ADS-B

Hudson Bay Implementation

NAV CANADA

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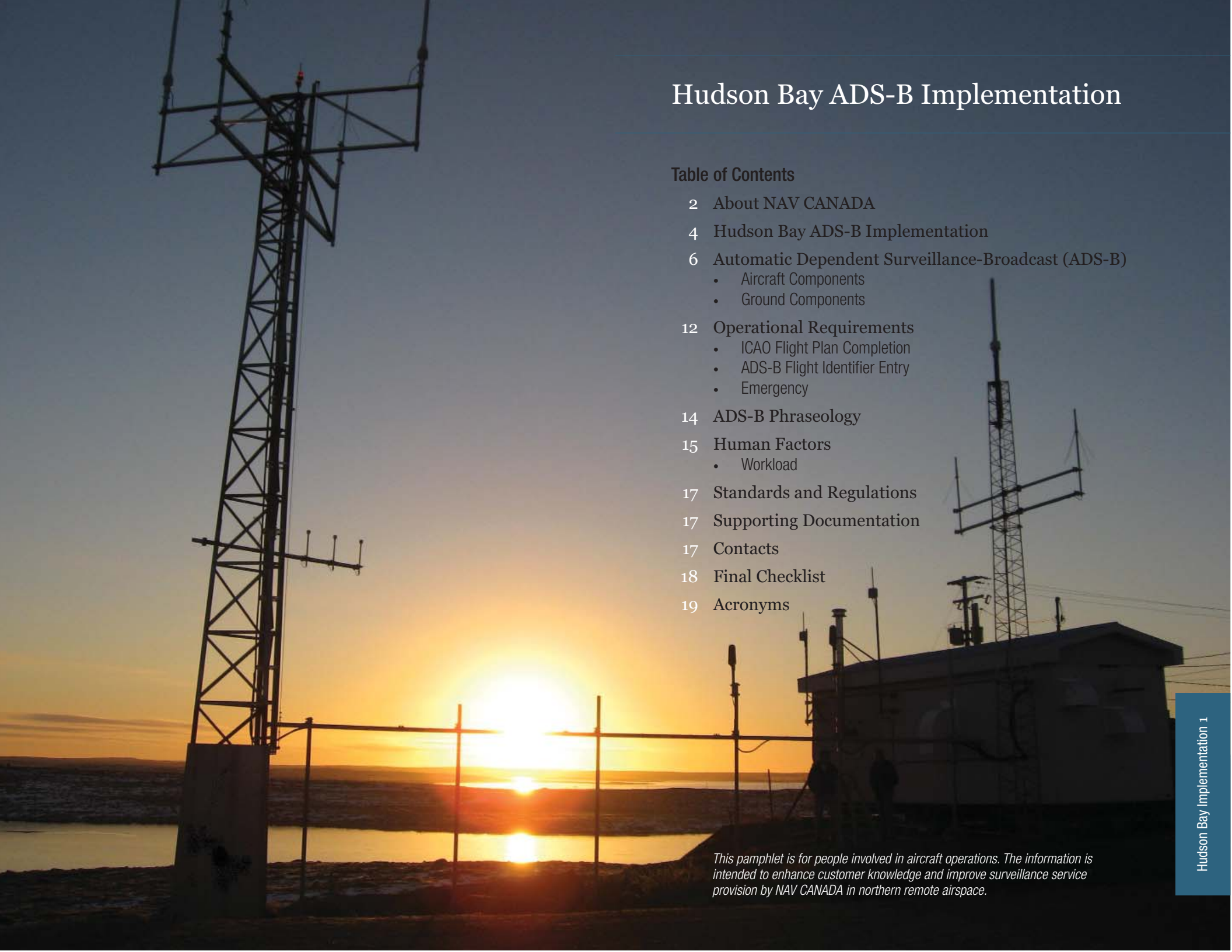

Hudson Bay ADS-B Implementation

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This pamphlet is for people involved in aircraft operations. The information is intended to enhance customer knowledge and improve surveillance service provision by NAV CANADA in northern remote airspace.

About NAV CANADA

NAV CANADA is the private sector, non-share capital corporation that owns and operates Canada's civil air navigation service (ANS), providing for the safe and efficient movement of aircraft in Canadian domestic airspace and international airspace assigned to Canadian control.

Through its coast-to-coast operations, NAV CANADA provides air traffic control, flight information, weather briefings, aeronautical information, airport advisory services, and electronic aids to navigation. The Company's infrastructure consists of seven area control centres, 41 control towers, 60 flight service stations, eight flight information centres and over 1,000 ground-based navigational aids across the country.

The Company is committed to implementing new technologies and procedures that improve safety and efficiency and reduce greenhouse gas emissions.

Hudson Bay ADS-B Implementation

Automatic Dependent Surveillance-Broadcast (ADS-B) will bring surveillance coverage for the first time to 250,000 square nautical miles of airspace over Hudson Bay in Northern Canada. About 35,000 flights a year use this airspace. The majority of these flights link Europe and North America, while many transit to Asia, including those using polar tracks.

ADS-B is a next generation surveillance technology that supports radar-like separation standards. The system brings significant safety and efficiency benefits, offering properly-equipped and certified aircraft more flexible, fuel-saving routes through airspace previously managed using only procedural air traffic control. Aircraft with ADS-B automatically transmit accurate position reports with integrity every second to Air Traffic Control (ATC). As a result, ADS-B will reduce separation minima for equipped aircraft and allow more aircraft to follow the most efficient flight trajectory.

Service will commence on January 15, 2009.

Controllers will initially use ADS-B tactically by applying reduced separation between equipped aircraft on an opportunity basis within the Hudson and Minto sectors. This means each aircraft will have the appropriate protected airspace around it applied based on its capability.

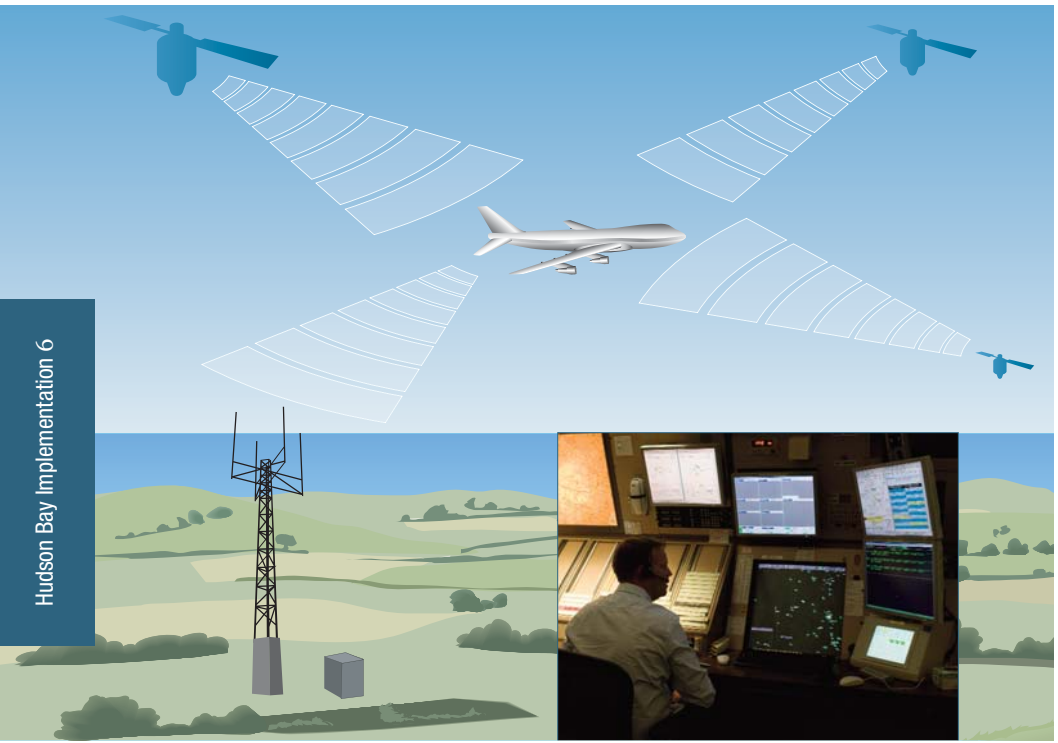
As more aircraft equip, and in full consultation with customers, NAV CANADA will segregate airspace vertically in 2009, likely requiring ADS-B for flight between FL350 and FL400 inclusive. Segregation will provide maximum benefits to equipped aircraft and the incentive for others to equip. Eventually all flights at and above FL290 will require ADS-B. The transition period will provide a reasonable time frame for operators to obtain the necessary equipment and regulatory approvals for their aircraft and crew.

The map on the opposite page depicts installations and coverage for the Hudson Bay ADS-B surveillance service. ADS-B will cover Hudson Bay airspace completely above FL370, but with a coverage gap approximately 100 nautical miles (nm) x 100 nm at FL290.

Automatic Dependent Surveillance - Broadcast

ADS-B is a surveillance system that uses satellites, aircraft avionics and ground infrastructure to relay a range of aircraft parameters such as identification, position and altitude to air traffic controllers. It is *Automatic* since no external stimulus is required for operation, and *Dependent* since it relies on aircraft avionics to provide *Surveillance* through *Broadcast* messages.

Three major components make up the ADS-B system: aircraft avionics, ground stations and controller displays. Aircraft avionics are responsible for generating, compiling and transmitting surveillance information. Ground stations, an array of receiver units strategically located in the surveillance service volume, detect the aircraft transmission and relay the data to the Area Control Centre (ACC). The data is analysed and configured for the controller's displays.



Aircraft Components

Onboard aircraft sensors are responsible for selecting required data and providing it to the Mode S transponder. Following the compilation of an ADS-B message, the transponder transmits the data through an Extended Squitter (ES), on 1090 MHz. Modern transponders are capable of compiling and transmitting ADS-B messages once per second, allowing ATC access to real-time aircraft position information.

The following minimum parameters must be broadcast:

1. Airborne Position
2. Navigation Uncertainty Category - Position (NUCp) ≥ 5, or Navigation Integrity Category (NIC) ≥ 6
3. ICAO 24-Bit identifier
4. Flight ID (equivalent of ACID)
5. Pressure Altitude
6. Special Position Indicator (SPI)
7. Emergency Status

Automatic Dependent Surveillance - Broadcast *(cont.)*

Airborne Position

The GPS receiver, which must comply with Technical Standard Order (TSO) C-129, C145 or C146, generates position data with integrity. Reduced traffic separation is based on the coordinates provided by the aircraft, placing a high degree of reliance on the GPS data. To assure the integrity of the provided position, the GPS receiver provides a value for Horizontal Protection Limit (HPL). The transponder, using the Receiver Autonomous Integrity Monitoring (RAIM) algorithm, in turn calculates NUCp. (DO 260) or NIC (DO 260A). NUCp and NIC equate to a Radius of Containment (Rc) and provide assurance that separation can be applied safely.

The NUCp/NIC values range from 0-9 and 0-11 respectively. They are dynamic since the GPS constellation is constantly changing. Any detection of poor satellite geometry diminishes position integrity, resulting in a corresponding reduction of NUCp/NIC values. Ground stations will accept the position data incorporated in an ADS-B message with a NUCp value as low as 5 (0.5 NM Rc) or a minimum NIC of 6 (0.6 NM Rc). If the values fall below the required minima, the ground stations will automatically reject the ADS-B message and the target will be "coasted" on the controller display, indicating a loss of surveillance. The controller will advise the pilot "SURVEILLANCE SERVICE TERMINATED". Data collected to date from equipped aircraft shows that NUCp values in the Hudson Bay area are typically 6 or greater.

Avionics installations are required to be compliant with Transport Canada Advisory Circular (AC) 700-009. Non-compliant ADS-B avionics installations may provide ADS-B position information derived from the FMS or an IRS, but they can modify the original GPS position or impart a significant latency into the position report before it is transmitted. In these cases, there is no integrity associated with the reported position and extended squitter messages containing this position information are identified by a NUCp/NIC = 0. Aircraft compliance to AC 700-009 prevents these errors. Compliant aircraft are placed on an eligibility list derived from customers who have completed the avionics survey supplied by NAV CANADA. Only compliant aircraft, identified by the unique ICAO 24-Bit Identifier are displayed to the controller.

Pressure Altitude is provided by the onboard encoding altimeter.

Aircraft Identity: The ICAO 24-Bit aircraft identifier is transmitted with every message sent by the ADS-B avionics and is used to discriminate targets.

Flight ID is the Aircraft Identification (ACID), a four to seven character alphanumeric parameter entered by the pilot. Flight ID is used to pass the ADS-B target information to the controller's display and to correlate the filed flight plan information to the target. It is important that this field be correctly entered or ADS-B service may be denied.

Note: The way in which ADS-B avionics are integrated into the cockpit may prevent changing of Flight ID once airborne. Some avionics packages may be wired to a weight-on-wheels switch (WOW switch) that detects when the aircraft is airborne so that the Flight ID field is not editable after take-off.

NUCp / NIC is computed by the transponder from HPL (or HIL) provided by the GPS receiver and must be ≥ 5 for NUCp or ≥ 6 for NIC in order to be displayed to the controller.

Special Position Indicator is identical to the 'Squawk Ident' feature of a basic transponder and is used to positively identify an aircraft.

Emergency Flag: ADS-B incorporates a single emergency bit for the squawk codes 7500, 7600 and 7700. Thus when activated, the pilot will need to contact ATC to communicate the type of emergency.

Note: Flight ID, Special Position Indicator and the Emergency Flag are the only elements that can be modified by the flight crew.

Automatic Dependent Surveillance - Broadcast *(cont.)*

Ground Components

The ground portion of NAV CANADA's ADS-B system consists of an array of remote ground stations, target processors and ATC displays.

Remote Ground Stations

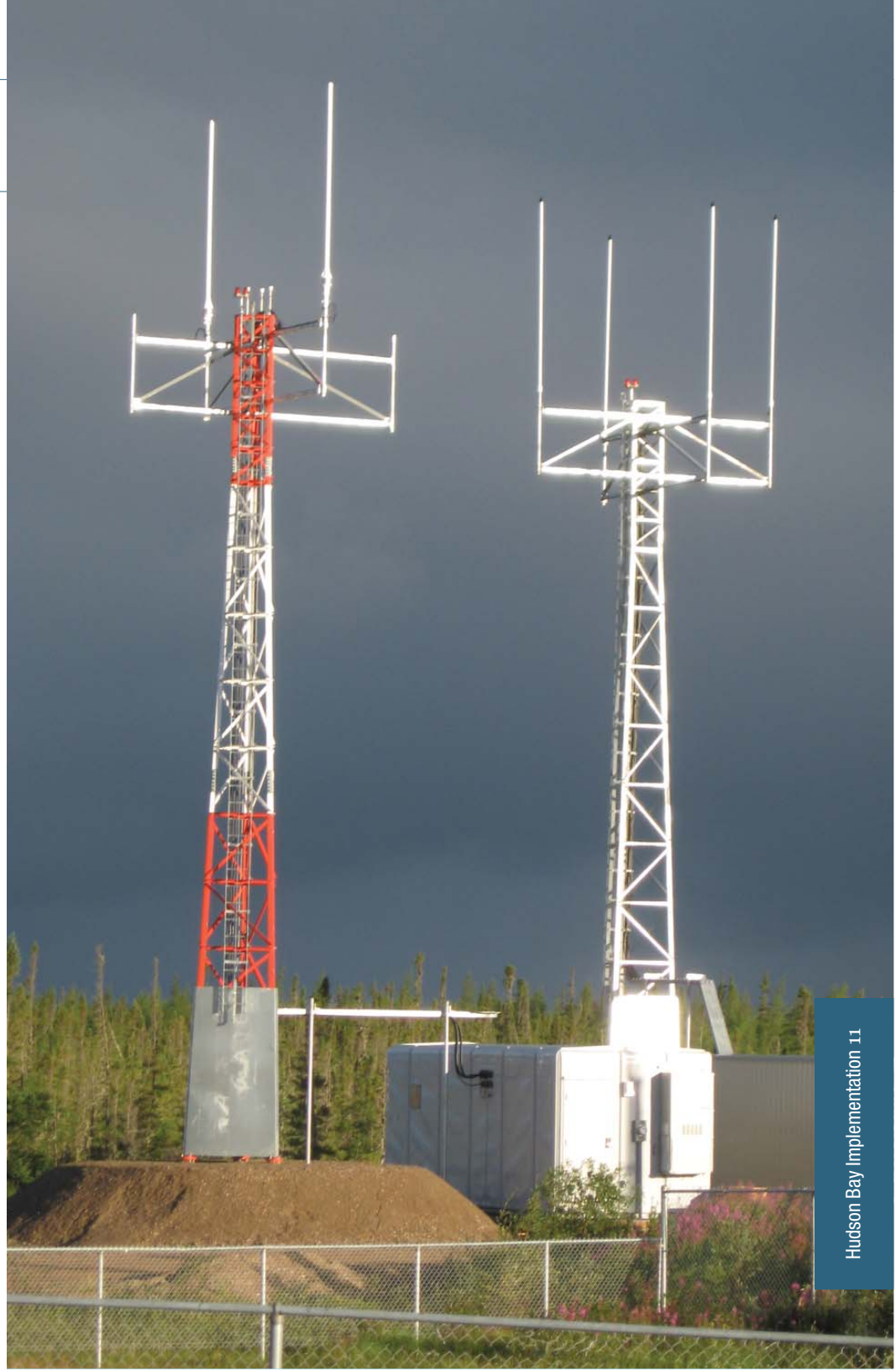
The remote ground stations are responsible for ADS-B signal detection and data transfer to the target processor located at the ACCs. Subsequent to the instantaneous detection of an airborne transmission, the ADS-B message is time-stamped and relayed with minimal delay (less than two seconds) to the appropriate ACC via land line or satellite data link.

ADS-B Target Processing

Once the ADS-B data is received from the remote ground stations, a target processor builds a track file based on the ICAO 24-Bit Identifier. The target processor uses subsequent target positions to determine velocity. This feature allows the target position to be predicted for short periods of time.

ATC Display Facility

The ATC display emulates that of a rotating radar display. At each update, new target information is provided to the display. Flight ID is used as the title for track information provided from the ADS-B target processor to the ATC display. This is why the correct entry of Flight ID is so important.



Operational Requirements

Prior to using the ADS-B service, operators should be familiar with the following aspects of ADS-B functionality from a pilot's perspective:

1. proper completion of the ICAO Flight Plan,
2. correct entry of ADS-B identifiers,
3. ADS-B phraseology through surveillance airspace, and
4. emergency procedures.

ICAO Flight Plan Completion

To date, there is no equipment suffix on the ICAO Flight Plan form to indicate specific ADS-B equipment. If the aircraft is equipped with approved and tested ADS-B equipment, a notification of ADS-B capability should be placed in Field 18 as RMK/ADSB.

ADS-B Flight Identifier Entry

ADS-B uses two means of identifying transmitting aircraft. The first is the aircraft Mode S address (also known as the ICAO 24-Bit Identifier). The second is the Flight Identification (FLTID), which is the equivalent of a call sign.

Aircraft Address Input

Each Mode S equipped aircraft has a unique address which consists of the ICAO 24-Bit code assigned by the State of Aircraft Registry. The code is entered into the Mode S transponder during installation and cannot be modified from the flight deck by pilots. The Mode S address must remain associated with the specific aircraft registration. This address is used by the target processor during ADS-B aircraft identification and track processing.

Flight Identification Input

Flight Identification is the equivalent of the Aircraft Identification (ACID), and is used in both ADS-B and Mode S SSR technology. Usually set by the flight crew, the maximum seven character Flight Identification can be entered through either the Transponder Control Panel (if present) or the FMS. The Flight ID enables the target on the pilot's display to be positively transferred to the ATC display and correlated with the filed flight plan information. To ensure proper functionality, the FLTID must match the ACID entered in Item 7 of the ICAO Flight Plan.

Note: Airline aircraft will use the three-letter ICAO airline code used in flight plans, not the two-letter IATA codes. Pilots should be aware that some aircraft do not allow changes to the FLTID once airborne. This feature stresses proper FLTID entry on the ground.

Emergency

Upon activation of an emergency code by the flight crew, a common emergency bit is sent through the ADS-B transmitter. Communication with ATC will be required to positively report the nature of the emergency.

ADS-B Phraseology

Flight through ADS-B airspace is similar to that of radar airspace. Pilots will not be advised they have entered ADS-B surveillance airspace from a radar coverage area, or that they have exited ADS-B surveillance airspace and entered a radar coverage area.

The following phraseology will be employed within ADS-B airspace:

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/SSR code) (track and altitude) (other information).	POINT-OUT (position) (identification) (track and altitude) (other information).
POINT-OUT APPROVED (Identification/SSR Code).	POINT-OUT APPROVED (Identification).
	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.

Human Factors

Workload

With the introduction of ADS-B, pilots can expect a small increase in workload. One additional task is the data entry of the assigned FLTID into the transponder/FMS and verification of its accuracy.

Note: When entering FLTID into the FMS, the first available spaces must be used.

Since ATC displays match the flight plan to FLTID, incorrect flight plan correlation will lead to ATC complications and possible termination of surveillance services and reversion to procedural separation. The FLTID consists of two possible formats, each with *seven character maximums*:

1. the ICAO designator followed by the flight number, (ACA5, MLV096, TGR0001), and
2. the registration marking of the aircraft (N6890DE, 9OHYT, CGSCV).

FLTID Entry into FMS / Transponder

Pilots must ensure that the FLTID entered into aircraft avionics is an EXACT replica of the FLTID written on the ICAO Flight Plan (Field 7) as these two parameters are correlated by ATC to link the aircraft on display to the appropriate flight plan. Here are two examples:

Air Canada Flight 45
Air Canada ICAO Assigned Registration: ACA
Flight Number: 45
IF entered on ICAO Flight Plan as: **ACA45**
THEN FLTID input by pilot will be: **A C A 4 5**, not A C A 0 4 5 0 or A C A 0 0 4 5

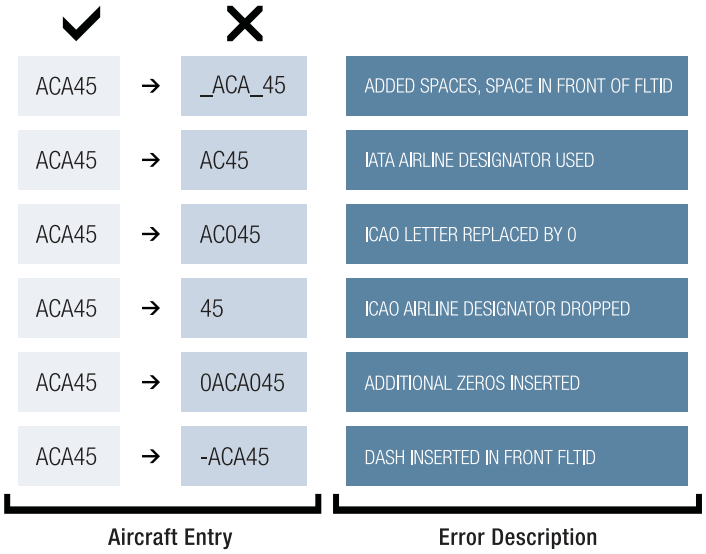
WestJet Flight 371
WestJet ICAO Assigned Registration: WJA
Flight Number: 371
IF entered on ICAO Flight Plan as: **WJA0371**
THEN FLTID input by pilot will be: **W J A 0 3 7 1**, not W J A 3 7 1 0 or W J 3 7 1 0

Important: FLTID entered should not have any leading zeros, hyphens, dashes or spaces added. Zeros only appear when part of the ICAO Flight Plan number, as shown in the WJA0371 example above.

Human Factors *(cont.)*

Many errors and discrepancies can arise during FLTID entry due to confusion of FLTID format. The following chart summarizes potential errors that might arise:

ICAO Assigned Registration: ACA
Flight Number: 45
ICAO Flight Plan Entry: ACA45



Standards and Regulations

Standards and regulations that apply to aircraft operating in ADS-B airspace in Canada are available in the *Transport Canada Advisory Circular (AC) No. 700-009 Issue 1*. The requirements have been drawn from the European Aviation Safety Agency (EASA) *Acceptable Means of Compliance (AMC) 20-24*. Transport Canada can be contacted for further inquires regarding technical and operational approval.

The following URL will bring you to the **Transport Canada ADS-B Advisory Circular:** *http://www.tc.gc.ca/civilaviation/IMSdoc/ACs/700/700-009.htm*

Supporting Documentation

The following documents can be referenced for further information on ADS-B requirements and certification:

- **EASA AMC 20-24:** *http://www.easa.eu.int/getpdf.php?file=ws_prod/g/doc/Agency_Mesures/Agency_Decisions/2008/Annex%20II%20-%20AMC%2020-24.pdf*
- **Transport Canada ADS-B Advisory Circular:** *http://www.tc.gc.ca/civilaviation/IMSdoc/ACs/700/700-009.htm*
- **NAV CANADA ADS-B Advisory Information Circular of August 28, 2008:** *http://www.navcanada.ca/ContentDefinitionFiles/Publications/AeronauticalInfoProducts/AIP/Current/PDF/EN/part_5_aic/5aic_eng.pdf#section_34_08*
- **RTCA Transponder Certification:** *http://www.rtca.org*

Contacts

Transport Canada:
Chief, Airspace Standards
and Procedures
613-998-9855

NAV CANADA Customer Service:
1-800-876-4693-4
(within North America
disregard the last digit)
service@navcanada.ca

Final Checklist – Are You Ready?

Review the items on the following list to ensure that you are prepared for flight through ADS-B airspace:

Background Knowledge

- ✔ ADS-B Technical Systems and Operations
  - Position Integrity
  - ADS-B message contents/sources
- ✔ Surveillance airspace coverage and limitations
- ✔ Proper ICAO flight plan completion

Operational Knowledge

- ✔ Proper FLTID input and common errors associated with input
- ✔ Limitations of the ADS-B equipment during operations
  - FLTID adjustment during flight
  - Disabling ADS-B transmissions without turning off SSR
- ✔ ADS-B phraseology
- ✔ Operations prior, through and after airspace penetration
- ✔ Emergency limitations
  - Flight crew knows how to inform ATC of the emergency they are experiencing: 7700, 7600, 7500

Acronyms

AC	Advisory Circular (Transport Canada)
ACC	Area Control Centre
ACID	Aircraft Identification
ADS-B	Automatic Dependent Surveillance-Broadcast
AIC	Aeronautical Information Circular
AME	Aircraft Maintenance Engineer
AMC	Acceptable Means of Compliance
ANS	Air Navigation Service
ATC	Air Traffic Control
EASA	European Aviation Safety Agency
ES	Extended Squitter
FL	Flight Level
FLTID	Flight Identification
FMS	Flight Management System
GPS	Global Positioning System
HPL	Horizontal Protection Limit (aka HIL – Horizontal Integrity Limit)
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IRS	Inertial Reference System
NUCp	Navigation Uncertainty Category - Position
NIC	Navigation Integrity Category
NRA	Non-Radar Airspace
RAIM	Receiver Autonomous Integrity Monitoring
Rc	Radius of Containment
RTCA	RTCA Inc. (Standards Body)
SPI	Special Position Indicator (IDENT feature)
SSR	Secondary Surveillance Radar
TSO	Technical Standard Order
URL	Uniform Resource Locator

The Future of ADS-B

NAV CANADA plans to install ADS-B initially in areas where radar services are not offered, mainly in Northern Canada. NAV CANADA has developed a phased approach to the implementation of ADS-B.

Phase 1 - Hudson Bay Implementation:
Services will commence in early 2009.

Phase 2 - North Eastern Coast Implementation:
Coverage on the North Eastern shore of Canada. Work is in progress to receive authority and establish sites to provide optimal ADS-B surveillance coverage in the portion of the North Atlantic (NAT) airspace over Greenland where NAV CANADA provides oceanic control. Initial benefits in this area could begin accruing as early as the start of 2010, using early climb clearances for westbound NAT traffic. The details regarding service in this airspace will be addressed in consultation with customers.

A proposed **Phase Three** would see the implementation of ADS-B in Northern Canada. With this phase complete, Canadian airspace would be fully covered with radar and/or surveillance.