the primary source of surveillance data in the New Zealand FIR, all ADS-B data transmitted from aircraft equipment must meet the requirements of rule 91.257 and NTC 91.258.

Non-compliant data includes incomplete, inaccurate and/or misleading ADS-B OUT data, as well as data not transmitted frequently enough to meet the system requirements. The risks associated with non-compliant or misleading data are that the aircraft's position, identity, heading, velocity etc. may not be displayed on ATC screens; or, more seriously, give air traffic controllers an incorrect indication of those parameters.

To ensure an effective and safe surveillance and traffic management system in controlled airspace, rule 91.257A includes a definition of "Non-compliant ADS-B data" that includes data that does not meet the requirements of the Notice referred to in rule 91.258.

Aircraft that transmit non-compliant or misleading data may be excluded from entering or may be managed by ATC as provided for by rule 91.247(e). Operators of these aircraft will be advised that the aircraft is transmitting non-compliant data and asked to rectify the problem.

7.8 Design Change/Modification Classification Guidance

Acceptable Technical Data (ATD) is required for all ADS-B installations. ATD includes Service Bulletins issued by the aircraft manufacturer, Supplemental Type Certificates STCs) issued by the State of Design for the aircraft type, or any other such data approved by the Director.

If no acceptable technical data is available for your aircraft type or the equipment to be installed, you should seek the support of an approved Part 146 Design Organisation.

For any specific questions about ATD for your aircraft, please contact certification@caa.govt.nz

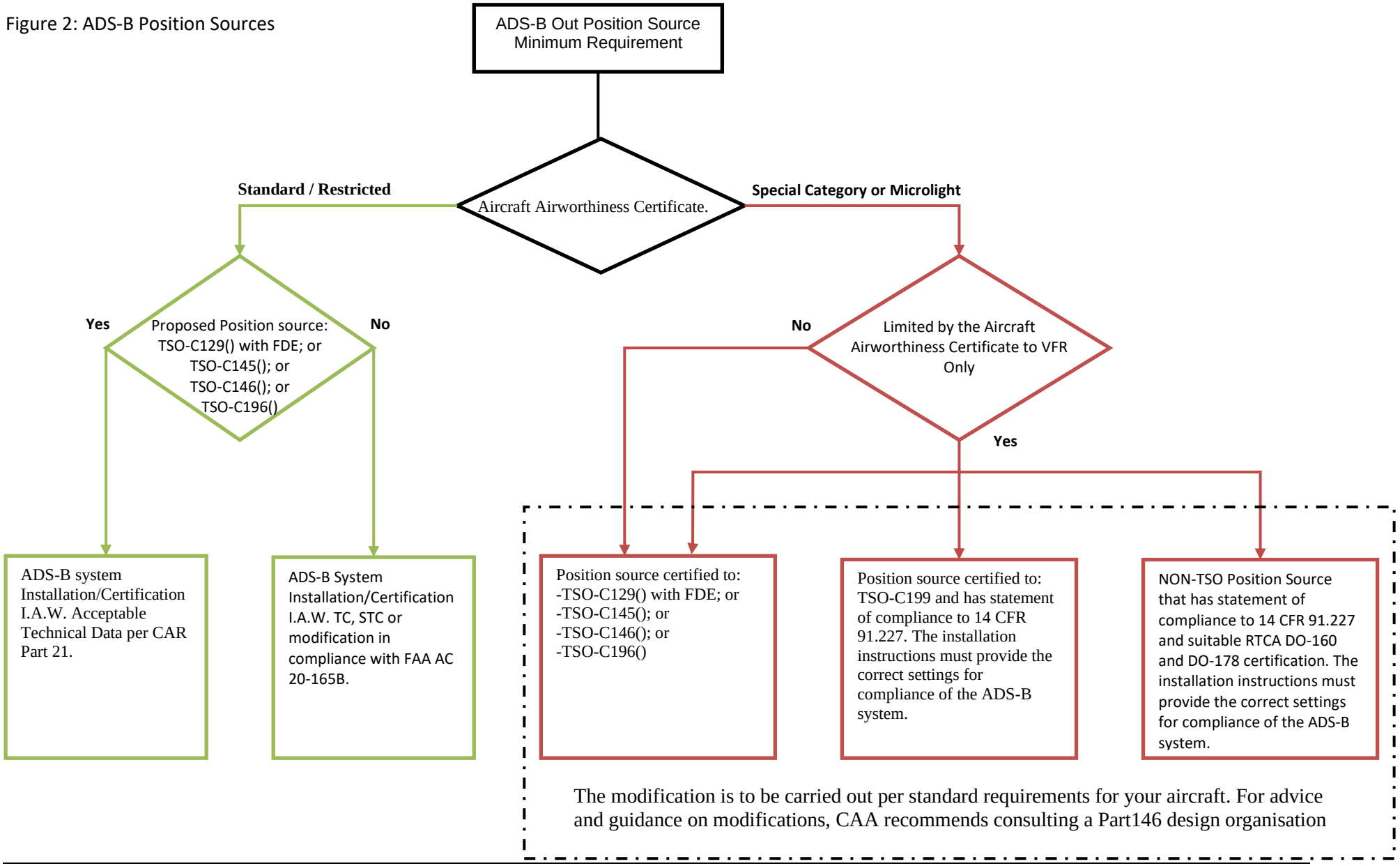
7.9 ADS-B OUT System Approval

ADS-B OUT systems will require approval by the Director. Systems meeting the requirements in NTC 91.258 Section 4(a) are automatically approved. Approval for systems that do not meet the criteria in section 4(a) can be obtained from the Director, provided the system meets the performance requirements in Section 2 of NTC 91.258. Systems approved in this manner by the Director will be published on the CAA website (www.aviation.govt.nz). This approval ensures the system will perform reliably and provide accurate ADS-B data to the aviation surveillance system.

7.9.1 ADS-B Position sources Approved by the Director

NTC 91.258 Section 4(a)(2)(ii) refers to position sources approved by the Director other than those listed in Section 4(a)(2)(i). To ensure both aircraft certification and operational requirements are met, the position sources approved by the Director differ depending on the aircraft certification standard and the operations the aircraft can legally perform. The flow chart in Figure 2 illustrates what position sources the Director has approved for Standard and Restricted Category aircraft, as well as Special Category aircraft and Microlights.

Figure 2: ADS-B Position Sources



7.10 System Testing

Systems with existing acceptable technical data (e.g. STC)

Operators must conduct post installation testing in accordance with the manufacturer's instructions. Testing should be conducted, including appropriate specialist test equipment, to prove the ADS-B OUT system meets the required transponder performance requirements (refer to rule Part 43, Appendix E.12(a) and CAA NTC 91.258 clause 4(a)(5)).

Operators must provide CAA with evidence and results of the test for transponder performance requirements on initial installation of the ADS-B OUT system, or as required by CAA, or document it in the aircraft maintenance records (refer to rule Part 43, Appendix E.12(b)). Evidence may be in the form of automated test reports or test equipment screen shots if automated test reports are not available.

While the Airways' surveillance system will identify aircraft that are not transmitting appropriate ADS-B OUT data, it is not a proxy test system. The onus is on the operators to ensure their ADS-B systems are transmitting accurate data prior to their aircraft entering transponder-mandatory airspace where ADS-B OUT is required.

Operators should not rely on ATC to advise them of ADS-B equipment problems, as the ATC system cannot identify all equipment failure modes in all situations, and may not be able to distinguish between data that appear to be normal but are in fact misleading. For that reason, robust testing is essential at the time of installation, and on a regular basis (refer to Part 43, Appendix E.12(a)).

Note: Online ADS-B position reporting applications such as Flightradar24, and flight following systems are not acceptable for ADS-B OUT transponder testing.

Newly developed systems

For newly developed ADS-B systems, either a one-off modification or a new STC, adequate testing must be included. This testing is expected to include flight testing to ensure satisfactory performance in all phases of flight. Testing in accordance with FAA AC20-165B is an acceptable means of compliance.

7.11 Flight Testing

Depending on the acceptable technical data used for the ADS-B installation, flight testing may be required. If the ADS-B installation uses an existing STC or aircraft OEM SB, flight testing may not be required, as the data holder would have proven the flight test performance during the certification of the data. There are STCs available that allow for variation on equipment location such as the location of the GNSS antenna. The installer must refer to the technical data to determine if flight testing is required to account for their specific installation. When flight testing is required a special flight permit under Part 21 will be required (Form CAA 24091/7).

7.12 Instructions for Continued Airworthiness

Installers and operators should consult OEM and/or designers' requirements for instructions for continued airworthiness.

Under rule 91.605(e)(3) every ADS-B OUT system must be tested every 24 months as a minimum to ensure it continues to transmit compliant data.

Note: *The Mode S and ADS-B message sets include Mode A/C data.*

8. ADS-B IN Systems for Traffic Situational Awareness

Installation of ADS-B IN provides operators with supplemental information. ADS-B IN does not change any existing responsibilities. The situational applications described in this AC, which are defined in (E)TSO-C195b, supplement awareness, but do not replace the need under VFR to maintain a visual lookout so as to see and avoid other aircraft.

ADS-B IN systems come in two categories: systems that are certified and systems that are not certified. Both categories provide the operator with increased situational awareness. Certified ADS-B IN systems are those that meet (E)TSO-195b and are installed in accordance with FAA AC 20-172B (or equivalent standards and guidance). The information in this AC assumes the ADS-B IN system meets these standards.

If your aircraft is equipped with a system not meeting these requirements, it may not have the functionality described and it may not be used for any operational procedures if they were to be implemented.

8.1 ADS-B IN System description

Most ADS-B IN systems will include or interface with a traffic display picturing traffic consisting of ADS-B OUT equipped aircraft or airport ground vehicles. This display may be a dedicated display, or it can be part of a navigation display (ND) or multifunction display (MFD). All input or output devices associated with the display of traffic are collectively known as Cockpit Display of Traffic Information (CDTI). The terms traffic display and CDTI are often used interchangeably.

8.2 ADS-B IN Limitations

Pilots should understand the proper use and limitations of their equipment and should pay close heed to the following:

- Only use a traffic display to supplement what can be seen out of the cockpit window, except when authorised to carry out In-Trail Procedure (ITP) or CDTI Assisted Visual Separation (CAVS).
- Unless specifically certified for the function, a traffic display is not intended for collision avoidance or self-separation.
- Not all ground and airborne traffic will appear on the traffic display. The traffic display can only display properly equipped ADS-B OUT traffic that are broadcasting on the received frequencies. Systems with active traffic systems such as TCAS may also see Mode A/C only transponder traffic.
- Unless initiated by an air traffic controller within controlled airspace, pilots should refrain from using the callsign or aircraft identification of observed traffic in radio communications as this could create confusion for both ATC and pilots monitoring the frequency.
- In multi-piloted aircraft, pilots must establish and comply with crew coordination procedures on the use of CDTI and ADS-B IN information to minimise head-down time.
- Use of a traffic display does not change pilot or air traffic controller responsibilities.
- If at any time the presented information becomes unreliable, inoperative, or a distraction, pilots should disregard the information presented on the traffic display.

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

8.3 Equipment Classes

ADS-B IN equipment is defined by four classes in TSO-C195b:

Class A: CDTI – Surface only.

Class B: CDTI.

Class C: Airborne Surveillance and Separation Assurance Processing (ASSAP).

Class D: ADS-B Traffic Advisory System (ATAS).

Class A equipment is intended to support the display of ADS-B traffic while your aircraft is on the ground and your speed does not exceed 80 kts. Class A equipment must deactivate the CDTI when becoming airborne or when your speed exceeds 80 kts. Class B equipment supports ADS-B traffic display both on the ground and in the air regardless of speed. Class C equipment processes the ADS-B data in order to generate the traffic data for the CDTI. Class D equipment supports audio only implementations (no CDTI).

The table below, shows the application on the classes per TSO-C195b. With the exception of the ATAS application an installation requires both CDTI and ASSAP.

Table 1 ADS-B IN Equipment Class TSO-195b

		Criticality		**Equipment Class**			
Application		Loss of Function	Hazardously Misleading Information	Class A CDTI (surface only)	Class B CDTI	Class C ASSAP	Class D Annunciator Panel
1	Enhanced Visual Acquisition (EVAcq)	Minor	Major	Not Permitted	B1	C1	N/A
2	Basic Surface (SURF) Runways	Minor	>80 kts Major <80 kts Minor	A2	B2	C2	N/A
3	Basic Surface (SURF) Runways & Taxiways	Minor	>80 kts Major <80 kts Minor	A3	B3	C3	N/A
4	Visual Separation on Approach (VSA)	Minor	Major	Not Permitted	B4	C4	N/A
5	Basic Airborne (AIRB)	Minor	Major	Not Permitted	B5	C5	N/A
6	In-Trail Procedures (ITP)	Minor	Major	Not Permitted	B6	C6	N/A
7	ADS-B Traffic Advisory System (ATAS)	Minor	Major	Not Permitted	B7	C7	D7
8	CDTI Assisted Visual Separation (CAVS)	Minor	Major	Not Permitted	B8	C8	N/A

8.4 ADS-B IN applications

TSO-C195b ADS-B IN certified system may offer any of the following capabilities which may or may not be implemented for use in New Zealand in the future. They may already be in use by foreign ATM providers.

ADS-B Traffic Advisory System (ATAS)

ATAS is an ADS-B IN application intended to reduce the number of mid-air collisions and near misses involving general aviation aircraft. This system has previously been known as Traffic Situational Awareness with Alerts (TSAA). The use of the term ATAS has been adopted in TSO-C195b to be more consistent with existing traffic advisory systems. ATAS provides voice annunciations to pilots to draw attention to alerted traffic and also adds visual cues to the underlying basic traffic situation awareness application in installations where a traffic display is available (e.g. EVAcq or AIRB). ATAS uses ADS-B information (and where available ADS-R and TIS-B) to provide the pilots with indications of nearby aircraft to support their see-and-avoid responsibility. ATAS is the only ADS-B IN application with an audio-only implementation (via an annunciator panel) and does not require a traffic display.

Enhanced Visual Acquisition (EVAcq)

The EVAcq application displays ADS-B traffic on a plan view. This application is designed to support only the display and alerting of ADS-B and TCAS derived traffic. Implementations that include application classes other than EVAcq and ATAS must use AIRB instead.

Basic airborne application (AIRB)

AIRB displays the ADS-B traffic on a plan view. This application is the minimum requirement for installations that implement other applications such as VSA (see below) or ITP. Each aircraft symbol displayed shows position, direction and altitude. Additional information, such as identity, may be displayed as well. This traffic information aids the pilot in visually acquiring the traffic out of the window.

Surface application (SURF)

The basic surface application displays the ADS-B traffic on a plan view superimposed on a map of the airport surface. This map consists of all runways at supported airports and includes taxiways if that data is available. On ground traffic of both aircraft and ADS-B equipped ground vehicles as well as in air aircraft traffic is displayed by various symbols assisting the pilot in visual acquisition of the relevant traffic.

Visual Separation on Approach (VSA)

The VSA application builds on AIRB. It allows the pilot to select an aircraft to follow on approach. Additional information about the selected aircraft, such as range and ground speed, is displayed to the pilot to enhance the flight crew's situational awareness. The CDTI display is used to assist the pilots in acquiring and maintaining visual contact during a visual approach.

Note: *VSA is not an approach operation in itself, and all existing operational responsibilities remain unchanged when using VSA.*

CDTI Assisted Visual Separation (CAVS)

The CAVS application is designed for use on approach procedures when visual separation is approved by ATC. CAVS requires the pilots to visually acquire the preceding aircraft out of the cockpit window during the approach procedures. Once visually acquired the pilot will cross-check the information on the CDTI. Once the preceding aircraft is identified and checked on the CDTI the

pilot may use the CDTI to maintain "visual" separation even if visual contact out of the cockpit window is lost. CAVS does not modify any VMC minima as defined by ICAO.

Note: *CAVS requires operational approval for use.*

In-Trail Procedure (ITP)

The ITP application enables aircraft that desire flight level changes in procedural airspace to achieve these changes on a more frequent basis, thereby improving flight efficiency and safety. ITP permits a climb-through or descent-through manoeuvre between properly equipped aircraft, using a distance-based longitudinal separation minimum during the manoeuvre. The procedure requires the flight crew to use information derived from the aircraft to determine that procedure initiation criteria are met for the ITP. The initiation criteria are designed so that throughout the ITP the aircraft exceeds separation minima with acceptable probability. ITP requires specific processing and display parameters which are unique to the ITP application.

Note: *ITP requires operational approval for use.*

9. Operational Guidance

9.1 System Familiarity

The pilot/operator of the aircraft should be familiar with the ADS-B system installed in the aircraft. The pilot should be familiar with the content of the flight manual or flight manual supplement that relates to the operation of the ADS-B system, as well as any additional documentation such as pilot guides or quick reference guides.

When familiarising with these, the pilot must be sure the failure indications of the ADS-B system in the aircraft they are operating are well understood so that appropriate action can be taken.

Air/ground determination

Rule 91.247 requires ADS-B to be operational in controlled airspace and functioning from when the aircraft begins to move under its own power until it comes to a complete stop at the end of its flight. It is advisable to also operate ADS-B OUT where not required by the rule, as it provides additional situational awareness. It is important to understand how the ADS-B system operates in your aircraft and how the system determines whether you are on the ground or in the air. Many general aviation (light) aircraft do not use a physical air/ground switch but an algorithm within the transponder to determine whether the aircraft is on the ground or in the air. These systems take inputs from GNSS and air-data provided to the transponder and, based on changes in groundspeed, altitude and various other considerations, determine when the aircraft transitions from being on ground into the air.

For these systems to accurately determine this change it is often important to have a GNSS position fix prior to taxiing the aircraft (refer to the equipment manuals for unit specific requirements). It also means that when these systems are turned on in air, either when transitioning into controlled airspace or when power to the unit is cycled, the system may incorrectly report as being on ground. This is considered as non-compliant data under rule 91.257A.

If needed, many ADS-B systems have an option to stop transmitting ADS-B data without turning the transponder off. This ensures the system retains the correct air/ground status (refer to the equipment manuals to determine this is an option on your ADS-B system).

9.2 Non-compliant data due to pilot action

Rule 91.257A prohibits the transmission of ADS-B data that does not meet the requirements called out in rule 91.258. The transmission of non-compliant data may be the result of several factors such as incorrect equipment selection and/or installation, as well as incorrect control of the ADS-B system by the pilot.

As stated in Section 9.1, the pilot should be familiar with the equipment and its manuals to avoid non-compliant data transmission within their control. As many systems are installed on an FAA STC it may be worth noting that the FAA refers to this non-compliance as "non-performing equipment" or "NPE".

Examples of pilot action that may result in the transmission of non-compliant data include:

- Movement of the aircraft under its own power with the ADS-B system turned off (unless permitted to do so by ATC or otherwise)
- Operating with a non-conforming flight identification. This includes how the flight identification is entered in the system, as well as any discrepancies between what is entered and what is filed on the flight plan
- Operating with barometric altitude reporting turned off (unless instructed to do so by ATC), or
- Operating the ADS-B system in ground mode whilst airborne.

9.3 Flight Plans

This section addresses pertinent flight plan information as it relates to ADS-B. For more information refer to AIP table ENR1.10 on the AIP New Zealand website.

Flight Plan

When filing an ICAO flight plan, ensure the surveillance equipment is correctly filled out in Item 10b. The correct ADS-B capability code should reflect your aircraft capability.

- B1: ADS-B with dedicated 1090MHz ADS-B OUT capability.
- B2: ADS-B with dedicated 1090 MHz ADS-B OUT and IN capability.

Note: *B2 should only be filed for TSO-C195() or equivalent ADS-B IN equipment. If your aircraft is fitted with an ADS-B IN device that that does not meet certification standards file B1 for ADS-B OUT only.*

As ADS-B in New Zealand uses 1090MHz ES, the transponder ID should reflect the correct Mode S capability.

- EB1 or EB2 for standard Mode S ES ADS-B transponders.
- LB1 or LB2 for Mode S transponders with enhanced surveillance.

Flight ID

Operators should ensure the callsign entered into the flight plan matches the Flight ID entered into the ADS-B system.

For those operations that do not require a flight plan to be lodged, the approved callsign or registration mark (without the dash between "ZK" and the remaining characters) should be entered into the ADS-B system.

9.4 Emergency/priority Status

The ADS-B message set includes the ability to transmit emergency/priority status codes as part of the ES ADS-B message and occurs when a valid Mode A emergency code is entered into the transponder. In this situation the system transmits both the Mode A emergency code as well as the ADS-B generated emergency status code.

DO-260B includes 8 different emergency/priority status messages. The following ADS-B messages are associated with Mode A codes:

Mode A Code	ADS-B Emergency/Priority Status	ADS-B code
7500	Unlawful Interference	5
7600	No Communication	4
7700	General Emergency	1

The remaining emergency/priority status messages which are not associated with a Mode A code include:

ADS-B Emergency/Priority Status	ADS-B code
No Emergency (default)	0
Lifeguard/medical Emergency	2
Minimal Fuel	3
Downed Aircraft	6
- Reserved -	7

Refer to your equipment manual to determine if your equipment supports transmission of these messages and what conditions are required for their transmission.

9.5 Privacy ICAO Address (PIA)

PIA is an FAA program and is not supported in New Zealand. The use of PIA should not be confused with discreet operations under rule 91.255D.

The PIA program allows the FAA to assign an alternate temporary ICAO address to an aircraft, which is linked to the aircraft's normal address. This program can only be used within the United States, as operation with a PIA address outside domestic U.S. airspace is prohibited.

Given the limited number of ICAO addresses assigned to New Zealand, CAA has no plans to implement a similar program, as the underlying need for PIA like operations is adequately covered by rule 91.255D.

9.6 Operation of aircraft without ADS-B for discreet operations

Rule 91.225D allows for the operation of an aircraft in controlled airspace without ADS-B for discrete operations. These operations include those for:

1) national defence or security purposes

2) intelligence or law enforcement purposes, or

3) any other suitable purpose approved by the Director, where the transmitting of ADS-B data would compromise the security of the operation or pose a safety risk to the aircraft, crew or people and property in the air or on the ground.

The rule requires that the Director is informed of discreet operations in case of items 1) and 2), above. This is to be done within 14 days of completing this operation, unless it is required to report an accident or incident involving the discreet operation as required under rule Part 12.

The Director can be informed of the discreet operation through Form CA005 – Occurrence report (https://www.aviation.govt.nz/assets/forms/CA005_Form.pdf). At a minimum, the following information should be included in the appropriate fields of the form:

- Reporter's details
- Occurrence details (POB information is not required)
- Description of the occurrence
    - "Discreet operation per Rule 91.255D(a)(1) and/or 91.255D(a)(2)"
    - any additional details to the discreet operation, and
- Operational details relating to Flight number/Call sign
    - Nature of flight: "Other: ADS-B Discreet Ops".

Note: *Form CA005 is a means of informing the Director of the discrete operation. Depending on the nature and frequency of the operations, other means of informing the Director may be agreed upon with CAA.*

Appendix A - ADS-B Message Set

The following message set elements may be contained in an ADS-B OUT message[2]. This list is used to explain what may be contained in an ADS-B OUT message. It is not a requirements list.

(a) *ADS-B capability* – only the 1090 ADS-B IN message (which indicates if the aircraft has the ability to receive 1090 ES ADS-B messages installed).

(b) *Barometric pressure altitude* indicates the aircraft's barometric pressure altitude referenced to standard sea level pressure of 29.92 inches or 1013.2 hectopascals.

(c) *Call sign/flight ID* is the radiotelephony call sign assigned to an aircraft for voice communication purposes sometimes called "flight identification" or "flight ID". For general aviation aircraft, it is normally the national registration number; for airline aircraft, it is usually the company identification and flight number; and for the military it is usually numbers and code words with special significance for the operation conducted. The call sign is required to be transmitted except when using the TSO-C154c anonymity feature.

(d) *Emergency status* alerts ATC that the aircraft is experiencing emergency conditions and indicates the type of emergency so the aircraft can take appropriate action. Applicable emergency codes are found in ICAO Annex 10 Volume 4, Surveillance Radar and Collision Avoidance Systems, and FAA AC 20-165B, Appendix A.

(e) *Emitter category* provides an indication of the aircraft's size and performance capabilities as defined in TSO-C166b and TSO-C154c. It is designed to provide information on the wake turbulence that an aircraft produces.

(f) *Geometric altitude* is a measure of altitude provided by a satellite-based position service and is not affected by atmospheric pressure. It is only available with a GNSS position source.

(g) *Geometric vertical accuracy (GVA)* indicates the 95% accuracy of the reported vertical position (geometric altitude) within an associated allowance.

(h) *GNSS antenna offset and position offset applied (POA).* GNSS antenna offset indicates the longitudinal distance between the most forward part of the aircraft and the GNSS antenna, and the lateral distance between the longitudinal center line of the aircraft and the GNSS antenna.

(i) *Ground speed* provides ATC with the aircraft's speed over the ground.

(j) *Ground track angle* is the direction of the horizontal velocity vector over the ground and must be transmitted while on the ground in order to complete velocity information.

(k) *Heading* indicates the direction in which the nose of the aircraft is pointing and must be transmitted while on the ground to complete velocity information.

[2] *Source: FAA AC 20-165B*

(l) *Horizontal velocity* provides the rate at which an aircraft changes its horizontal position with a clearly stated direction and is expressed with north/south velocity and east/west velocity while airborne and a combination of ground speed, heading, ground track while on the ground).

(m) *ICAO 24-bit address* is a unique address assigned to an aircraft during the registration process and is defined blocks of addresses for countries or states worldwide. Additional information regarding the address can be found in ICAO Annex 10, Part 1, Volume III, appendix to Chapter 9, A World-Wide Scheme for the Allocation, Assignment and Application of Aircraft Addresses.

(n) *IDENT* is a flag manually set by the pilot at the request of ATC in ATCRBS, Mode S and ADS-B Out messages and highlights the aircraft on the controller's screen.

(o) *Latitude and longitude* are derived from the position source and provide a geometric based position.

(p) *Length and width of aircraft* provides ATC and other aircraft with quick reference to the aircraft's dimensions while on the surface.

(q) *Mode 3/A Code* is a four-digit number. Secondary surveillance radars and ADS-B will concurrently provide surveillance so the Mode 3/A code is included in the ADS-B Out message.

(r) *Navigation Accuracy Category for Position (NACp).*

(s) *Navigation Accuracy Category for Velocity (NACv).*

(t) *Navigation Integrity Category (NIC).*

(u) *System Design Assurance (SDA).*

(v) *Source Integrity Level (SIL).*