COM – COMMUNICATIONS

1.0 GENERAL INFORMATION

1.1 General

This section contains a description of the radio navigation aids and communication facilities available in Canada and in the Gander Oceanic Control Area.

1.2 Responsible Authority

Enquiries relating to regulations and standards for communication, navigation, surveillance (CNS) and air traffic management (ATM) systems in Canada should be addressed to:

Aerodrome and Air Navigation Standards (AARTA)
Transport Canada
Ottawa ON KIA 0N8

Tel.: 613-998-9855

Fax: 613-954-1602

E-mail: .... *ron.carter@tc.gc.ca*

1.3 Provision of Services

1.3.1 NAV CANADA

NAV CANADA is responsible for the installation, maintenance and operation of the majority of aeronautical telecommunication systems in Canada (see GEN 1.1 for address). This includes the operation of a network of area control centres, terminal control units, airport control towers and flight service stations used for the provision of air traffic services. The types of services provided by these facilities are described in RAC 1.1.

1.3.2 Canadian Base Operators (CBO)

At Portage la Prairie/Southport Airport, Manitoba, Canadian Base Operators is responsible for the installation and operation of the aeronautical telecommunication systems. Midwest ATC Canada is responsible for the provision of air traffic services. Enquiries should be addressed to:

Canadian Base Operators (CBO)
P.O. Box 241
Southport MB R0H 1N0

Tel.: 204-428-2401

Fax: 204-428-2419

1.3.3 Other Telecommunication System Operators

A number of CNS/ATM systems throughout Canada are owned and operated by individuals, companies or government. See COM 3.1.1 for details.

2.0 LOCATION INDICATORS

2.1 General

Responsibility for Canadian location indicators rests with the Aeronautical Information Services Division of NAV CANADA. Location indicators are listed and updated every 56 days in the CFS.

3.0 RADIO NAVIGATION AIDS

3.1 General

The following types of radio navigation and surveillance systems exist in Canada, although signal coverage cannot be guaranteed in all parts of the Canadian domestic airspace:

- distance measuring equipment (DME)
- en route and terminal radar
- instrument landing system (ILS)
- localizer (LOC)
- global navigation satellite system (GNSS)
- non-directional beacon (NDB)
- precision approach radar (PAR)
- tactical air navigation (TACAN)
- VHF direction finder (VDF)
- VHF omnidirectional range (VOR)
- VHF omnidirectional range and
- tactical air navigation (VORTAC).

A complete list of all Canadian NDBs, VORs, VORTACs and TACANs is contained in the CFS.

3.1.1 Non-NAV CANADA Navigation Aids

Some non-NAV CANADA owned navigation aids (NAVAIDs) are shown on aviation charts and maps. They are depicted as ‘private’, but must meet ICAO standards as required by CAR 802.02.

The status of non-NAV CANADA NAVAIDs used in instrument approaches is normally provided through the NOTAM system.

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3.1.2 Interference with Aircraft Navigational Equipment

Some portable electronic devices can interfere with aircraft communications and radio navigation systems. The radiation produced by FM radio receivers and television broadcast receivers falls within the ILS localizer and VOR frequency band, while the radiation produced by the AM radio receivers falls into the frequency range of ADF receivers. This radiation could interfere with the correct operation of ILS, VOR and ADF equipment. Pilots are therefore cautioned against permitting the operation of any portable electronic device on board their aircraft during takeoff, approach and landing. See COM Annex B for more information.

After extensive testing, Industry Canada (IC) has concluded that the switching on or use of hand-held electronic calculators can cause interference to airborne ADF equipment in the 200 to 450 kHz frequency range when the calculator is held or positioned within 5 feet of the loop or sense antenna, or lead-in cable installation of the system. Pilots, especially of small aircraft and helicopters, are therefore cautioned against allowing the operation of calculators on board their aircraft while airborne.

3.2 Removal of Identification

During periods of routine or emergency maintenance, the identification is removed from NDBs, VORs, DMEs, TACANs, and ILSs. The removal of this identification warns pilots that the facility may be unreliable even though it transmits. Under these circumstances the facility should not be used. Similarly, prior to commissioning, a new facility (particularly VOR or ILS) may transmit with or without identification. In such cases, the facility is advertised as being 'ON TEST' and it should not be used for navigation.

3.3 Accuracy, Availability and Integrity of Navigation Aids

Aviation navigation systems must meet stringent accuracy, availability and integrity requirements as specified in ICAO Annex 10. These terms may be defined as follows:

Accuracy – conformance with the ICAO standards, i.e., course guidance for the intended operation, whether it be en route navigation, non-precision approach or precision approach systems, must meet the required standards;

Availability – the proportion of time that the system is available for operational use versus the proportion of time that it is not available; and

Integrity – the ability of the systems to provide a warning if it is not providing service or providing false information, e.g., warning flags on ILS and VOR cockpit displays.

Operators of aeronautical telecommunications systems shall ensure that they meet these stringent standards. This may be achieved through:

(a) *electronic means* – the provision of alternate or redundant circuitry for the electronic elements of the NAVAID;

(b) *emergency back-up power* – all precision approach aids are provided with emergency power and all TACANs for which NAV CANADA has responsibility are provided with emergency power.

Other NAVAIDs provided with emergency power are:
(i) *within terminal RADAR coverage* – one primary terminal NAVAID, and
(ii) *outside of RADAR coverage* – all NAVAIDs which are used for airways or air routes and one primary NAVAID at each aerodrome with a published instrument approach.

(c) *Monitoring* – is accomplished in three ways:
(i) *Executive monitoring* is an electronic means in which the system checks its critical parameters and in the event of an out of tolerance condition, either changes to an auxiliary back-up equipment or shuts the system down if there is no redundancy or if the redundant circuit is also failed. This monitoring is continuous.
(ii) *Status monitoring* is the automatic notification, either to the maintenance centre or to an operational position, that the system has taken executive action and the navigation system is off-the-air. Many NAVAIDs are not continuously status–monitored.
(iii) *Pilot monitoring* is when pilots tune and identify NAVAIDs prior to use and monitor the indicator displays to ensure they are appropriate. When flying instrument approach procedures, particularly NDB approaches, it is recommended that pilots aurally monitor the NAVAID identifier.

(d) *Flight Inspection* – NAVAIDs are flight inspected by specially equipped aircraft on a regular basis to ensure that standards are met; and

(e) *NOTAM* – when NAVAIDs are identified as not meeting the required performance standard, NOTAM are issued to advise pilots of the deficiency.

The end result of these combined efforts is a safe and reliable air navigation system which meets the established standards. Nevertheless, prior to using any NAVAID, pilots should:

(a) check NOTAM prior to flight for information on NAVAID outages. These may include scheduled outages for maintenance or calibration. For remote aerodromes, or aerodromes with Community Aerodrome Radio Stations (CARS), it is recommended that pilots contact the CARS observer/communicator or the aerodrome operator prior to flight to determine the condition of the aerodrome, availability of services, and the status of NAVAIDs;

(b) ensure that on board navigation receivers are properly tuned and that the NAVAID identifier is aurally confirmed; and

(c) visually confirm that the appropriate indicator displays are presented.

3.4 Pilot Reporting of Abnormal Operation of Navigation Aids

It is the responsibility of pilots to report any NAVAID failure or abnormality to the appropriate ATS facility. If it is not practical to report while airborne, a report should be filed after landing.

Reports should contain:

(a) the nature of the abnormal operation detected by the pilot, and the approximate magnitude and direction of any course shift (if applicable). The magnitude may be either in miles or degrees from the published bearing;

(b) the approximate distance of the aircraft from the NAVAID when the observation was made; and

(c) the time and date of the observation.

3.5 VHF Omnidirectional Range

The VHF Omnidirectional Range (VOR) is a ground-based, short distance NAVAID which provides continuous azimuth information in the form of 360 usable radials to or from a station. It is the basis for the VHF airway structure. It is also used for VOR non-precision instrument approaches.

(a) *Frequency Band*: The frequency range 108.1 to 117.95 MHz is assigned to VORs. Frequency assignment has been in 0.1 MHz (100 kHz) increments. However, in some areas the number and proximity of VOR installations are such that existing spacing does not allow for a sufficient number of frequencies. In these areas additional channels will be obtained by reducing the spacing to 0.05 MHz (50 kHz).

The implication for users is that, in airspace serviced solely by VOR, aircraft equipped with VOR receivers which cannot be tuned to two decimal places (e.g., 115.25 MHz) may not be able to operate under IFR. Of course, RNAV, where approved for use, may provide an alternative means.

Receivers with integrated DME (i.e., VOR/DME receivers) normally select the associated DME "Y" channel automatically, while stand alone DME receivers display the "X" and "Y" channels separately.

(b) *Range*: VOR reception is subject to line-of-sight restrictions and range varies with aircraft altitude. Subject to shadow effect, reception at an altitude of 1 500 feet AGL is about 50 NM. Aircraft operating above 30 000 feet normally receive VOR at a distance of 150 NM or more.

(c) *Voice Communication and Identification*: A VOR may be provided with a voice feature. Those without voice are identified on the aeronautical charts and in CFS. Identification is accomplished by means of a three-letter location indicator keyed in Morse code at regular 7.5 second intervals.

(d) *VOR Courses*: Theoretically, an infinite number of courses (radials) are radiated from a VOR station; however, in actual practice, 360° are usable under optimum conditions. The accuracy of course alignment for published VOR radials is ±3°. Unpublished radials are not required to meet a particular standard of accuracy and may be affected by siting difficulties. Any significant anomalies in these unpublished radials from VOR serving an aerodrome will be published in the CFS.

3.5.1 VOR Receiver Checks

In areas where RNAV routes have not been published, VOR remains the primary NAVAID for use in Canada. It is important that the accuracy of the aircraft equipment be checked in accordance with principles of good airmanship and aviation safety.

While standard avionics maintenance practices are used for checking aircraft VOR receivers, dual VOR equipment may be checked by tuning both sets to the same VOR facility and noting the indicated bearings to that station. A difference greater than 4° between the aircraft's two VOR receivers indicates that one of the aircraft's receivers may be beyond acceptable tolerance. In such circumstances, the cause of the error should be investigated and, if necessary, corrected before the equipment is used for an IFR flight.

3.5.2 VOR Check Point

VOR check point signs indicate a location on the aerodrome manoeuvring surface where there is a sufficiently strong VOR signal to check VOR equipment against the designated radial. The indicated radial should be within 4° of the posted radial and the DME should be within 0.5 NM of the posted distance. If beyond this tolerance, the cause of the error should be corrected before the equipment is used for IFR flight.

3.5.3 Airborne VOR Check

Aircraft VOR equipment may also be checked while airborne by flying over a landmark located on a published radial and noting the indicated radial. Equipment which varies more than ±6˚ from the published radial should not be used for IFR navigation.

3.6 NDB

NDBs combine a transmitter with an antenna system providing a non-directional radiation pattern within the low frequency (LF) and medium frequency (MF) bands of 190–415 kHz and 510–535 kHz. NDBs are the basis of the LF/MF airway and air route system. In addition, they function as marker beacons for ILS as well as non-precision approach aids for NDB instrument approaches.

(a) *Identification*: Identification consists of two- or three-letter or number indicators keyed in Morse code at regular intervals. (Private NDBs consist of a letter/number combination.)

(b) *Voice Feature*: Voice transmissions can be made from NDBs, unless otherwise indicated on the aeronautical charts and in the CFS.

(c) *Classification*: NDBs are classified by high, medium or low power output as follows:
- "H" power output 2 000 W or more;
- "M" power output 50 W to less than 2 000 W; or
- "L" power output less than 50 W.

(d) *Accuracy*: NDB systems are flight checked to an accuracy of at least ±5˚ for an approach and ±10˚ for enroute. However, much larger errors are possible due to propagation disturbances caused by sunrise or sunset, reflected signals from high terrain, refraction of signals crossing shorelines at less than 30˚ and electrical storms.

3.7 Distance Measuring Equipment

Distance Measuring Equipment (DME) functions by means of two-way transmissions of signals between the aircraft and the DME site. Paired pulses at a specific spacing are sent out from the aircraft and are received by the ground station. The ground station then transmits paired pulses back to the aircraft at the same pulse spacing but on a different frequency. The time required for the round trip of this signal exchange is measured in the airborne DME unit and is translated into distance (NM) from the aircraft to the ground station. Distance information received from DME equipment is slant range distance and not actual horizontal distance. Accuracy of the DME system is within ±0.5 NM or 3% of the distance, whichever is greater.

DME is normally collocated with VOR installations (VOR/DME) and may be collocated with an ILS or with localizers for LOC approaches. Where they can be justified, DME are also being collocated with NDBs to provide improved navigation capability. For collocated sites, a single keyer is used to key both the VOR/ILS/localizer and the DME with the three-letter location indicator. The VOR/ILS/localizer transmits three consecutive indicator codes in a medium pitch of 1 020 Hz followed by a single DME indicator code transmitted on the DME frequency (UHF) and modulated at a slightly higher pitch of 1 350 Hz. In the event that one system should fail, the identification of the other will be transmitted continuously at approximately 7.5 second intervals. Independent DMEs and those collocated with NDBs normally have a two-letter or a letter-number indicator.

The DME system is in the UHF frequency band and therefore is limited to line of sight reception with a range similar to that of a VOR. The DME frequency is "paired" with VOR and localizer frequencies. As a result, the receiving equipment in most aircraft provide automatic DME selection through a coupled VOR/ILS receiver. Otherwise, the DME receiver must be selected to the "paired" VOR or localizer frequency. Distance information from a TACAN facility can be obtained by selecting the appropriate paired VOR frequency. (In that case, only DME information is being received, any apparent radial information must be ignored.) The DME paired frequency and channel number are published in the CFS and on the Enroute IFR charts in the navigation data box for all TACAN and DME installations.

By convention, those frequencies requiring only one decimal place (e.g., 110.3 MHz) are known as "X" channels and those associated with two decimal places are designated as "Y" channels (e.g., 112.45 MHz)

3.8 Tactical Air Navigation

Tactical Air Navigation (TACAN) is a NAVAID used primarily by the military for en route, non-precision approaches and other military applications. It provides azimuth in the form of radials, and slant distance in NM from the ground station. The system operates in the UHF range with the frequencies identified by channel number. There are 126 channels.

TACAN users may obtain distance information from a DME installation by selecting their receiver to the TACAN channel that is "paired" with the VOR frequency. This TACAN "paired" channel number is published in the CFS for every VOR/DME facility. (Pilots are cautioned, however, that only DME information is being received. Any apparent radial information obtained through a coupled VOR receiver can only be false signals.)

3.9 VHF Omnidirectional Range and Tactical Air Navigation

A number of TACANs, supplied by DND, are collocated with VORs to form facilities called VORTACs.

This facility provides VOR azimuth, TACAN azimuth and slant distance from the site. Although it consists of more than one component, incorporates more than one operating frequency, and uses more than one antenna system, a VORTAC is considered to be a single NAVAID. Components of a VORTAC operate simultaneously on "paired" frequencies so that aircraft DME receivers, when selected to the VOR frequency, will obtain distance information from the DME component of the TACAN. An aircraft must be equipped with a VOR receiver to use VOR, DME equipment to use DME, or TACAN equipment to use TACAN (azimuth and DME).

3.10 VHF Direction Finding Equipment

VHF direction finding (VDF) equipment is installed at a number of FSSs and airport control towers. VDF normally operates on six pre-selected frequencies in the 115 to 144 MHz range, which are listed in the CFS entry for aerodromes where the equipment is installed. Information displayed to the VDF operator (either an airport controller or a flight service specialist) on a numerical readout gives a visual indication of the bearing of an aircraft from the VDF site. This is based on the radio transmission received from the aircraft, thus giving the VDF operator a means of providing bearing or heading information to pilots requesting the service (see RAC 1.6).

3.11 Localizer

A localizer without glide path guidance may be installed at some locations to provide positive track guidance during an approach. These aids may have a back-course associated with them. A cautionary note will be published on the approach plate whenever the localizer alignment exceeds 3˚ of the runway heading. No note will be published if the alignment is 3˚ or less.

Localizers operate in the 108.1 to 111.9 MHz frequency range and are identified by a three-letter indicator. Localizer alignment exceeding 3˚ of the runway heading will have an "X" as the first letter of the indicator, whereas localizers and back-courses with an alignment of 3˚ or less will have an "I" as the first letter.

The technical characteristics of this localizer are the same as described for the ILS localizer in COM 3.12.2.

3.12 ILS

At present, the ILS is the primary international non-visual precision approach system approved by ICAO.

The ILS is designed to provide an aircraft with a precision final approach with horizontal and vertical guidance to the runway. The ground equipment consists of a localizer, a glide path transmitter, as well as an NDB, a DME fix or an RNAV fix to denote the FAF. See Figure 3.2 for a typical ILS installation.

3.12.1 Caution—Use of ILS Localizers

(a) *Localizer Coverage and Integrity*: The coverage and validity of ILS localizer signals are regularly confirmed by flight inspection within 35° of either side of a front- or back-course nominal approach path to a distance of 10 NM, and through 10° of either side of a front- or back-course nominal approach path to a distance of 18 NM (see Figure 3.1).

(b) *Low Clearance Indications*: No problems with front and back courses have been observed within 6° of the course centreline. However, it has been found that failure of certain elements of the multi-element localizer antenna array systems can cause false courses or low clearances* beyond 6° from the front- or back-course centreline that are not detected by the localizer monitoring system. This could result in a premature cockpit indication of approaching or intercepting an on-course centreline. For this reason, a coupled approach should not be initiated until the aircraft is established within 6° of the localizer centreline. It is also essential to confirm the localizer on-course indication by reference to aircraft heading and other NAVAIDs (such as an ADF bearing or RNAV track) before commencing final descent. Any abnormal indications experienced within 35° of the published front- or back-course centreline of an ILS localizer should be reported immediately to the appropriate ATS facility.

*A low clearance occurs whenever there is less than full-scale deflection of the omnibearing selector or course deviation indicator (CDI) at a position where a full-scale deflection should be displayed outside of 6° from the localizer centerline.

(c) *Localizer False Course*: False course captures may occur when the pilot prematurely selects APPROACH MODE from either heading (HDG) or lateral navigation (LNAV) MODE. Some ILS receivers produce lower than expected course deviation outputs in the presence of high modulation levels of the localizer radiated signal. This can occur even when both the ground transmitter and the airborne receiver meet their respective performance requirements. The reduced course deviation can, in turn, trigger a false course capture in the automatic flight control system (AFCS). False course captures can occur at azimuths anywhere from 6° to 35°, but are most likely to occur in the vicinity of 6° to 10° azimuth from the published localizer course. A false capture is deemed to have occurred when the automatic flight control guidance system (AFCGS) allows the LOC to switch from ARMED to CAPTURED even though the omnibearing selector or CDI has not moved and is still at full-scale deflection.

In order to minimize the possibility of a false course capture during an ILS approach, pilots should use raw data sources to ensure that the aircraft is within 6° of the correct localizer course prior to initiating a coupled approach. The following cockpit procedures are recommended:

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(i) APPROACH MODE should not be selected until the aircraft is within 18 NM of the threshold and is positioned within 6° of the inbound ILS course; and
(ii) pilots should:
(a) ensure that the ADF bearing (associated with the appropriate NDB site) or RNAV track for the runway is monitored for correct orientation;
(b) be aware when the raw data indicates that the aircraft is approaching and established on the correct course; and
(c) be aware that, should a false course capture occur, it will be necessary to deselect and re-arm APPROACH MODE in order to achieve a successful coupled approach on the correct localizer course.

(d) *Electromagnetic Interference (EMI)*: The effect of EMI, particularly on ILS localizer system integrity, is becoming increasingly significant. In built-up areas, power transformer stations, industrial activity and broadcast transmitters have been known to generate interference that affects localizer receivers. The effect is difficult to quantify as the interference may be transitory, and certain localizer receivers are more susceptible than others to EMI. New ICAO standards for localizer and VOR receivers took effect on January 1, 1998. The increased immunity to FM broadcast interference may alleviate the situation once avionics are available. However, until new avionics are installed, operators may face increased interference and restricted operations in some areas, especially outside North America. In the interim, pilots must be aware, and compensating safety measures must be used. Unless the interference is of unusual intensity, or a very susceptible receiver is being used, the interference is not likely to cause any erroneous readings while the aircraft is flown within the area shown in Figure 3.1. If the localizer goes off the air, the "off" flag may remain out of sight or the flag and course deviation indicator may give erratic or erroneous indications. It is even possible that normal on-course cockpit indications may continue. Under normal circumstances, ATS will advise pilots conducting an approach if there is equipment failure.

(e) *Automatic Landing (Autoland) Operations*: It has been common practice for operators of aircraft that are appropriately equipped and certified to conduct AFCGS autoland (CAT III) operations on CAT II/III facilities when weather conditions are above CAT I minima to satisfy maintenance, training or reliability program requirements. To achieve the necessary autoland rate, a portion of these autolands are also being conducted on runways that are approved for CAT I operations only.

The successful outcome of any AFCGS autoland depends on the performance of the aircraft's AFCGS and the performance of the ILS localizer and glide path signals. The course structure and the integrity of an ILS can be compromised when protection of the ILS critical areas cannot be assured. The localizer is particularly sensitive due to its larger signal volume in the aerodrome area. Surface and airborne traffic as well as stationary vehicles that are crossing or parked in these critical areas can create a deflection in, or a disturbance to, the ILS signal. The AFCGS will respond to this interference in a manner dependent upon the effect the interference has on the ILS signal characteristics and the control methods of the AFCGS. The following elements provide sufficient evidence that extreme caution must be exercised during these operations: observed AFCGS responses to ILS interference; reported aircraft lateral flight path deviations; aircraft pitch-up or pitch-down in response to traffic in front of the glide path antenna; and/or hard landings during autoland operations conducted on CAT II, CAT III, or CAT I ILS systems without the requisite low visibility procedures.

The commissioning, periodic flight inspection, and maintenance of the ILS facility serving a CAT I or CAT II runway include analysis of the ILS localizer performance past the runway threshold and along the runway to point echo (2000 ft from the rollout end of the runway). Glide path signal quality is inspected and calibrated to support the minima associated with the category of operation. CAT I and II ILS facilities have the signal characteristics to support AFCGS operations to CAT I and II minima, as applicable, but may not have the requisite signal characteristics to support autoland operations. Several CAT I facilities are known to exhibit very poor glide path signal qualities (below minima) in areas where it is assumed that the pilot would maintain visual reference and that these poor signal characteristics would therefore have no bearing on the approach facility's status. NAV CANADA has posted graphs for localizer performance that are updated on an annual basis after inspections are completed. These graphs show the performance of the localizer along the approach and runway, with the protected critical areas, and are available from NAV CANADA Flight Operations.

The commissioning, periodic flight inspection, and maintenance of the ILS facility serving a CAT III runway include an analysis of the ILS localizer signal through the rollout to confirm that the ILS facility will support CAT III operations. However, this signal is protected by aerodrome and ATC only when low visibility procedures are in effect at that aerodrome. In general, the localizer critical area for CAT III operations extends along the runway, approximately 250 ft on either side of the runway centreline. CAT III critical area dimensions are based on the assumption that the entire longitudinal axis of any aircraft or vehicle is clear of this area.

Flight crews must recognize that changes in the ILS signal quality may occur rapidly and without warning from the ILS monitor equipment. Furthermore, flight crews are reminded to exercise extreme caution whenever ILS signals are used beyond the minima specified in the approach procedure and when conducting autolands on any category of ILS when the critical area protection is not assured by ATC. Pilots must be prepared to immediately disconnect the autopilot and take appropriate action should unsatisfactory AFCGS performance occur during these operations. (See AIR 2.15 for more information.)

(f) *Glide Path False Course*: Glide path installations generate a radiated signal resulting in a normal glide path angle of 3° (it can currently be anywhere from 2.5° to 3.5° for an unrestricted ILS). The glide path angle is set to cross the runway thresholds at a nominal 50 ft. The normal antenna pattern of glide path installations generates a side-lobe. The side-lobe pattern produces a false glide path angle at two and three times the set angle (e.g. at 6 °and 9° for a normal 3° glide path angle).

ATC procedures in terminal areas are designed to maintain aircraft at an altitude providing a normal rate of descent and a suitable position to capture the published glide path signal. Following the instrument procedures carefully will ensure an approach with a stable rate of descent and completely avoid the false glide path generated at two and three times the set angle. Failure to adhere to instrument procedures (e.g. remaining at a higher than published altitude) could result in positioning the aircraft in a false glide path radiated lobe.

In order to minimize the possibility of false glide path capture during an ILS approach, pilots should verify the rate of descent and the altitude at the FAF to ensure that the aircraft is on the published glide path.

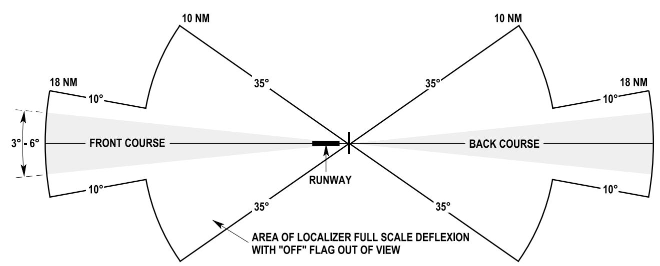
3.12.2 Localizer

The localizer operates within the frequency range of 108.1 to 111.9 MHz and provides the pilot with course guidance to the runway centreline. When the localizer is used with the glide slope, it is called the "front course." It is adjusted to provide an angular width between 3° and 6°. Normally, the width is 5°, which results in full deflection of the track bar at 2.5°. The transmitter antenna array is located at the far end of the runway from the approach. The localizer may be offset up to 3° from the runway heading and still publish as a straight-in procedure ; however, the amount of offset will be published as a cautionary note on the approach plate.

At a few aerodromes, a localizer "back course" is also provided. This allows for a non-precision approach in the opposite direction to a front course approach without glide path information. Note that not all ILS localizers radiate a usable back course signal.

The normal reliable coverage of ILS localizers is 18 NM within 10° of either side of the course centreline and 10 NM within 35° of the course centreline for both front and back courses.

Figure 3.1



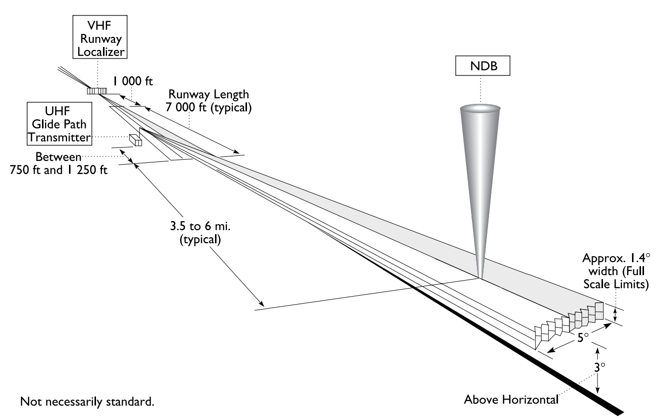
Identification for both the localizer and glide path is transmitted on the localizer frequency in the form of a two-letter or letter-number indicator preceded by the letter "I" (e.g. IOW).

3.12.3 Glide Path

The glide path transmitter operates within the frequency range of 329.3 to 335.0 MHz. The frequency is paired with the associated localizer frequency in accordance with ICAO standards. The glide path is normally adjusted to an approach angle of 3° and a beam width of 1.4°. There is no usable back course. The antenna array is located approximately 1 000 ft from the approach end of the runway and offset approximately 400 ft from the runway centreline. As the glide path is formed by reflecting the transmitted signal off the ground, the beam-forming area in front of the glide path antenna can be negatively affected by heavy snow buildup. Airports have snow-clearing plans in effect for this area as the snow must remain below the allowable design depth for proper glide path operation.

At some of the larger airports, an ILS is installed at each end of a runway. Consequently, a front course approach may be made to either end of the runway. The two systems are interlocked so that only one ILS can operate at any time.

Figure 3.2 — Typical ILS Installation



Not necessarily standard.

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3.12.4 NDBs

Low-powered NDB transmitters are sometimes located on the localizer (front and back course), 3.5 to 6 mi. from the runway threshold. If it is not possible to install an NDB, a DME fix or RNAV fix may be used instead to form the FAF. In a number of cases, an en-route NDB is located on a localizer so that it may serve as a terminal as well as an en-route facility. As a general rule, these NDBs transmit a two- or three-letter indicator. The FAF provides a fix to which the pilot can navigate for the transition to the ILS.

3.12.5 ILS/DME, ILS/RNAV

At some locations, it is not practicable to install an NDB because of terrain or costs. In such cases, DME provides distance information to define the IAF and MAP. In some locations, VOR/DME which are available either on the airport, or aligned with the appropriate runway, will be used to provide distance information for the transition to the ILS.

3.12.6 ILS Categories

(a) *Operational CAT I*: Operation down to a minima of 200 ft DH and RVR 2 600 ft with a high probability of success. (When RVR is not available, 1/2 SM ground visibility is substituted.)

(b) *Operational CAT II*: Operation down to a minima below 200 ft DH and RVR 2 600 ft, to as low as 100 ft DH and RVR 1 200 ft, with a high probability of success.

(c) *Operational CAT III*: CAT III minima will be prescribed in the carrier's operating specifications, in the operator's operations manual, or in CAP.

3.12.7 CAT II/III ILS

CAT II/III ILS enable pilots to conduct instrument approaches to lower weather minima by using special equipment and procedures in the approaching aircraft and at the airport.

The following airport systems must be fully serviceable to meet CAT II/III standards:

(a) *Airport Lighting*: a lighting system which includes:
- approach lights
- runway threshold lights
- touchdown zone lights
- centreline lights
- runway edge lights
- runway end lights
- all stop bars and lead-on lights
- essential taxiway lights

(b) *ILS Components*: including:
- localizer
- glide path
- NDB, DME or RNAV fix

(c) *RVR Equipment*: for CAT II operations, two RVRs: one located adjacent to the runway threshold (touchdown or RVR A), and one located adjacent to the runway mid-point (mid-point or RVR B). For CAT III operations, three RVRs: one located adjacent to the runway threshold (touchdown or RVR A), one located adjacent to the runway mid-point (mid-point or RVR B), and one located at the rollout end (rollout or RVR C) of the runway (ref. ICAO recommendation Annex III, para 4.7.2).

(d) *Power Source*: Airport emergency power (primary electrical source for all essential system elements), commercial power available within one second as backup.

The tower controller will determine the suitability for CAT II/III operations. Complete information regarding CAT II/III operations is found in the Manual of All Weather Operations (Categories II and III) (TP 1490E).

3.13 RADAR

The use of radar increases airspace utilization by allowing ATC to reduce separation between aircraft. In addition, radar permits an expansion of flight information services such as traffic information and navigation assistance. Radar is also used by AES meteorological staff for locating and defining storm areas and for tracking airborne equipment to determine upper winds, etc.

There are two types of radar systems currently in use: *Primary Surveillance Radar* (PSR) and *Secondary Surveillance Radar* (SSR). PSR determines the position (range and azimuth) of contacts (aircraft and weather) by measuring and displaying reflected radio frequency signals from the contacts. It does not rely on information transmitted from the aircraft. SSR relies on measurement of the time interval between the interrogation and reply by an airborne transponder to determine aircraft range. The instantaneous direction of the antenna determines contact azimuth.

SSR will provide neither a position for aircraft without operating transponders, nor will it locate weather. However, SSR offers significant operational advantages to ATC, such as increased range, positive identification and aircraft altitude, when the aircraft has an altitude encoding transponder.

Radar is currently in use for the following functions:

(a) *En Route and Terminal Control*: SSR is the main source of en route (airways) information. Several locations have "stand alone" SSR. SSR is a long-range radar in the +200 NM range transmitting on 1030 MHz and receiving the transponder reply on 1090 MHz.

In general, SSR is complemented by the shorter range PSR for terminal operations. The radar types predominantly in use are:

(i) *Terminal surveillance radar (TSR)*, which consists of:
- *primary surveillance radar (PSR)*—a short-range

radar (80 NM) operating on 1250 to 1350 MHz; and

- *secondary surveillance radar (SSR)*—a long-range radar (250 NM) transmitting on 1030 MHz and receiving airborne transponder replies on 1090 MHz.

(ii) *Independent secondary surveillance radar (ISSR)*: a long-range radar (250 NM) transmitting on 1030 MHz and receiving airborne transponder replies on 1090 MHz.

(b) *Precision Approach Radar (PAR)*: PAR is a high definition short-range PSR operating on 9000 to 9180 MHz, and is used as an approach aid. The system provides the controller with altitude, azimuth and range information of high accuracy to assist pilots in executing approaches. While basically a military system, PAR is available at some civilian airports and may be used by civilian pilots. Civil approach limits are published in CAP.

(c) *Airport Surface Detection Equipment (ASDE)*: Radar surveillance of surface traffic is provided at certain airports where traffic warrants. This high-definition primary surveillance radar operating on 16 GHz is used by tower controllers to monitor the position of aircraft and vehicles on the manoeuvring areas of the airport (runways and taxiways) particularly during conditions of reduced visibility.

(d) *Weather Radar*: Weather radar is a PSR used by EC to monitor for hazardous weather conditions.

3.14 Area Navigation

Area Navigation (RNAV) is a method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained navigation aids, or a combination of these.

Existing navigation systems which provide a RNAV capability include inertial navigation system (INS), VOR/DME (RHO-THETA), DME-DME (RHO-RHO) and GPS. Airspace management systems and procedures, and the future planning of ground based navigation aids, will focus on an area navigation concept to enable aircraft operators to exploit the benefits of RNAV. These benefits equal savings in operational costs resulting from more efficient routings.

Radio transmission based area navigation systems provide accurate positioning through the use of hyperbolic or direct-ranging techniques.

The hyperbolic mode of operation defines a line of position (LOP) by plotting points which have the same relative signal phase or time difference from two stations. The use of three stations will produce two LOPs, the intersection of which is the actual position of the receiver. The use of additional transmitting stations will normally provide better accuracy. The advantages of this mode are: no requirement for a costly high precision time reference in the receiver, improved dynamic performance, long-term accuracy, and freedom from phase related errors.

The direct-ranging mode of operations defines the position by measuring the signal phase from two or more stations. A high precision oscillator reference is required in the aircraft receiver to provide acceptable accuracy when only two stations (RHO-RHO) are used. However, with three stations (RHO-RHO-RHO) the requirement for a precise oscillator reference is not as stringent because self-calibration of the low cost oscillator is possible.

RNAV systems may exhibit local inaccuracies as a result of propagation anomalies, errors in geodesy and non-programmed variations in signal timing. The effects of these variances may be substantially reduced by employing differential signal techniques. The differential facility is a precisely located receiver which continually monitors signals from the system and compares them with the expected signal at that location. If a difference is determined, a resulting correction factor is transmitted to users to upgrade the precision and performance of the receiver processor. The area over which corrections can be made from a single differential facility depends on a number of factors such as timeliness of the transmission of the correction factor, range of the correction signal, uniformity of the system grid and user receiver limitations.

3.14.1 VOR/DME (RHO-THETA) System

The capability of on-board RNAV computer systems which utilize VOR/DME signals varies considerably. The computer electronically offsets a VOR/DME station to any desired location within reception range. The relocated position is known as a way point and is defined by its bearing and distance from the station. Way points are used to define route segments and the computer provides steering guidance to and from way points.

3.14.2 DME-DME (RHO-RHO) System

DME-DME is a system which combines DME receivers with a microprocessor to provide an RNAV capability. The system has the location of the DME facilities in its data base. Measuring the distance from two or more of these stations can provide a positional fix. The system provides a means of entering way points for a random route and displays navigation information such as bearing, distance, cross-track error and time to go between two points.

3.14.3 LORAN-C System

On August 3, 2010 the United States Coast Guard and the Canadian Coast Guard terminated transmission of all LORAN-C signals. As a result, LORAN-C is no longer available for navigational use.

COM

3.15 Global Navigation Satellite System (GNSS)

3.15.1 Satellite Navigation (SatNav)

The GNSS includes navigation satellites and ground systems that monitor satellite signals and provide corrections and integrity messages, where needed, to support specific phases of flight.

Currently, there are two navigation satellite systems in orbit: the U.S. GPS and the Russian global navigation satellite system (GLONASS). The U.S. and Russia have offered these systems as the basis of a GNSS that is free of direct user charges. A third system, Galileo, is being developed by the European Union, and its initial operational capability is expected sometime after 2016.

Only GNSS based on GPS is approved for aviation use; it is the cornerstone of SatNav in Canada. Transport Canada has authorized the use of GNSS under IFR in Canada for en-route, terminal and approach phases of flight. Terms and conditions of the domestic approval are found in AIC 16/08 and in a Special Notice in the CAP. Detailed information and guidance material is provided later in this section.

GNSS is also approved as a source of guidance in NAT MNPS airspace, as described in AIC 15/08.

GNSS supports RNAV, permitting aircraft operation on any desired flight path, thus allowing operators to choose fuel-efficient routes. GNSS also supports better instrument approaches at many airports, including vertical navigation when augmented, reducing delays and diversions. For these reasons, many Canadian aircraft operators have equipped with GNSS avionics.

3.15.2 Navigation Performance Requirements

Navigation systems used for IFR must meet international safety standards for accuracy, integrity, availability and continuity, which are key to safety and user acceptance. These terms are explained below:

Accuracy is the measure of position error, which is the difference between the estimated and the actual position.

Integrity is the measure of trust that can be placed in the correctness of the information supplied by the system. Integrity includes the system's ability to tell the user, in a timely fashion, when the system must not be used for the intended operation. The level of integrity required for each phase of flight is expressed in terms of horizontal (and in some cases, vertical) alert limits, as well as time-to-alarm.

Continuity is the system's capability (expressed as a probability) to perform its function throughout a specific operation. For example, there must be a high probability that the service remains available without interruption during a full instrument approach procedure.

Availability is the portion of time during which the system is able to deliver the required accuracy, integrity and continuity for a specific phase of flight.

3.15.3 Global Positioning System (GPS)

GPS was developed by the U.S. military, but since 1996, it has been managed by an executive board, chaired jointly by the departments of Defense and Transportation, that is comprised of representatives from several other departments to ensure that civil users' requirements are considered in the management of the system. A Presidential Statement was issued in December 2004 that made commitments to ensure the continued operation of the GPS constellation, with uninterrupted access to its signals, free of direct user charges.

The design GPS constellation contains 24 GPS satellites, orbiting the earth twice a day at an altitude of 10 900 NM (20 200 km). They are arranged in six separate orbital planes, with four satellites in each; this gives complete global coverage. In the past few years, there have actually been 26 to 28 operational satellites, but one or two can be out of service temporarily for orbital manoeuvres or maintenance.

All GPS orbits cross the equator at a 55° angle, so it is not possible to see a GPS satellite directly overhead north of 55° N or south of 55° S latitude. This does not affect service in polar areas adversely; in fact, on average, more satellites are visible at high latitudes since receivers can track satellites over the poles.

Each satellite transmits a unique coded signal, allowing identification by receivers, on two frequencies: 1575.42 (L1) and 1227.60 MHz (L2).

GPS provides a precise positioning service (PPS) and a standard positioning service (SPS). The PPS broadcast on L1 and L2 is encrypted and reserved for military applications. The SPS broadcast on L1 is for civil users.

GPS positioning is based on precise timing. Each satellite has four atomic clocks on board, guaranteeing an accuracy of one billionth of one second, and broadcasts a digital pseudorandom noise (PRN) code that is repeated every millisecond. All GPS receivers start generating the same code at the same time. Code matching techniques establish the time of arrival difference between the generation of the signal at the satellite and its arrival at the receiver. The speed of the signal is closely approximated by the speed of light, with variations resulting from ionospheric and atmospheric effects modeled or directly measured and applied. The time of arrival difference is converted to a distance, referred to as a pseudorange, by computing the product of the time of arrival difference and the average speed of the signal. The satellites also broadcast orbit information (ephemeris) to permit receivers to calculate the position of the satellites at any instant in time.

A receiver normally needs four pseudoranges to calculate a three-dimensional position and to resolve the time difference between receiver and satellite clocks. In addition to position and time, GPS receivers can also calculate velocity—both speed and direction of motion.

GPS accuracy depends on transit time and signal propagation speed to compute pseudoranges. Therefore, accurate satellite clocks, broadcast orbits, and computation of delays as the signals pass through the ionosphere are critical. The ionosphere, which is a zone of charged particles several hundred kilometres above the earth, causes signal delays that vary from day to night and by solar activity. Current receivers contain a model of the nominal day/night delay, but this model does not account for variable solar activity. For applications requiring high accuracy, GPS needs space or ground-based augmentation systems (GBAS) to correct the computed transit time to compensate for this delay. These are discussed later.

Another key to GPS accuracy is the relative position of satellites in the sky, or satellite geometry. When satellites are widely spread, geometry and accuracy are better. If satellites are clustered in a small area of the sky, geometry and accuracy are worse. Currently, GPS horizontal and vertical positions are accurate to 6 m and 8 m, respectively, 95% of the time.

The GPS satellite constellation is operated by the U.S. Air Force from a control centre at Schriever Air Force Base in Colorado. A global network of monitor and uplink stations relays information about the satellites to the control centre and sends messages, when required, to the satellites.

If a problem is detected with a satellite, it is commanded to send an "unhealthy" status indication, causing receivers to drop it from the position solution. Since detection and resolution of a problem take time, and this delay is unacceptable in aviation operations, augmentation systems are used to provide the level of integrity required by aviation.

Current GNSS approvals require retention of traditional ground aids as a backup. Future approvals will emerge as GNSS evolves and can demonstrate that it meets availability requirements.

3.15.4 Augmentation Systems

Augmentation of GPS is required to meet the accuracy, integrity, continuity and availability requirements for aviation. There are currently three types of augmentation:

(a) aircraft-based augmentation system (ABAS);

(b) satellite-based augmentation system (SBAS); and

(c) ground-based augmentation system (GBAS).

3.15.4.1 Aircraft-Based Augmentation System (ABAS)

The RAIM and fault detection and exclusion (FDE) functions in current IFR-certified avionics are considered ABAS. RAIM can provide the integrity for the en-route, terminal, and non-precision approach phases of flight. FDE improves the continuity of operation in the event of a satellite failure and can support primary-means oceanic operations.

RAIM uses extra satellites in view to compare solutions and detect problems. It usually takes four satellites to compute a navigation solution, and a minimum of five for RAIM to function. The availability of RAIM is a function of the number of visible satellites and their geometry. It is complicated by the movement of satellites relative to a coverage area and temporary satellite outages resulting from scheduled maintenance or failures.

If the number of satellites in view and their geometry do not support the applicable alert limit (2 NM en route, 1 NM terminal and 0.3 NM non-precision approach), RAIM is unable to guarantee the integrity of the position solution. (Note that this does not imply a satellite malfunction.) In this case, the avionics RAIM function will alert the pilot, but will continue providing a navigation solution. Except in cases of emergency, pilots must discontinue using GNSS for navigation when such an alert occurs.

A second type of RAIM alert occurs when the avionics detects a satellite range error (typically caused by a satellite malfunction) that may cause an accuracy degradation that exceeds the alert limit for the current phase of flight. When this occurs, the avionics alerts the pilot and denies navigation guidance by displaying red flags on the HSI or course deviation indicator (CDI). Continued flight using GNSS is then not possible until the satellite is flagged as unhealthy by the control centre, or normal satellite operation is restored.

Some avionics go beyond basic RAIM by having an FDE feature that allows the avionics to detect which satellite is faulty, and then to exclude it from the navigation solution. FDE requires a minimum of six satellites with good geometry to function. It has the advantage of allowing continued navigation in the presence of a satellite malfunction.

Most first generation avionics do not have FDE and were designed when GPS had a feature called selective availability (SA) that deliberately degraded accuracy. SA has since been discontinued, and new generation (wide area augmentation system) WAAS-capable receivers (TSO C145a/C146a) account for SA being terminated. These receivers experience a higher RAIM availability, even in the absence of WAAS messages, and also have FDE capability.

For avionics that cannot take advantage of SA being discontinued, average RAIM availability is 99.99% for en-route and 99.7% for non-precision approach operations for a 24-satellite GPS constellation. FDE availability ranges from 99.8% for en-route to 89.5% for non-precision approach. Avionics that can take advantage of SA having been discontinued have virtually 100% availability of RAIM for en-route and 99.998% for non-precision approach; FDE availability ranges from 99.92% for en-route to 99.1% for non-precision approach. These figures have been computed for mid-latitudes, and are dependent on user position and also on which satellites are operational at any given time. RAIM and FDE availability is typically even better at high latitudes, since the receiver is able to track satellites on the other side of the North Pole.

The level of RAIM or FDE availability for a certain airspace at a certain time is determined by an analysis of satellite geometry, rather than signal measurement. This is why it can be predicted by receivers or with PC-based computer software. The difference between the two methods is that the receivers use the current constellation in their calculations while the PC software can use a constellation definition that takes into account scheduled satellite outages.

Most TSO C129a avionics also accept signals from an aircraft altitude encoder. This is called baro-aiding, and it essentially reduces the number of satellites required by one, thus further increasing the availability of RAIM and providing an additional measure of tolerance to satellite failures. Operators contemplating the installation of SatNav receivers are encouraged to incorporate a baro encoder input to the receiver wherever possible.

With proper integration, IRS can augment/enhance GNSS navigation. This system allows "coasting" through periods of low availability. IRS is costly; therefore, it is usually found in commercial airline and sophisticated business aircraft. A low cost IRS-like alternative for aviation, using solid-state sensors, is starting to emerge, but none is currently approved in Canada.

3.15.4.2 Satellite-Based Augmentation System (SBAS)

SBAS uses a network of ground-based reference stations that monitor navigation satellite signals and relay data to master stations, which assess signal validity and compute error corrections. The master stations generate two primary types of messages: integrity, and range corrections. These are broadcast to users via geostationary earth orbit (GEO) satellites (hence SBAS) in fixed orbital positions over the equator. The SBAS GEO satellites also serve as additional sources of navigation ranging signals.

The integrity messages provide a direct validation of each navigation satellite's signal. This function is similar to RAIM, except that the additional satellites required for RAIM are not necessary when SBAS integrity messages are used. The integrity messages are available wherever the GEO satellite signal can be received.

The range corrections contain estimates of the errors introduced into the range measurements as a result of ionospheric delays, and satellite ephemeris (orbit) and clock errors. Ionospheric delay terms are critical for correction messages, and are also the most challenging to characterize. First, each reference station measures the ionospheric delay for each visible satellite. These observations are sent to the master station, where they are combined, and used to generate a model of the ionosphere, which is then transmitted to the receivers via the GEO satellite. The accuracy of the model is dependent on the number and placement of the reference stations providing observations of ionospheric delays.

By compensating for these errors, SBAS receivers can compute the position of the aircraft with the accuracy necessary to support advanced flight operations with vertical guidance. SBAS can provide lateral accuracy similar to a localizer, and vertical performance somewhat better than barometric vertical navigation (BARO VNAV), but without the need for temperature correction or a local field altimeter setting.

Unlike BARO VNAV, SBAS vertical guidance is not subject to altimeter setting errors, or non-standard temperatures or lapse rates. Vertical guidance provides safer stabilized approaches and transition to visual for landing. This represents one of the principal benefits from SBAS service. The other is lower approach minima at many airports, as a result of greater lateral accuracy. SBAS has the potential to meet CAT I approach standards with the next generation of GPS satellites.

The first SBAS, the U.S. FAA's WAAS, was commissioned in 2003. Europe, Japan and India are also building compatible systems to augment GPS [EGNOS (European Geostationary Navigation Overlay Service), MSAS (Multi-functional Transport Satellite (MTSAT) Satellite-Based Augmentation System) and GAGAN (GPS and GEO Augmented Navigation), respectively].

The use of WAAS receivers for en-route, terminal, and non-precision approach (RNAV and overlay) operations has been permitted in Canada since January 2003. Vertical guidance provided by WAAS receivers is now authorized for RNAV approaches.

WAAS currently uses two GEO satellites located over the Atlantic and Pacific Oceans.

This gives integrity message coverage over most of Canada south of 70° latitude, and increases the availability of non-precision approach to virtually 100%.

There is a program underway to deploy additional GEO satellites to provide redundant WAAS coverage over all but the extreme north of Canada.

The coverage of WAAS vertical guidance is also dependent on the location of the reference stations. There must be a sufficient number of ionospheric delay measurements to model the ionosphere accurately to determine its effect at a receiver's position.

Currently, all the reference stations are located in the conterminous United States and Alaska. Consequently, WAAS service that supports vertical guidance is now available in most of the Yukon Territory, the western half of the Northwest Territories, British Columbia, Alberta, Saskatchewan, the southern half of Ontario, and the portion of Quebec south of a line running from Rouyn-Noranda to Québec City.

NAV CANADA is currently working to extend WAAS vertical service throughout much of Canada by establishing reference stations in Canada and linking them to the FAA WAAS network. It is anticipated that this will result in the expansion of WAAS vertical guidance capability to the southern half of Quebec, all of Nova Scotia, New Brunswick and Prince Edward Island, and the western portion of Newfoundland by late 2006. Another expansion phase during 2007 will result in these services being available to all of Ontario, Quebec, Labrador, and most of Newfoundland.

3.15.4.3 Ground-Based Augmentation System (GBAS)

Another augmentation system being developed is GBAS, or the local-area augmentation system (LAAS). It is called GBAS because corrections are sent directly to user receivers from a ground station at an airport.

GPS receivers with antennas at surveyed locations provide measurements used to generate and broadcast pseudorange corrections. Aircraft receivers use the corrections for increased accuracy, while a monitor function in the ground station assures the integrity of the broadcast. GBAS provides service over a limited area, typically within 30 NM of the ground station.

The goal of GBAS is to support all precision approach categories and, possibly, surface movement guidance. There are still a number of technical challenges to overcome, and it is not clear when GBAS will be available in Canada.

3.15.5 IFR Approval to Use GNSS and WAAS in Domestic Airspace

Pilots in Canada can use GNSS (GPS, or GPS augmented by WAAS), to fly IFR in the en-route, terminal and non-precision approach phases of flight.

Approach procedures with vertical guidance (APV) classified as LPV (localizer performance with vertical guidance) and lateral navigation / vertical navigation (LNAV/VNAV) approaches may be flown using WAAS.

Suitably-equipped aircraft may fly LNAV/VNAV approaches using GNSS to provide lateral navigation and BARO VNAV for the vertical.

The following table lists the capability required for each phase of flight:

Phase Of Flight	SatNav Capability
En-route	GPS or WAAS
Terminal	GPS or WAAS
Non-precision approach (LNAV)	GPS or WAAS
LNAV/VNAV	WAAS (for lateral and vertical)
LNAV/VNAV	GPS or WAAS lateral BARO VNAV vertical
LPV	WAAS (for lateral and vertical)

SatNav capability may be provided by a panel-mount GPS or WAAS receiver, or an FMS that uses a GPS or WAAS sensor.

Avionics have to meet appropriate equipment standards, which are listed in the CAP Special Notice and AIC 16/08, and referenced throughout this document.

Equally important, the avionics installation must be approved by Transport Canada to ensure proper avionics integration and display.

Hand-held and other VFR receivers do not support integrity monitoring, nor do they comply with other certification requirements; therefore, they cannot be used for IFR operations.

Holders of air operator certificates (AOC) issued under Part VII of the CARs, and private operator certificates issued under Subpart 604 of the CARs, are required to be authorized by an operations specification to conduct GNSS instrument approach operations in IMC. This is explained in Commercial and Business Aviation Advisory Circular (CBAAC) 0123R, dated 25 March 2004.

3.15.5.1 Domestic En-Route and Terminal Operations

GNSS may be used for all en-route and terminal operations, including navigation along airways and air routes, navigation to and from ground-based aids along specific tracks, and RNAV. In accordance with the approval described in the CAP Special Notice, the aircraft must also carry approved traditional systems, such as VOR and ADF, to serve as a backup when there are not enough GPS satellites in view to support RAIM. Certain GNSS avionics systems can also meet long-range navigation requirements for flight in CMNPSA and RNPC airspace. For more information on MNPS, RNPC and CMNPS certification, contact the Transport Canada Regional Manager, Commercial and Business Aviation.

In practice, pilots can use GNSS for guidance most of the time. If an integrity alert occurs while en route, the pilot can then continue by using traditional aids, diverting if necessary from the direct routing, notifying ATS of any changes to the flight and obtaining a new clearance, as required.

When using GNSS to maintain a track in terminal operations, the avionics shall be in terminal mode and/or the course deviation indicator (CDI) shall be set to terminal sensitivity. (Most avionics set the mode and sensitivity automatically within 30 NM of the destination airport, or when an arrival procedure is loaded.)

When using GNSS to navigate along airways, VOR or ADF reception is not an issue. This means that pilots using GNSS for navigation can file or request an altitude below the MEA, but at or above the MOCA, to avoid icing, optimize cruise altitude, or in an emergency. However, an ATS clearance to fly at a below-MEA altitude could be dependent on issues such as traffic communications reception and the base of controlled airspace. In the rare case of a RAIM alert while en route below the MEA, and out of range of the airway navigation aid, pilots should advise ATS and climb to continue the flight using VOR or ADF.

GNSS avionics typically display the distance to the next waypoint. To ensure proper separation between aircraft, a controller may request the distance from a waypoint that is not the currently-active waypoint in the avionics; it may even be behind the aircraft. Pilots must be able to obtain this information quickly from the avionics. Techniques vary by manufacturer, so pilots should ensure familiarity with this function.

At times outside radar coverage, pilots may be cleared by ATS to a position defined by a latitude and longitude. As these are usually outside the range of traditional navigation aids, there is no means to cross check that the coordinates have been entered accurately. Pilots must be particularly careful to verify that the coordinates are correct.

3.15.5.2 GNSS-Based RNAV Approach Procedures

Prior to the advent of GNSS, ICAO defined only two approach and landing operations: precision approach (PA) and non-precision approach (NPA). It has now added definitions for approach and landing operations with vertical guidance (APV) to cover approaches that use lateral and vertical guidance, but that do not meet the requirements established for precision approach.

GNSS-based approaches are charted as “RNAV (GPS) RWY XX” or “RNAV (GNSS) RWY XX.” The “(GPS)” before the runway identification indicates that GNSS must be used for guidance. Pilots and controllers shall use the prefix “RNAV” in radio communications (e.g. “cleared the RNAV RWY 04 approach”).

GNSS-based RNAV approaches are designed to take full advantage of GNSS capabilities. A series of waypoints in a “T” or “Y” pattern eliminates the need for a procedure turn. The accuracy of GNSS often means lower minima and increased capacity at the airport. Because GNSS is not dependent on the location of a ground-based aid, straight-in approaches are possible for most runway ends at an airport.

GNSS-based RNAV approaches are often provided for runways that have no traditional approach, runways that are served only by circling approaches, or runways that have traditional approaches, but where a GNSS-based approach would provide an operational advantage. At this time, over 350 public RNAV (GPS) approaches are published in the CAP. This number will continually increase because the great majority of new approaches designed in Canada are RNAV (GPS) or RNAV (GNSS) approaches.

RNAV (GPS) and RNAV (GNSS) approach charts will, in many cases, depict three sets of minima:

- LPV (localizer performance with vertical guidance—APV)
- LNAV/VNAV (lateral/vertical navigation—APV); and
- LNAV (lateral navigation only—NPA);

The airborne equipment required to fly to the various minima is described in later sections.

The LNAV minima indicate a non-precision approach, while the LNAV/VNAV and LPV minima refer to APV approaches (RNAV approaches with vertical guidance). However, the actual terms “NPA” and “APV” do not appear on the charts because they are approach categories not related to specific procedure design criteria. The depiction of the three sets of minima is analogous to the way that an ILS approach may show landing minima for ILS, localizer (LOC) and CIRCLING.

The approach chart may indicate a WAAS channel number. This is used for certain types of avionics, and permits the approach to be loaded by entering the number shown.

All approaches must be retrieved from the avionics database, and that database must be current. While it is sometimes acceptable to use pilot-generated waypoints en route, it is not permitted for approach procedures, as any database or waypoint coordinate errors could have serious consequences.

Because flying GNSS-based approaches requires good familiarity with the avionics, it is recommended that pilots make use of PC-based simulation features available from most manufacturers (often via the Internet). Several approaches should first be flown VFR to build confidence and familiarity before attempting operations in IMC. Of particular concern is the missed approach procedure, where some older avionics may require several pilot actions.

3.15.5.2.1 RNAV Approaches with Lateral Guidance Only

RNAV (GPS) LNAV approaches do not define a vertical path through space; as such, each approach segment has a minimum step-down altitude below which the pilot may not descend. These are normally flown using the “level-descend-level” method familiar to most pilots.

GPS (TSO C129/C129a Class A1, B1, B3, C1 or C3) and WAAS (TSO C145a/C146a, any class) avionics are both able to provide the lateral guidance required for these approaches.

Without vertical guidance, pilots fly to the LNAV MDA line depicted on the plate. The pilot is required to remain at or above the MDA unless a visual transition to landing can be accomplished, or to conduct a missed approach at the missed approach waypoint (MAWP), typically located over the runway threshold.

WAAS and some TSO C129/C129a avionics may provide advisory vertical guidance when flying approaches without LNAV/VNAV or LPV minima. It is important to recognize that this guidance is advisory only and the pilot is responsible for respecting the minimum altitude for each segment until a visual transition to land is commenced.

Pilots using TSO C129/C129a avionics should use the RAIM prediction feature to ensure that approach-level RAIM will be supported at the destination or alternate airport for the ETA (±15 min). This should be done before takeoff, and again prior to commencing a GNSS-based approach. If approach-level RAIM is not expected to be available, pilots should advise ATS as soon as practicable and state their intentions (e.g. delay the approach, fly another type of approach, proceed to alternate).

3.15.5.2.2 GPS Overlay Approaches

GPS overlay approaches are traditional VOR- or NDB-based approaches that have been approved to be flown using the guidance of IFR approach-certified GNSS avionics. Because of approach design criteria, LOC-based approaches cannot be overlaid.

GPS overlay approaches are identified in the CAP by including "(GPS)" in small capitals after the runway designation [e.g. NDB RWY 04 (GPS)]. When using GNSS guidance, the pilot benefits from improved accuracy and situational awareness through a moving map display (if available) and distance-to-go indication. In many cases, the pilot can bypass the procedure turn and fly directly to the FAF for a more efficient approach, as long as minimum sector altitudes are respected. Unless required by the aircraft flight manual (AFM) or AFM Supplement, it is not necessary to monitor the underlying navigation aid, and it is even permissible to fly a GPS overlay approach when the underlying navigation aid is temporarily out of service. Nevertheless, good airmanship dictates that all available sources of information be monitored.

Pilots shall request GPS overlays as follows: "request GPS overlay RWY XX." ATS may ask the pilot to specify the underlying navigation aid if more than one overlay approach is published for the runway.

GPS overlay approaches were intended to be a transition measure to allow immediate benefits while waiting for the commissioning of a GNSS stand-alone approach for a runway. For this reason, in most cases, the GPS overlay approach will be discontinued when a GNSS stand-alone approach is published for a given runway. There are still over 120 GPS overlay approaches published in the CAP.

When flying overlay approaches, pilots should use the RAIM prediction feature of TSO C129/C129a avionics to ensure that approach-level RAIM will be supported, as described in the preceding section.

3.15.5.2.3 Vertical Guidance on RNAV Approaches

LNAV/VNAV and LPV describe approaches with vertical guidance. These will deliver the safety benefits of a stabilized approach and, in many cases, will improve airport accessibility. However, as with any advance in aviation, pilots must appreciate the relevant requirements and limitations.

Aircraft with TSO C145a/C146a (WAAS Class 2 or 3) or TSO C115b (multi-sensor FMS) avionics, may fly RNAV (GPS) and RNAV (GNSS) approaches to LNAV/VNAV minima with vertical guidance in a similar manner to the way they fly an ILS approach: with both a lateral course deviation indicator (CDI) and a vertical deviation indicator (VDI). The lateral guidance must be based on GPS or WAAS. The vertical guidance may be based on WAAS, or on barometric inputs (BARO VNAV), depending on the approach and the aircraft equipage.

Aircraft with WAAS Class 3 avionics may fly RNAV (GNSS) approaches to LPV minima in a similar manner. In this case, both the lateral and vertical guidance are based on WAAS.

The nominal final approach course vertical flight path angle for LNAV/VNAV and LPV approaches is 3°, avoiding the step-down minimum altitudes associated with traditional non-precision approaches.

The LNAV/VNAV and LPV minima depict a decision altitude (DA), which requires the pilot to initiate a missed approach at the DA if the visual reference to continue the approach has not been established. In most cases, the DA associated with LNAV/VNAV or LPV approaches will be lower than the LNAV MDA, since the LNAV/VNAV and LPV approach designs use a sloped vertical obstacle clearance surface.

3.15.5.2.4 RNAV Approaches with Vertical Guidance Based on BARO VNAV

Multi-sensor FMSs meeting TSO C115b have been certified since the late eighties to provide guidance for a stabilized final approach segment while flying non-precision approaches. The vertical guidance for these systems has been derived from a barometric altitude input; hence, these approaches are known as BARO VNAV approaches. This equipment has typically only been installed on transport category airplanes. The information provided by these systems is advisory only, and pilots are required to respect all minimum altitudes, including step-down altitudes, since non-precision approaches are not specifically designed to take advantage of BARO VNAV capability.

With the publication in Canada of RNAV (GNSS) approaches with vertical guidance, suitably-equipped aircraft may fly BARO VNAV approaches to the LNAV/VNAV minima published on these approach plates. The standard for equipage is a multi-sensor FMS meeting TSO C115b and certified in accordance with FAA Advisory Circular (AC) 20-129, or equivalent. The FMS must use GNSS sensor input, but does not require a WAAS-capable receiver to fly to LNAV/VNAV minima.

Pilots must note that the vertical path defined by BARO VNAV is affected by altimeter setting errors. For this reason, BARO VNAV is not authorized unless a local field altimeter setting is available.

Non-standard atmospheric conditions, particularly temperature, also induce errors in the BARO VNAV vertical path. For example, a nominal 3° glide path may be closer to 2.5° at very low temperatures. Similarly, at above ISA temperatures, a BARO VNAV vertical path would be steeper than normal. To compensate for these temperature effects, some avionics allow input of the temperature at the airport, and apply temperature compensation so that the BARO VNAV vertical path is not biased as a function of temperature. Unfortunately, not all systems have the capability to compensate for temperature effects.

The sample vertical path angle (VPA) deviation chart, below, indicates the effect of temperature on the uncorrected BARO VNAV VPA, for an aerodrome at sea level.

VPA Deviations	
Aerodrome Temp.	Uncorrected VPA
+30°C	3.2°
+15°C	3.0°
0°C	2.8°
-15°C	2.7°
-31°C	2.5°

When temperature compensation is not, or cannot be, applied through the FMS, pilots shall refer to a temperature limit, referred to as T_{Lim}, published on the approach chart. Below this temperature, the approach is not authorized using BARO VNAV guidance. T_{Lim} will be a function of the reduced obstacle clearance resulting from flying an uncompensated VPA, and will vary from approach to approach. For avionics systems that have the capability to correctly compensate the VPA for temperature deviations, the published T_{Lim} does not apply if the pilots enable the temperature compensation.

Regardless of whether the FMS provides temperature compensation of the vertical path or not, all altitudes on the approach, including DA, should still be temperature-corrected (by FMS temperature compensation or per the Altitude Correction Chart in the CAP GEN section and TC AIM RAC Section 9.17.1, Figure 9.1).

3.15.5.2.5 RNAV Approaches with Vertical Guidance Based on WAAS

RNAV (GNSS) approaches with vertical guidance based on WAAS require a Class 2 or 3 (for LNAV/VNAV minima) or Class 3 (for LPV minima) TSO C145a WAAS receiver, or a TSO C146a sensor interfaced to appropriate avionics.

RNAV (GNSS) approaches with vertical guidance based on WAAS are entirely dependent on the WAAS signal. WAAS meets essentially the same navigation performance requirements (accuracy, integrity and continuity) as ILS, and pilots can expect that guidance will be similar to that provided by an ILS, with some improvement in signal stability over ILS. The LPV approach design criteria are similar to ILS CAT I, although the lowest currently-attainable DA will be 250 ft HAT.

WAAS avionics continuously calculate integrity levels during an approach and will provide a message to the crew if alert limits are exceeded, analogous to ILS monitors that shut down an ILS signal when its accuracy does not meet the required tolerances.

Although the WAAS integrity monitor is very reliable, good airmanship nevertheless dictates that pilots verify the final approach waypoint (FAWP) crossing altitude depicted on approach plates with LNAV/VNAV and LPV minima, in the same way that the beacon crossing altitude is checked when flying an ILS approach. Large altitude deviations could be an indication of a database error or otherwise undetectable incorrect signal.

3.15.6 Flight Planning

NOTAM on ground-based navigation aid outages are of direct use to pilots because if a navigation aid is not functioning, the related service is not available. With GPS and WAAS, the knowledge of a satellite outage does not equate to a direct knowledge of service availability. The procedures for determining service availability are different for GPS (TSO C129/C129a) and WAAS (TSO C145a/C146a) avionics, and are explained in the next sections.

3.15.6.1 GPS NOTAM

This section is applicable only to operators using TSO C129/C129a avionics.

Research has shown minor differences among avionics' computations of RAIM availability, making it impractical to develop a GPS RAIM NOTAM system that will work reliably for all receivers. Because of this, and since the IFR GPS approval requires aircraft to be equipped with traditional avionics to be used when RAIM is unavailable, NOTAM information on GPS RAIM availability is not provided in Canada.

Canadian flight information centres (FIC) can supply NOTAM on GPS satellite outages by querying the international NOTAM identifier KNMH. (This information is also available at <*https://www.notams.jcs.mil*>.) The availability of RAIM can then be computed from the satellite availability information by entering the expected outages into PC-based RAIM prediction software provided by some avionics manufacturers or through direct entry into FMS computers that support this function.

GNSS avionics also contain such a model, and this allows pilots to determine if approach-level RAIM will be supported (available) upon arrival at destination or an alternate. The calculation typically uses current information, broadcast by the satellites, identifying which satellites are in service at that time. However, unlike the software that is based on the NOTAM data, this prediction does not take into account scheduled satellite outages.

Operators using TSO C129/C129a avionics who wish to take advantage of an RNAV (GPS) or RNAV (GNSS) approach when specifying an alternate airport must check KNMH NOTAM to verify the status of the constellation, as described in Section 3.15.12.

3.15.6.2 WAAS NOTAM

NAV CANADA has implemented a NOTAM system for users of WAAS avionics (TSO C145a/C146a). It makes use of a service volume model (SVM) that considers current and anticipated GPS constellation status and geometry, and the availability of WAAS GEO satellites, and computes estimates of the availability of service where SatNav-based approach procedures are published.

The SVM runs twice daily, at 0000Z and 1200Z. It computes the expected availability of LPV, and WAAS-based LNAV/VNAV and LNAV for a period of eighteen hours for all aerodromes in its database. When a service is predicted not to be available for a duration of more than fifteen minutes, an aerodrome NOTAM will be issued. In the event that two outages of less than fifteen minutes each are predicted, and are separated by a period of less than fifteen minutes during which the service is available, a NOTAM will be issued for a single outage covering the entire period.

The SVM is also run in response to an unscheduled change in the GPS constellation status. This typically implies a satellite failure.

Pilots should flight plan based on the assumption that the services referred to in a NOTAM will not be available. However, once they arrive at the aerodrome, they may discover that a service is, in fact, available because of the conservative nature of the prediction, in which case they may use the approach safely if they so choose.

When LPV and WAAS-based LNAV/VNAV are not available, pilots may fly the LNAV procedure to the published MDA; this will almost always be available to pilots using WAAS avionics. Since LNAV procedures will be used when LPV and LNAV/VNAV is not available, pilots should ensure that they maintain their skills in flying these approaches.

Because of the high availability of services supporting en-route and terminal operations, no NOTAMs are issued for these phases of flight.

Some examples of WAAS NOTAMs are listed below:

(a) LPV NOT AVBL 0511211200 TIL 0511211240. This is issued as an aerodrome NOTAM, and indicates that the SVM has predicted that LPV service may not be available for the specified period.

(b) LPV AND WAAS-BASED LNAV/VNAV NOT AVBL 0511211205 TIL 0511211235. This aerodrome NOTAM indicates that LPV and LNAV/VNAV based on WAAS is expected to be unavailable for the specified period. This will be the most common type of WAAS NOTAM. Note that if LNAV is available, the LNAV/VNAV approach may be flown by aircraft equipped for BARO VNAV.

(c) WAAS-BASED LNAV NOT AVBL 0511211210 TIL 0511211225. This is an aerodrome NOTAM that indicates that the SVM has predicted that LNAV service may not be available for the specified period.

(d) LPV AND WAAS-BASED LNAV/VNAV NOT AVBL WEST OF LINE FM WHITEHORSE TO CALGARY 0511011800 TIL APRX 0511071800. This will be issued as an FIR NOTAM, and is used to communicate that a GEO satellite failure has occurred, disrupting all WAAS messages for the area covered by that satellite.

(e) LPV AND WAAS-BASED LNAV/VNAV NOT AVBL 0511200800 TIL APRX 0511241600. When issued as a national (CYHQ) NOTAM, this indicates the complete loss of WAAS services. Note that LNAV will still likely be available for operators using WAAS avionics; NOTAM for LNAV outages will be issued for each affected aerodrome, as described in (c) above.

(f) WAAS UNMONITORED 0511302100 TIL APRX 0512011200. This national NOTAM is used to indicate a failure in the WAAS NOTAM system itself. Since pilots would not be alerted to disruptions of WAAS services, flight planning should be based on the assumption that LPV and WAAS-based LNAV/VNAV may be unavailable.

Note that WAAS NOTAM information is not applicable to users of TSO C129a avionics.

3.15.6.3 Negative W Notation

Normally, WAAS-based approaches will only be designed and published where the nominal availability of the required service is greater than 99%. This policy avoids issuing a large number of NOTAM for sites where the availability is low.

However, there may be aerodromes for which an LNAV/VNAV approach is published because of a local demand by operators flying BARO VNAV-equipped aircraft. These procedures will appear in the database of WAAS receivers, and will be flyable by them. In the event that such an aerodrome is located in a region of poor WAAS availability, NOTAMs will not be issued when WAAS-based LNAV/VNAV is expected to be unavailable. Pilots will be alerted to this fact by a negative "W" (white on a black background) on the approach plate.

Pilots should flight plan as though WAAS-based LNAV/VNAV will not be available at these aerodromes; however, if the service is available, it may be used safely at the pilot's discretion.

3.15.7 Flight Plan Equipment Suffixes

The letter "G" in item 10 of the IFR flight plan (equipment) indicates that the aircraft has IFR-approved GPS or WAAS avionics, and can therefore be cleared by ATS on direct routings while en route, in terminal areas, and for GNSS-based approaches. It is the pilot's responsibility to ensure that the relevant equipage requirements are met for GNSS-based approaches.

Pilots using GPS or WAAS, including hand-held units, who are filing VFR flight plans are also encouraged to use the "G" notation to convey their ability to follow direct routings. This does not imply a requirement for IFR-approved avionics.

3.15.8 Avionics Databases

GNSS avionics used for IFR flight require an electronic database that can be updated, normally on 28- or 56-day cycles. The updating service is usually purchased under subscription from avionics manufacturers or database suppliers.

Database errors do occur, and should be reported to the avionics database supplier. Jeppesen accepts e-mailed database reports at <navdatatechsupport@jeppesen.com>. It is good practice to verify that retrieved data is correct, and it is mandatory to do so for approach data. Verification can be accomplished either by checking waypoint co-ordinates or by checking bearings and distances between waypoints against charts.

3.15.9 Use of GNSS in Lieu of Ground-based Aids

Subject to any overriding conditions or limitations in the aircraft flight manual (AFM) or AFM Supplement, GNSS may be used to identify all fixes defined by DME, VOR, VOR/DME and NDB, including fixes that are part of any instrument approach procedure, to navigate to and from these fixes along specific tracks, including arcs, and to report distances along airways or tracks for separation purposes. This can be done as long as there is no integrity alert, and provided that all fixes that are part of a terminal instrument procedure (arrival, departure, or approach) are named, charted and retrieved from a current navigation database. GNSS may be used to identify fixes defined by ground-based aids, even if they are temporarily out of service.

For example, if the DME associated with an ILS/DME approach is unserviceable, traditional aircraft would be denied the approach; however, under these rules, the pilot of a GNSS-equipped aircraft may request and fly the approach.

Note that for NDB or VOR approaches that are not part of the GPS overlay program described in Section 3.15.5.2.2, pilots shall use ADF or VOR as the primary source for final approach track guidance. For these approaches, and for approaches based on a localizer (LOC) for lateral guidance, pilots shall not use GNSS as the primary source for missed approach guidance when the missed approach procedure requires flying a published track to or from an NDB or VOR. Where ATS requests a position based on a distance from a DME facility for separation purposes, the pilot should report GPS distance from the same DME facility, stating the distance in "miles" and the facility name (e.g. "30 miles from Sumspot VOR"). This phraseology is used for all RNAV systems. When reporting DME distance, the pilot includes "DME" in the report (e.g. "30 DME from Sumspot VOR"). This enables ATS to allow for the DME slant range.

Note that under this approval, there is no requirement to carry the avionics normally used to identify fixes defined by ground-based aids, but other considerations may apply. This topic is discussed in Section 3.15.10.

3.15.10 Replacement of DME or ADF by GNSS Avionics

Before making a decision on avionics equipment, aircraft operators should take GNSS performance and their operational environment into consideration. Some analysis is required to determine how CAR 605.18(j) relates to a specific operation. The following paragraphs highlight some of the factors that should be considered.

In the settled areas of southern Canada, aerodromes are relatively plentiful and a variety of navigation aids is typically available. In these areas, operators equipped with GNSS avionics meeting the conditions of approval described in the CAP Special Notice may consider eliminating DME and perhaps ADF avionics. Such a decision should be based on a thorough analysis of the navigation aids available in the normal area of operations, the availability of GNSS approaches, and the availability of alternate aerodromes. The decision should also be made within the context of the regulatory requirements described above. Operators should also remember that the availability of RAIM or WAAS integrity depends on the phase of flight and on the number of satellites in view at any given time.

In sparsely settled areas, particularly in the Arctic, aerodromes are farther apart and the most common navigation aid is the NDB. In these areas, operators equipped with GNSS avionics meeting the conditions in this document may consider eliminating DME avionics, but would likely not meet the CAR 605.18 requirements without ADF. On the other hand, with either a GNSS stand-alone or GPS overlay approach available at virtually all aerodromes, a single ADF would likely meet the requirements. Generally, approach-level RAIM availability should be highest in northern Canada because satellites over the other side of the North Pole are visible to receivers at high latitudes.

3.15.11 NAT MNPS Operations

In the NAT, a single GPS/RAIM unit can be used to replace one of the two required long range navigation systems, as specified in AIC 15/08. In this case, inertial reference systems can be used if RAIM is lost.

Alternatively, as described in AIC 15/08, a dual GPS/FDE (global positioning system / fault detection and exclusion) installation, including TSO C145a/C146a avionics, can meet requirements, provided that operators complete a software-based pre-flight RAIM/FDE prediction to ensure service will be available for the Atlantic crossing. On very rare occasions, operators may have to delay a flight based on the RAIM/FDE prediction.

3.15.12 GPS and WAAS Approaches at Alternate Aerodromes

Risk assessment of GNSS performance has made it possible to relax the restriction that prohibited taking credit for GNSS-based approaches when selecting alternate aerodromes for flight planning purposes. This includes aerodromes served only by GPS-based approaches.

Pilots can take credit for a GNSS-based approach at an alternate aerodrome when all of the following conditions are met:

(a) A usable approach at the planned destination is served by a functioning traditional aid. This is to ensure that an approach is available in the event of a widespread GPS outage. (Good airmanship dictates that the weather forecast at the destination should provide confidence that the approach could be used successfully.) This approach must be completely independent of GNSS. Note that this precludes the GNSS in lieu of ground-based aids credit;

(b) The published LNAV minima are the lowest landing limits for which credit may be taken when determining alternate weather minima requirements. No credit may be taken for LNAV/VNAV or LPV minima;

(c) The pilot-in-command verifies that the integrity, provided by RAIM or WASS, and that is required for an LNAV approach, is expected to be available at the planned alternate aerodrome at the ETA, taking into account predicted satellite outages; and

(d) For GPS TSO C129/C129a avionics, periodically during the flight, and at least once before the mid-point of the flight to the destination, the pilot-in-command verifies that approach-level RAIM is expected to be available at the planned alternate aerodrome at the ETA. This may be accomplished using the RAIM prediction capability of the avionics. If an in-flight prediction indicates that approach-level RAIM will not be available at the alternate, the pilot should plan accordingly. (In-flight predictions are not required for TSO C145a/C146a avionics.)

For the purposes of determining alternate weather minima per TC AIM RAC 3.14.1 or the CAP GEN section, LNAV/VNAV shall be considered to be a non-precision approach.

NOTE: These provisions are applicable to meet the legal flight planning requirements for alternate airports. Once airborne, pilots are free to re-plan as needed to accommodate changing situations while exercising good airmanship.

Taking credit for RNAV (GPS) and RNAV (GNSS) approaches at an alternate aerodrome for IFR flight plan filing purposes is possible because the availability of RAIM or WAAS integrity to support non-precision approaches is normally very high. However, when satellites are out of service, availability could decrease. Consequently, it is necessary to determine satellite status to ensure that the necessary level of integrity will be available at the ETA at the alternate, as indicated by 3.15.12(c), above. The procedures for this are explained in the next two sections.

3.15.12.1 GNSS Approaches at Alternate Aerodromes – GPS (TSO C129/C129a) Avionics

The status of the GPS constellation may be obtained through the FAA by contacting a NAV CANADA flight information centre (FIC) and requesting the international NOTAM file KNMH.

A procedure that meets the requirement to ensure that approach-level RAIM will be available at the alternate for TSO C129/C129a avionics is:

(a) Determine the ETA at the proposed alternate aerodrome following a missed approach at the destination.

(b) Check GPS NOTAM (KNMH) file for a period of 60 min before and after the ETA. If not more than one satellite outage is predicted during that period, then 3.15.12(c) is satisfied. If two or more satellites are anticipated to be unserviceable during the ETA ±60-min period, then it is necessary to determine if approach-level RAIM will be available, taking into account the reduced availability resulting from the outages. This may be accomplished by using commercially-available dispatch RAIM prediction software, acquiring a current almanac, and manually deselecting those satellites for the times described in the NOTAM.

The RAIM availability requirement is satisfied if the resulting prediction indicates that RAIM will be unavailable for a total of 15 min or less during the ETA ±60-min period.

It may be possible to change the alternate or adjust the departure time (and hence the ETA at the alternate) and re-run the prediction to find a time for which the required RAIM availability is achieved, or simply to find a time when fewer than two satellite outages are predicted.

3.15.12.2 GNSS Approaches at Alternate Aerodromes – WAAS Avionics

Verifying that an LNAV approach is expected to be available is less complicated for operators using WAAS avionics (TSO C145a/C146a). Simply check the national (CYHQ) and FIR NOTAM files to ensure that the WAAS NOTAM system has not failed, and that no widespread WAAS outages have occurred, and then check the aerodrome NOTAM file for the alternate to ensure that LNAV will be available.

The NOTAM system automatically evaluates if sufficient integrity will be available from WAAS GEO satellite messages. In the event of a widespread outage of WAAS messages (as in the rare case of a GEO satellite or total system failure), or at an aerodrome outside the GEO coverage area, it determines if approach-level RAIM, as computed by a WAAS receiver, will be available. For all of these situations, the absence of an aerodrome NOTAM will give the pilot a reasonable assurance that an LNAV approach will be available.

If the WAAS NOTAM system has failed, a national NOTAM will be issued, indicating that WAAS is unmonitored. In this case, the pilot may use the procedure described in the preceding section for TSO C129/C129a avionics. This will provide a safe, although conservative indication of the availability of LNAV.

3.15.13 Next Generation GNSS

The U.S. has started planning for the next-generation GPS satellites, and Europe is proceeding with Galileo, which should be interoperable with GPS. These new systems will have features that improve performance considerably. Both will transmit higher power signals on at least two frequencies in protected navigation bands. Because ionospheric delay is related to frequency, next-generation avionics will be able to calculate the delay directly. This will mean that SBAS should readily support CAT I approaches over wide areas because the greatest challenge for today's SBAS is ensuring the integrity of the ionospheric corrections.

Latest estimates suggest that the Galileo constellation should be commissioned for aviation use by 2010, while the modernized GPS constellation should be fully operational by 2015.

3.15.14 Required Navigation Performance (RNP) and SatNav

In the future, standards for operations in specified airspace or to fly specific procedures will likely follow the RNP concept. In principle, instead of legislating that aircraft be equipped with specific avionics to operate within designated airspace, an RNP level will be specified. The pilot and operator will be responsible for ensuring that the aircraft has the proper equipment.

RNP is based on an RNAV system, but uses a total performance-based approach to ensure a high probability of containment within a defined corridor.

This requires availability of containment integrity and continuity. Since all SatNav systems are designed to these standards, it is expected that SatNav will support these advanced operations.

Potential benefits expected from RNP include tighter lateral and longitudinal separation, more direct routings, and lower approach minima and increased capacity at certain airports. There are, however, other factors to consider when implementing RNP, including the availability of surveillance and communications. Therefore, separation standards will depend on total system performance, not just navigation performance.

3.15.15 GNSS Vulnerability – Interference/Anomaly Reporting

One of the most controversial issues surrounding SatNav is its ability to become a "sole means" system, thus allowing the decommissioning of traditional ground aids.

Recent studies confirmed that interference (unintentional and intentional) is the key concern, because GNSS signals are very weak. In reality, intentional interference is the key threat, because a well-regulated spectrum and the fact that next-generation satellites will broadcast on multiple frequencies make the probability of unintentional interference negligible. The solution will be some combination of ground-based systems, on-board systems (e.g. IRS) and operating procedures. The appropriate mix for a given area will result from careful analysis of threats, area complexity, benefits, costs and risk acceptance.

The primary goal when developing a mitigation strategy is to ensure safety. A secondary but very important goal is to reduce disruption and economic impact to a minimum. If the impact of intentional interference is reduced to the nuisance level, it will not be worth the effort to interfere with the signal.

Decisions on the retention of ground aids will be based on an area-specific analysis. Approach guidance is a critical application, but this does not mean that each approach would require backup guidance. The number of backup approaches in an area would be based on a thorough analysis of the hazard and on ensuring that all aircraft could land safely somewhere.

Vulnerability and backup issues must be coordinated globally to ensure that a uniform and appropriate strategy is applied by all States. Material on the subject was presented at the 11th ICAO Air Navigation Conference, held in September 2003, and should help countries make planning decisions.

Canada must find a solution that is matched to the traffic density and potential for interference in Canada. NAV CANADA is actively researching this issue, and will make decisions in consultation with its customers and Transport Canada. Regardless, even if SatNav never attains "sole means" status for all phases of flight, it will deliver significant safety and efficiency benefits to aircraft operators.

In the near term, pilots using IFR-certified GNSS avionics are protected against interference-induced navigation errors by integrity monitoring provided by RAIM or WAAS. A degraded SNR can also hinder navigation. In the event of suspected GPS interference or other problems with GPS, pilots should advise ATS, and, if necessary, revert to using traditional aids for navigation. Pilots are also requested to complete a "GPS Anomaly Report Form" (Figure 3.4), or equivalent, in order to assist in the identification and elimination of sources of interference or degradation of the GPS signal.

3.15.16 Proper Use of GNSS

SatNav offers a great opportunity to improve aviation safety and efficiency. Many pilots are already benefiting from the advantages of GPS as a principal navigation tool for IFR flight or for VFR operations. To ensure safety, pilots must use GNSS properly. Here are some safety tips:

- Use only IFR-certified avionics for IFR flights because hand-held and panel-mount VFR do not provide the integrity needed for IFR operations;
- For IFR flight, a valid database shall be used for approach—a new one is required every 28 or 56 days;
- Data storage limitations have resulted in some manufacturers omitting certain data from the avionics database. Prior to flight to remote or small aerodromes, pilots should verify that all procedures that could be required are present in the database;
- Do not become approach designers—approach designers require special training and specific tools, and there are many levels of validation before an approach is commissioned. Furthermore, the receiver RAIM level and course deviation indicator (CDI) sensitivity will not be appropriate if an approach is not retrieved from the avionics database;
- Never fly below published minimum altitudes while in instrument conditions. Accidents have resulted from pilots relying too much on the accuracy of GNSS;
- VFR receivers may be used to supplement map reading in visual conditions, but are not to be used as a replacement for current charts;
- Hand-held receivers and related cables should be positioned carefully in the cockpit to avoid the potential for electromagnetic interference (EMI), and to avoid interfering with aircraft controls; hand-held units with valid databases can also be useful in emergencies when IFR units fail; and
- When navigating VFR, resist the urge to fly into marginal weather. The risk of becoming lost is small when using GNSS, but the risk of controlled flight into terrain or obstacles increases in low visibility. VFR charts must also be current and updated from applicable NOTAM, and should be the primary reference for avoiding alert areas, etc. Some VFR receivers display these areas, but there is no guarantee that the presentation is correct, because there is no standard for such depictions.

3.15.17 Communication, Navigation, Surveillance Implementation Team (CNS IT)

NAV CANADA and Transport Canada work together on GNSS implementation and transition issues through the joint CNS IT. The CNS IT has taken over the functions of the GNSS Implementation Team (GIT). One of the concerns of the CNS IT is ensuring that new GNSS services meet aviation's stringent safety standards while serving the needs of the Canadian aviation community.

The CNS IT often forms working groups to address specific issues. These groups discuss the expansion of approvals to use SatNav or the resolution of an operational or technical problem. The working groups present the results of their work to the CNS IT for discussion, endorsement and forwarding to Transport Canada and NAV CANADA management for final approval.

The CNS IT follows a safety management methodology that dictates that a risk assessment be completed before implementing new services.

3.15.18 GNSS User Comments

NAV CANADA's CNS Service Design (CNS SD) Branch is constantly assessing the capabilities and limitations of SatNav in order to bring maximum benefits to users as soon as possible. CNS SD staff participate in the development of international standards, keep abreast of technology developments and assess the operational application of GNSS.

Through the CNS IT, NAV CANADA and Transport Canada are working with national user organizations on GPS and other initiatives to make aircraft operations more efficient. As a pilot or operator, you can relay your comments on GNSS and related issues via one of these organizations, or you can contact the CNS SD directly:

NAV CANADA
CNS Service Design
77 Metcalfe Street
Ottawa ON K1P 5L6

Fax: 613-563-7995
E-mail: .... *satnav@navcanada.ca*
Web site: .... *<www.navcanada.ca>*

NAV CANADA

Figure 3.4—GPS Anomaly Report Form

ORIGINATOR INFORMATION

Prepared by:	Date:
Address:	Telephone: Fax: E-mail:

GPS EQUIPMENT INFORMATION

Aircraft Registration:		Aircraft Type:	
GPS Receiver Type:	❑ Hand-held	❑ Panel Mount	❑ FMS Sensor
TSO C129 Approved?	Yes / No	Installation Approved for:	❑ IFR ❑ VFR

GPS Make/Model:

GPS Antenna Location: ❑ on aircraft ❑ suction cup ❑ on unit

Remarks:

OCCURRENCE INFORMATION

Date of Occurrence:	Approx. Altitude:
Approx. Time of Occurrence:	

Approx. Location of Occurrence (Lat./Long. or nearest city or landmark):

What did the receiver indicate during the problem:

❑ Large position errors (details): ❑ Degraded signal to noise (details):
❑ Loss of integrity (RAIM warning/alert): ❑ Other:
❑ Loss of coverage (details):
❑ Loss of satellites in view (details):

Problem duration: ❑ Seconds ❑ Minutes ❑ Hours ❑ Days

What did the receiver indicate prior to the problem:

Action taken by operator to correct problem, or did the anomaly resolve itself:

Possible causes (e.g. on-board VHF radio transmission, TV Radio transmitter antennas, buildings, suspicious activity)

Comments or details:

Return form to: SatNav Program Office
NAV CANADA
77 Metcalfe Street
Ottawa ON K1P 5L6
Fax: 613 563-7995

COM

4.0 TIME SIGNALS

4.1 General

The National Research Council time signals emanate from Ottawa station CHU on the frequencies 3330, 7335 and 14670 kHz. Transmissions are AM, continuous and simultaneous on all frequencies and the area of coverage includes most of North America and many other parts of the world.

The listener hears a beat for each mean second which is a pulse 1/5 of a second long except that the zero pulse of each minute is increased to 1/2 second long and the zero pulse for each hour is a full second long followed by 40 seconds of silence. In order to permit the listener to detect half-minutes, the 29th pulse of each minute is omitted.

A voice announcement of the time is made each minute in the ten-second gap between the 50th and 60th seconds. The announced time refers to the beginning of the minute pulse which follows the announcement. The voice announcements are made in English and French using the 24-hour system.

5.0 RADIO COMMUNICATIONS

5.1 General

This part deals with radio communications between aircraft and ground stations. Particular emphasis is placed on radiotelephony procedures that are intended to promote understanding of messages and reduce communications time.

The primary medium for aeronautical communications in Canada is VHF-AM in the frequency range of 118 to 137 MHz. For increased range in the northern areas and the North Atlantic, HF-SSB is available in the frequency range of 2.8 to 22 MHz.

Regulations

Operator's Certificates: In accordance with the

Radiocommunication Regulations, a person may operate radio apparatus in the aeronautical service only where the person holds a Restricted Operator Certificate with Aeronautical Qualification, issued by Industry Canada.

Station Licences: All radio equipment used in aeronautical services required to be licensed by Industry Canada.

For complete information on the requirements for communication in Canada, please consult the *Study Guide for the Radiotelephone Operator's Restricted Certificate Aeronautical*, (RIC21). This study guide is available from the nearest Industry Canada district office or by calling 1-877-604-7493.

5.2 Language

The use of English and French for aeronautical radio communications in Canada is detailed in sections 602.133, 602.134, and 602.135 of the CARs. The regulations specify that air traffic services shall be provided in English and sets out the locations where services shall be provided in French as well. The tables containing the names of those locations, as well as the pertinent section of the CARs are contained in COM Annex A.

For safety and operational efficiency, once the language to be used has been determined, the pilot should refrain from changing language in the course of communications without formal notification to that effect. In addition, pilots should endeavour to become thoroughly familiar with the aeronautical phraseology and terminology applicable to the type of service being provided in the official language of their choice.

5.3 VHF Communication Frequencies–Channel Spacing

The standard VHF A/G channel spacing in Canada is 25 kHz. A 760 channel transceiver is necessary for operation of 25 kHz channels. In some areas of Europe, channel spacing has been reduced to 8.33 kHz.

This channel spacing means that some operators with 50 kHz capability will have their access to certain Canadian airspace and airports restricted as 25 kHz channels are implemented for ATC purposes. Similarly, where ATC makes use of 8.33 kHz channels in Europe, restrictions may also apply.

Because the frequency selectors on some 25 kHz transceivers do not display the third decimal place, misunderstanding may exist in the selection of frequencies. With such transceivers, if the last digit displayed includes 2 and 7, then the equipment is capable of 25 kHz operations.

Example:

Toronto Centre: .... 132.475 (actual frequency)
ATC Assigned Frequency: .... 132.47 (digit 5 omitted)
Aircraft Radio Display: ....132.475 or 132.47

In either case, the aircraft radio is actually tuned to the proper frequency.

5.4 Use of Phonetics

Phonetic letter equivalents shall be used for single letters or to spell out groups of letters or words as much as practicable. The ICAO phonetic alphabet should be used.

THE PHONETIC ALPHABET AND MORSE CODE

LETTER	CODE	WORD	PRONUNCIATION	LETTER	CODE	WORD	PRONUNCIATION
A	•–	Alfa	AL fah	N	–•	November	no VEM ber
B	–•••	Bravo	BRAH VOH	O	–––	Oscar	OSS cah
C	–•–•	Charlie	CHAR lee or SHAR lee	P	•––•	Papa	pah PAH
D	–••	Delta	DELL tah	Q	––•–	Quebec	keh BECK
E	•	Echo	ECK oh	R	•–•	Romeo	ROW me oh
F	••–•	Foxtrot	FOKS trot	S	•••	Sierra	see AIR rah
G	––•	Golf	GOLF	T	–	Tango	TANG go
H	••••	Hotel	hoh TELL	U	••–	Uniform	YOU nee form or OO nee form
I	••	India	IN dee ah	V	•••–	Victor	VIK tah
J	•–––	Juliett	JEW lee ETT	W	•––	Whiskey	WISS key
K	–•–	Kilo	KEY loh	X	–••–	X-ray	ECKS RAY
L	•–••	Lima	LEE mah	Y	–•––	Yankee	YANG key
M	––	Mike	MIKE	Z	––••	Zulu	ZOO loo
NUMBER	CODE	WORD	PRONUNCIATION	NUMBER	CODE	WORD	PRONUNCIATION
O	–––––	Zero	ZE RO	5	•••••	Five	FIFE
1	•––––	One	WUN	6	–••••	Six	SIX
2	••–––	Two	TOO	7	––•••	Seven	SEV en
3	•••––	Three	TREE	8	–––••	Eight	AIT
4	••••–	Four	FOW er	9	––––•	Nine	NIN er

When spoken, capitalized syllables are given equal stress, e.g., ECKS-RAY. When only one syllable is capitalized, that syllable is given primary stress, e.g., NINE-er.

5.5 Airways and Air Routes Designation

Phonetics are used with the designation of Canadian airways and air routes.

Examples:

	WRITTEN	*SPOKEN*
AIRWAYS	G1	GOLF1
	A2	ALFA 2
	J500	JET 500
AIR ROUTES	RR3	ROMEO ROMEO 3
	BR4	BRAVO ROMEO 4

5.6 Distance Reporting

Distance reporting based on RNAV and GPS will be provided in miles, e.g. 30 mi. from Someplace. When distance reports are based on DME, pilots will state DME, e.g. 30 DME from Someplace.

5.7 Use of Numbers

All numbers except whole thousands should be transmitted by pronouncing each digit separately:

Examples:

572 *FIVE SEVEN TWO*
11000 *ONE ONE THOUSAND*

Altitude above sea level is expressed in thousands and hundreds of feet. Separate digits must be used to express flight levels.

Examples:

2700 *TWO THOUSAND SEVEN HUNDRED*
FL260 *Flight Level TWO SIX ZERO*

Aircraft type numbers, wind speed and cloud base may be expressed in group form:

Examples:

DC10 *DC TEN*
Wind 270/10 *WIND TWO SEVEN ZERO AT TEN*
3400 broken *THREE THOUSAND FOUR HUNDRED BROKEN*

Time – Co-ordinated Universal Time (UTC)

Examples:

0920Z *ZERO NINE TWO ZERO ZULU*
09 minutes *ZERO NINE (past the next hour)*

Aircraft headings are given in groups of three digits prefixed by the word “Heading”. If operating within the Southern Domestic Airspace, degrees are expressed in “magnetic”. If operating within the Northern Domestic Airspace, degrees are expressed in “True”.

Example:

005 degrees *HEADING ZERO ZERO FIVE*

Aerodrome elevations are expressed in feet, prefixed by the words “Field Elevation”.

Example:

150 *FIELD ELEVATION ONE FIVE ZERO*

Transponder codes are preceded by the word SQUAWK.

Example:

code 1200 *SQUAWK ONE TWO ZERO ZERO*

Numbers containing a decimal point are expressed with the decimal point in the appropriate sequence by the word DECIMAL except that for VHF or UHF frequencies, the decimal point may be omitted if the omission is not likely to cause any misunderstanding.

5.8 Call Signs

5.8.1 Civil Aircraft

In radio communications, use phonetics at all times if the call sign consists of the aircraft’s registration.

The word “heavy” is used to indicate an aircraft is certified for a maximum take-off weight of 300 000 lbs or more.

After communication has been established, and when no likelihood of confusion exists, the word “heavy” may be omitted, and call signs may be abbreviated.

A MEDEVAC is a flight responding to a medical emergency for the transport of patients, organ donors, organs or other urgently needed life-saving medical material. This can also apply to certain medical flights, including helicopters, which may be designated as Air Ambulance Flights.

Canadian and Foreign Air Carriers:

(a) *Initial contact*: The operator's radiotelephony designator followed by: the flight number, or the last four characters of the aircraft registration, and the word "heavy" if applicable.

Examples:

Air Canada 149 Heavy (AIR CANADA ONE FOUR NINE HEAVY)
Air Canada FTHA Heavy (AIR CANADA FOXTROT TANGO HOTEL ALFA HEAVY)
Speedbird GABCD Heavy (SPEEDBIRD GOLF ALFA BRAVO CHARLIE DELTA HEAVY)

(b) *Subsequent communications*: The word "heavy" may be omitted, and where the aircraft registration is used, it may be abbreviated to the operator's radiotelephony designator and at least the last two characters of the aircraft registration.

Examples:

Air Canada HA (AIR CANADA HOTEL ALFA)
Speedbird CD (SPEEDBIRD CHARLIE DELTA)

Canadian Private Civil Aircraft and Canadian or Foreign Carriers Without an Assigned Radiotelephony Designator:

(a) *Initial contact:* The manufacturer's name or the type of aircraft, followed by the last four characters of the registration.

Examples:

Cessna GADT (CESSNA GOLF ALFA DELTA TANGO)
Aztec FADT (AZTEC FOXTROT ALFA DELTA TANGO)

NOTE: The words "helicopter," "glider" or "ultralight" are an acceptable substitute for the type of aircraft when these types of aircraft are used.

(b) *Subsequent communications*: May be abbreviated to the last three characters of the registration, if this abbreviation is initiated by ATS.

Examples:

Cessna GADT becomes "ADT" (ALFA DELTA TANGO)
Aztec FADT becomes "ADT" (ALFA DELTA TANGO)

Foreign Private Civil Aircraft:

(a) *Initial contact*: The manufacturer's name or the type of aircraft, followed by the full aircraft registration.

Example:

Mooney-N6920K (MOONEY NOVEMBER SIX NINE TWO ZERO KILO).

(b) *Subsequent communications*: May be abbreviated to the last three characters of the registration, if this abbreviation is initiated by ATS.

Example:

Mooney-N6920K becomes 20K (TWO ZERO KILO).

Medical Evacuation Flights (MEDEVAC):

(a) Initial contact: The manufacturer's name or type of aircraft or operator's radiotelephony designator, followed by:

(i) the flight number and the word MEDEVAC, or
(ii) the last four characters of the aircraft registration and the word MEDEVAC.

Examples:

Austin 101 MEDEVAC (AUSTIN ONE ZERO ONE MEDEVAC)
Cessna FABC MEDEVAC (CESSNA FOXTROT ALFA BRAVO CHARLIE MEDEVAC).

(c) *Subsequent communications*: May be abbreviated as per normal procedures, retaining the word MEDEVAC.

Formation Flights:

(a) Initial contact: The aircraft call sign or the last four characters of the aircraft's registration followed by "Flight, Formation of (number of aircraft)".

Examples:

Griffin 11, Flight, Formation of 4 (GRIFFIN ONE ONE, FLIGHT, FORMATION OF FOUR)
FLVM, Flight, Formation of 2 (FOXTROT LIMA VICTOR MIKE, FLIGHT, FORMATION OF TWO)

(b) *Subsequent communications:* The number of aircraft may be eliminated. All subsequent communications to and from the formation should include the word "Flight".

Examples:

Griffin 11, Flight (GRIFFIN ONE ONE, FLIGHT)
FLVM, Flight (FOXTROT LIMA VICTOR MIKE, FLIGHT)

Similar Sounding Call Signs:

If communicating with two or more aircraft that are using the same flight number or similar sounding identifications, ATS will advise each of the aircraft concerned of the other's presence.

In order to further minimize the chance for call sign confusion, ATS may:

(a) restate the operator's radiotelephony designator of the aircraft involved after the flight number, for emphasis.

Examples:

JAZZ EIGHT EIGHT ONE THREE JAZZ
TRANSPORT EIGHT ONE THREE TRANSPORT

(b) add the type of aircraft to the identification:

Examples:

CHEROKEE ALFA BRAVO CHARLIE

or

(c) instruct aircraft using the same flight number or similar sounding identification to use:
- (i) the aircraft registration; or
- (ii) the operator's radiotelephony designator, followed by at least the last two characters of the aircraft registration.

Example:

JAZZ NOVEMBER DELTA
CANJET ECHO PAPA ALFA

5.8.2 Ground Stations

General

The aerodrome name as published in the CFS is used to form the call sign to the associated ground stations. When the aerodrome name is different from the community (location) name, it will be published following the community (location) name and will be separated by a diagonal (/). Exceptions should be listed in the COMM Section of the CFS.

Example:

TORONTO/LESTER B. PEARSON INTL ONT

COMM TWR	Toronto	TORONTO TOWER

Other Examples of Call Signs:

	CFS		Call Sign
	COMM		
Area Control Centre	CENTRE		MONTRÉAL CENTRE
Flight Service Station	RADIO		MONCTON RADIO
Terminal Control	TML		QUÉBEC TERMINAL
Arrival Control	ARR		VANCOUVER ARRIVAL
Departure Control	DEP		EDMONTON DEPARTURE
Clearance Delivery	CLNC DEL		OTTAWA CLEARANCE DELIVERY
Community Aerodrome Radio Station	APRT RDO		REPULSE BAY AIRPORT RADIO
Pilot to Forecaster	PMSV		COMOX METRO
Apron Advisory Service	APRON		MIRABEL APRON
Remote Communication Outlet	RCO	*Rouyn rdo*	ROUYN RADIO
Mandatory Frequency	MF	*rdo*	FREDERICTON RADIO
Aerodrome Traffic Frequency	ATF		MANIWAKI UNICOM
Peripheral Station	PAL	*Winnipeg Ctr*	WINNIPEG CENTRE
VFR Advisory	VFR ADV		TORONTO TERMINAL

5.8.3 RCO

An RCO is a facility remotely established from an FSS or flight information centre (FIC) to provide communications between aircraft and this FSS or FIC. They are intended only for FISE and RAAS communications. There is only one procedure to be used to establish communications on any RCO.

On initial contact, the pilot should state the identification of the ATS unit (FSS or FIC) controlling the RCO, the aircraft identification, and the name of the location of the RCO followed by the individual letters R-C-O in a non-phonetic form.

Example:

HALIFAX RADIO, CHEROKEE GOLF ALFA BRAVO CHARLIE ON THE FREDERICTON R-C-O

The name of the RCO assists the flight service specialist in identifying the RCO on which the call is made, as the same person can monitor many frequencies. The specialist will respond with the aircraft identification followed by the identification of the unit controlling the RCO.

Example:

GOLF ALFA BRAVO CHARLIE, HALIFAX RADIO

5.9 Standard Radio Telephony

General

The *Radio communication Regulations* specify that aeronautical radio communications are restricted to communications relating to
- the safety and navigation of an aircraft;
- the general operation of the aircraft; and
- the exchange of messages on behalf of the public.

In addition, a person may operate radio apparatus only to transmit a non-superfluous signal or a signal containing non-profane or non-obscene radiocommunications.

Pilots should

(a) send radio messages clearly and concisely using standard phraseology whenever practical;

(b) plan the content of the message before transmitting; and

(c) listen out before transmitting to avoid interference with other transmissions.

Message: Radiotelephony traffic generally consists of four parts: the call-up, the reply, the message and the acknowledgement.

Pilot: *REGINA TOWER, (THIS IS) CESSNA FOXTROT BRAVO CHARLIE DELTA (OVER).*

Tower: *CESSNA FOXTROT BRAVO CHARLIE DELTA, REGINA TOWER.*

Pilot: *REGINA TOWER, FOXTROT BRAVO CHARLIE DELTA, TEN SOUTH THREE THOUSAND FIVE HUNDRED FEET VFR LANDING INSTRUCTIONS*

Tower: *BRAVO CHARLIE DELTA, REGINA TOWER, RUNWAY TWO SIX, WIND TWO THREE ZERO AT TEN, ALTIMETER TWO NINE NINE TWO, CLEARED TO THE CIRCUIT.*

Pilot: *BRAVO CHARLIE DELTA.*

The terms "this is" and "over" may be omitted, and if no likelihood of confusion exists, the call sign for the agency being called maybe abbreviated as follows:

Pilot: *TOWER, BRAVO CHARLIE DELTA, CONFIRM RIGHT TURN.*

Message Acknowledgement: Pilots should acknowledge the receipt of all messages directed to them, including frequency changes. Such acknowledgement may take the form of a transmission of the aircraft call sign, a repeat of the clearance with the aircraft call sign or the call sign with an appropriate word(s).

Tower: *VICTOR LIMA CHARLIE, CLEARED TO LAND.*

Pilot: *VICTOR LIMA CHARLIE.*

Tower: *FOXTROT VICTOR LIMA CHARLIE, CONFIRM YOU ARE AT FIVE THOUSAND.*

Pilot: *FOXTROT VICTOR LIMA CHARLIE, AFFIRMATIVE.*

NOTE: The clicking of the microphone button as a form of acknowledgement is not an acceptable radio procedure.

COM

5.10 Communications Checks

The readability scale from one to five has the following meaning:

1. unreadable;
2. readable now and then;
3. readable with difficulty;
4. readable; and
5. perfectly readable.

The strength scale from one to five used in HF communications has the following meaning:

1. bad;
2. poor;
3. fair;
4. good; and
5. excellent.

Communications checks are categorized as follows:

Signal Check — if the test is made while the aircraft is airborne.

Pre-flight Check — if the test is made prior to departure.

Maintenance Check — if the test is made by ground maintenance.

Pilot: *THOMPSON RADIO, CESSNA FOXTROT ALFA BRAVO CHARLIE, RADIO CHECK ON FIVE SIX EIGHT ZERO.*

Radio: *FOXTROT ALFA BRAVO CHARLIE, THOMPSON RADIO, READING YOU STRENGTH FIVE, OVER.*

5.11 Emergency Communications

General

An emergency situation is classified in one of the two following categories, in accordance with the degree of danger or hazard present:

(a) distress is a condition of being threatened by serious and/or imminent danger and of requiring immediate assistance. The spoken word for distress is MAYDAY, and it is pronounced three times.

(b) urgency is a condition concerning the safety of an aircraft or other vehicle, or of some person on board or within sight, but which does not require immediate assistance. The spoken word for urgency is PAN PAN, and it is pronounced three times.

The first transmission of the distress call and message by an aircraft should be on the air-to-ground frequency in use at the time. If the aircraft is unable to establish communication on the frequency in use, the distress call and message should be repeated on the HF general calling or distress frequency 3 023.5 kHz, 5 680 kHz, 121.5 MHz, 406.1 MHz, or other distress frequency available, such as 2 182 kHz, in an effort to establish communications with any ground station or the maritime service.

The distress call shall have absolute priority over all other transmissions. All stations hearing it shall immediately cease any transmission that may interfere with it and shall listen on the frequency used for the distress call.

Example of a distress message from an aircraft:

MAYDAY, MAYDAY, MAYDAY, THIS IS FOXTROT ZULU X-RAY YANKEE, FOXTROT ZULU X-RAY YANKEE, FOXTROT ZULU X-RAY YANKEE, FIVE ZERO MILES SOUTH OF YELLOWKNIFE AT ONE SEVEN TWO FIVE ZULU, FOUR THOUSAND, NORSEMAN, ICING, WILL ATTEMPT CRASH LANDING ON ICE, FOXTROT ZULU X-RAY YANKEE, OVER.

Example of an urgency message addressed to all stations:

PAN PAN, PAN PAN, PAN PAN, ALL STATIONS, ALL STATIONS, ALL STATIONS, THIS IS TIMMINS RADIO, TIMMINS RADIO, TIMMINS RADIO, EMERGENCY DESCENT AT TIMMINS AIRPORT, ATC INSTRUCTS ALL AIRCRAFT BELOW SIX THOUSAND FEET WITHIN RADIUS OF ONE ZERO MILES OF TIMMINS NDB LEAVE EAST AND NORTH COURSES IMMEDIATELY, THIS IS TIMMINS RADIO OUT.

Emergency procedures are contained in RAC and SAR.

121.5 MHz in the Air Navigation System (ANS)

Only control towers and FSSs have 121.5 MHz capability, a nd this emergency frequency is only monitored during these facilities' hours of operation. Remote communication facilities (PAL, RAAS RCO and FISE RCO) do not have 121.5 MHz capability.

During an emergency, a pilot has the following options for communicating with ATS:

- When within radio reception of a control tower or FSS during the facility's hours of operation, call ATS on the tower frequency/FSS mandatory frequency (MF) or 121.5 MHz. It is recommended that pilots use the normal or frequency in use at the time.
- When within radio reception of a remote communications facility (FISE RCO, RAAS RCO or PAL), call ATS on the published frequency (Note: FISE RCOs and PALs operate 24 hr, while most RAAS RCOs operate part time).
- When out of range for VHF communications (for example at low altitude, along a highway corridor), pilots may use a cell phone if they have cell phone coverage (see COM 5.15).
- If beyond the radio reception of an ATS facility, or when outside the facility's hours of operation, broadcast on 121.5 MHz or 126.7 MHz, or both, for assistance from other pilots who may be monitoring the frequency.

Satellite Voice

Inmarsat, in conjunction with ICAO, has developed a telephone numbering plan to facilitate the use of satellite voice by suitably equipped aircraft as a backup to the existing primary A/G facilities. The use of SATCOM voice for this purpose requires on board embedded equipment. Permanent satellite voice equipment is installed and tested in accordance with appropriate certification and airworthiness standards.

The telephone numbering plan assigns a code specific to each FIR. When a ground earth station receives the unique code from the aircraft via satellite, it is converted and the call is routed to the appropriate ATS unit.

For emergency communications, the Inmarsat short codes and public switched telephone network (PSTN) numbers are as follows:

Location	Short Code/ Inmarsat	PSTN Number
Gander Oceanic FIR	431603	1-709-651-5324
Gander Domestic FIR	431602	1-709-651-5315
Gander Radio	431613	1-709-651-5328
Moncton FIR	431604	1-506-867-7173
Montréal FIR	431605	1-514-633-3211
Toronto FIR	431606	1-905-676-4509
Winnipeg FIR	431608	1-204-983-8338
Edmonton FIR	431601	1-780-890-8397
Vancouver FIR	431607	1-604-586-4500

5.12 Monitoring of Emergency Frequency 121.5 MHz

A pilot should continuously monitor 121.5 MHz when operating within sparsely settled areas or when operating a Canadian aircraft over water more than 50 NM from shore unless:

(a) essential cockpit duties or aircraft electronic equipment limitations do not permit simultaneous monitoring of two VHF frequencies; or

(b) the pilot is using other VHF frequencies.

5.13 VHF Frequency Allocations

5.13.1 Air Traffic Services

ATS frequencies are published in the *Canada Flight Supplements*(CFS), aeronautical charts and the *Canada Air Pilot* (CAP).

5.13.2 Soaring

Frequency 123.4 MHz is allocated for the use of soaring activities, which include balloons, gliders, sailplanes, ultralights and hang gliders. The use of this frequency for these activities includes air-to-air, air-to-ground instructional and air-to-ground aerodrome traffic communications; the use of this frequency as an *aerodrome traffic frequency* (ATF) is normally restricted to privately operated aerodromes used primarily for these activities.

5.13.3 Air-to-Air

For air-to-air communications between pilots within the Canadian Southern Domestic Airspace, the correct frequency to use is 122.75 MHz; in the Northern Domestic Airspace and the North Atlantic, the frequency allocated by ICAO is 123.45 MHz.

5.14 Use of Frequency 5680 kHz

This frequency provides long-range A/G communications coverage in the remote areas of Canada for the provision of FISE beyond the range of VHF communications. Aircraft must use SSBs when communicating on 5680 kHz.

HF 5680 kHz RCOs

Location	**Controlling ATS Unit**
Baker Lake, Nunavut	North Bay FIC
Inuvik, Northwest Territories	North Bay FIC
Iqaluit, Nunavut	North Bay FIC
Kuujjuaq, Quebec	Quebec FIC
Kuujjuarapik, Quebec	Quebec FIC
Resolute Bay, Nunavut	North Bay FIC
Roberval, Quebec	Quebec FIC
St. Anthony, Newfoundland & Labrador	Halifax FIC
Yellowknife, Northwest Territories	North Bay FIC

5.15 Phone Use During a Radio Communications Failure

COM 5.11 outlines the procedures for emergency communications using existing A/G facilities as the primary source of communications, and satellite voice as a backup.

In the event of an in-flight radio communications failure, and only after normal communications failure procedures have been followed (see RAC 6.3.2.1), the pilot-in-command may attempt to contact the appropriate NAV CANADA ATS unit by means of a conventional cell or satellite phone. Before placing the call, transponder-equipped aircraft should squawk Code 7600 (see RAC 1.9.7).

Public switched telephone network (PSTN) numbers to be used in the event of a communication failure are included in COM 5.11 and published in the CFS.

6.0 AERONAUTICAL FIXED SERVICES – INTERNATIONAL FLIGHTS

6.1 AFS

6.1.1 Voice Systems

Voice systems consist of the ATC Interphone system and AMIS.

6.1.2 AFTN

The AFTN is an integral part of a worldwide system of message switching centres and fixed circuits that allows for aeronautical data exchange between ICAO Member States. Canadian ACCs, FICs, FSSs and other aeronautical facilities are interconnected by the AFTN.

Canada's contribution to the AFTN is provided by the AFTN Message Handling System, owned and operated by NAV CANADA, in Ottawa. This centralized store-and-forward message handling system provides for the real-time reception, storage and delivery of aeronautical data nationally, via AFTN stations within Canada, and internationally via the USA, UK, Iceland and Greenland. Command and control of the AFTN Message Handling System is provided by NAV CANADA's National Systems Control Centre (NSCC). Queries on AFTN service can be directed to the NSCC at:

NAV CANADA
National Systems Control Centre
1601 Tom Roberts Avenue
P.O. Box 9824 Station T
Ottawa ON K1G 6R2
AFTN Message Address:... CYAAMCFA or CYAAYFAX
Tel.: 613-248-3993
Fax: 613-248-4001
E-mail: .... *nscc@navcanada.ca*

The standards, recommended practices and procedures for the acceptance, transmission and delivery of messages within the AFTN are in accordance with the provisions of ICAO Annex 10, Volume II and allow for the exchange of the following categories of aeronautical messages:

(a) distress messages;
(b) urgency messages;
(c) flight safety messages;
(d) meteorological messages;
(e) flight regularity messages;
(f) aeronautical information services (AIS) messages;
(g) aeronautical administrative messages; and
(h) service messages.

Canadian locations and location indicators are listed in ICAO DOC 7910. Messages addressed to aeronautical stations not directly connected to the AFTN Message Handling System are automatically routed to the nearest aeronautical facility for delivery.

ICAO standards, recommended practices and procedures contained in the following documents apply:

Annex 10—*Aeronautical Telecommunications*;
DOC 7910—*Location Indicators*;
DOC 8400—*ICAO Abbreviations and Codes*; and
DOC 8585—*Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services.*

6.2 International A/G Service

Gander international flight service station (IFSS) is the only Canadian aeronautical station providing international aeronautical telecommunication services.

6.2.1 HFAeromobile Operations in the NAT

All NAT HF frequencies are organized into six groups, known as families. The families are identified as NAT Family A, B, C, D, E and F. Initial contact with Gander IFSS on HF radio should be made on families B, C, D or F.

The specific frequencies belonging to each family and their corresponding hours of operation are listed in the table below:

HF Frequencies		
Family A	3 016 kHz	2030Z–0830Z
	5 598 kHz	2030Z–0830Z
	8 906 kHz	0830Z–2230Z
	13 306 kHz	1230Z–1830Z
Family B	2 899 kHz	2030Z–0830Z
	5 616 kHz	24-hr service
	8 864 kHz	0830Z–2230Z
	13 291 kHz	1000Z–2000Z
Family C	2 872 kHz	2030Z–0830Z
	5 649 kHz	24-hr service
	8 879 kHz	0830Z–2230Z
	11 336 kHz	1030Z–1830Z
Family D	2 971 kHz	2030Z–0830Z
	4 675 kHz	2030Z–0830Z
	8 891 kHz	24-hr service
	11 279 kHz	1030Z–1830Z
Family E	2 962 kHz	unavailable
	6 628 kHz	unavailable
	8 825 kHz	unavailable
	11 309 kHz	unavailable
	13 354 kHz	unavailable
	17 946 kHz	unavailable
Family F	3 476 kHz	2030Z–0830Z
	6 622 kHz	1130Z–0730Z
	8 831 kHz	0830Z–2230Z

The allocation of families is generally based on the route of flight of the aircraft. Aircraft whose route, or portion of route, transits oceanic airspace between 43°N and 47°N will generally be assigned Family A; aircraft operating on routes between 47°N and 64°N will generally be assigned Family B or C; aircraft operating on routes north of 62°N will generally be assigned Family D; aircraft operating on routes south of 43°N will generally be assigned Family E; and finally, aircraft operating on routes entirely within the Gander Oceanic and Shanwick Oceanic control areas will generally be assigned Family F.

When an aircraft fails to establish contact with Gander IFSS on the designated frequency, it shall attempt to establish contact on another frequency appropriate to the route. See chart below:

Family	Route Co-ordinates	Description of Route
Family A	Routes between 43°N and 47°N	Central routes
Family B and C	Routes between 47°N and 64°N	Central routes
Family D	Routes north of 62°N	Central routes
Family E	Routes south of 43°N	Central routes
Family F	Routes operating entirely within Gander Oceanic and Shanwick Oceanic control areas.	Gander/Shanwick route

In the event of the overloading of a family actually occurring or being anticipated, aircraft of one or more operators may be offloaded from that family to another appropriate family for the expected duration of the condition. The offloading may be requested by any station, but Shannon and Gander will be responsible for making a decision after co-ordination with all NAT stations concerned.

6.2.2 HF Operations—Anchorage Arctic

Aircraft operating in the Anchorage Arctic CTA/FIR beyond the line-of-sight range of remote control VHF A/G facilities operated from the Anchorage ACC shall maintain communications with Gander Radio and a listening or SELCAL watch on HF frequencies of NAT Delta (NATD) network 2 971 kHz, 4 675 kHz, 8 891 kHz and 11 279 kHz. Additionally, and in view of reported marginal reception of Honolulu Pacific VOLMET broadcast in and adjacent to Canadian airspace, Gander Radio can provide, on request, Anchorage and Fairbanks surface observations and aerodrome forecasts to flight crews.

6.2.3 VOLMET

The VOLMET is meteorological information for aircraft in flight, particularly those over the high seas. The VOLMET contains METARs and aerodrome forecasts (TAF) for selected aerodromes and may be provided either by data link (D-VOLMET) or by voice broadcasts on designated frequencies, normally high frequency (HF).

Information on the content, issue times and transmitter frequencies for North Atlantic VOLMET broadcasts is given in the CFS, Section "D", Radio Navigation and Communications.

6.3 Availability of SSB

All international HF equipment is operated on SSB J3E emission. In all cases, the USB is employed.

6.4 SELCAL

SELCAL is installed on all international frequencies at Gander Radio. SELCAL provides an automatic and selective method of calling any aircraft. Voice calling is replaced by the transmission of code tones to the aircraft over the international radiotelephony channels. A single selective call consists of a combination of four pre-selected audio tones requiring approximately two seconds of transmission time. The tones are generated in the ground station coder and are received by a decoder connected to the audio output of the airborne receiver. Receipt of the assigned tone code (SELCAL code) activates a light or chime signal in the cockpit of the aircraft.

It is the responsibility of the flight crew to ensure that Gander Radio is informed of the SELCAL code available in the airborne equipment, if they intend to communicate with Gander Radio. This may be done in connection with the "off-ground" report or when transferring in flight from one network to another.

ICAO establishes the standards and procedures for SELCAL in Annex 10 to the *Convention on International Civil Aviation*, Volume II. The worldwide administration of SELCAL code assignments has been delegated to Aviation Spectrum Resources, Inc. (ASRI). SELCAL code application forms may be obtained at: <www.asri.aero/selcal>.

6.5 Telecommunications and En Route Facilities Service Fees

A service fee is levied for each international flight in the course of which an aircraft uses air/ground frequencies to obtain telecommunication services. Also, there is a service fee for aircraft flying over the NAT. For details, see FAL 3.0.

6.6 Use of General Purpose VHF or SATCOM Voice in Lieu of International HF A/G Frequencies

6.6.1 NAT and Anchorage Arctic Regions—SATCOM Voice Use

SATCOM voice may be used to contact Gander Radio for non-routine flight safety calls or during periods of poor HF propagation. Gander Radio may be contacted using Inmarsat short code 431613.

6.6.2 NAT Region—VHF Coverage

VHF FREQUENCIES	
126.9	(45N050W – 51N050W)
126.9 (CYFB)	(61N070W – 67N070W)
127.1	(48N050W – 54N050W)
122.375	(45N050W – 54N050W)
127.9	(57N-63N040W – 57N-61N050W)

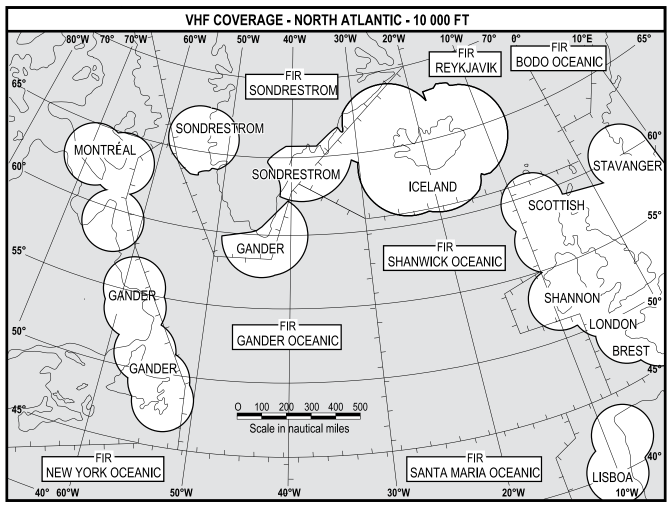
NOTE: SELCAL is utilized on all A/G frequencies.

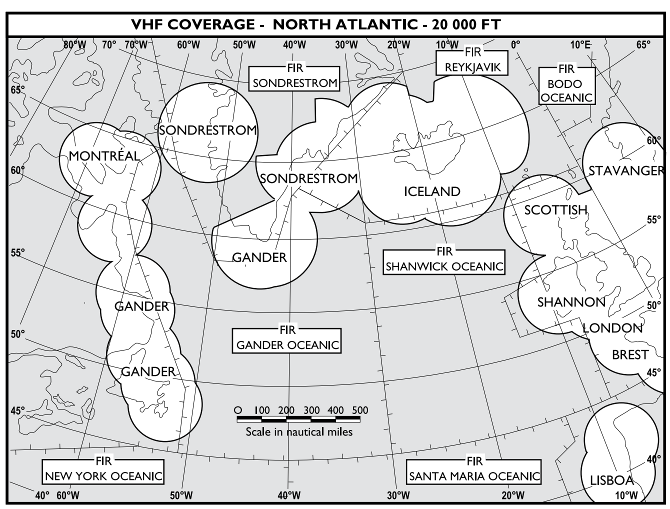
General purpose VHF communications facilities have been provided by Canada, Denmark and Iceland in order to supplement HF radio coverage in the NAT Region. General purpose VHF coverage is shown on the charts following this subsection. It should be noted that:

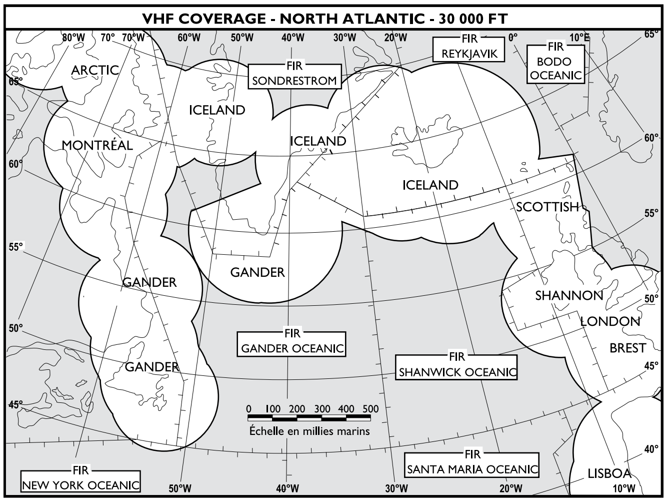
(a) charts depict approximate coverage areas only;

(b) coverage at lower altitudes will be less than depicted; and

(c) the minimum altitude for continuous VHF coverage across the NAT is considered to be 30 000 ft (see following charts).







NOTE : Minimum altitude for continuous VHF coverage across the North Atlantic is considered to be 30 000 feet

Several attempts to establish communication may be necessary upon entry into the "fringe area" of reception. Aircraft should maintain SELCAL watch on HF when in fringe areas of VHF coverage. Upon exiting, communication should be re-established on HF channels, preferably before flying beyond normal VHF coverage. Because VHF coverage is limited, aircraft must be equipped with an approved and serviceable HF radio capable of two-way radio communication with ATS from any point along the route during flight.

(See RAC 11.2 and CAR 602.39)

NOTE: Notwithstanding the foregoing, aircraft may proceed across the Atlantic without HF radio subject to the following restrictions:

(a) below FL195, routing Iqaluit (Frobay) – Sondre Stromfjord – Keflavík; and

(b) FL250 or above, routing Goose VOR – Prins Christian Sund (or Narsarsuaq) – Keflavík. The aircraft is not allowed to operate in MNPS airspace unless MNPS authority is held.

6.6.3 Canadian Northern Airspace—SATCOM Voice Use

When operating within Canadian northern airspace, SATCOM voice may be used as an alternative to HF for routine communications. The use of SATCOM voice for this purpose requires on board embedded equipment. Permanent satellite voice equipment must be installed and tested in accordance with appropriate certification and airworthiness standards.

Pilots electing to use SATCOM voice must, on initial contact, do a SELCAL check on the assigned HF frequency and continue to maintain a listening watch on that appropriate frequency. Pilots shall, in their first SATCOM voice transmission to Gander Radio, include the word "SATCOM" following the operator's telephony designator and flight number:

Pilot: *GANDER RADIO, AIR CANADA ZERO TWO ZERO (ACA020) SATCOM, POSITION REPORT.*

Gander Radio: *ACA020 SATCOM, GANDER RADIO, GO AHEAD.*

Pilot: *GANDER, ACA020, (message).*

Gander Radio: *ACA020, GANDER, (readback message, if required).*

Safety-level priority has been assigned to ATS communications by service providers such as Inmarsat. When accepting an incoming call, the pilot shall visually confirm and verify that it is an ATC safety-level priority call. Calls using other priorities delivering ATC instructions shall be disregarded and crews shall contact the ATC unit to confirm the validity of the message received.

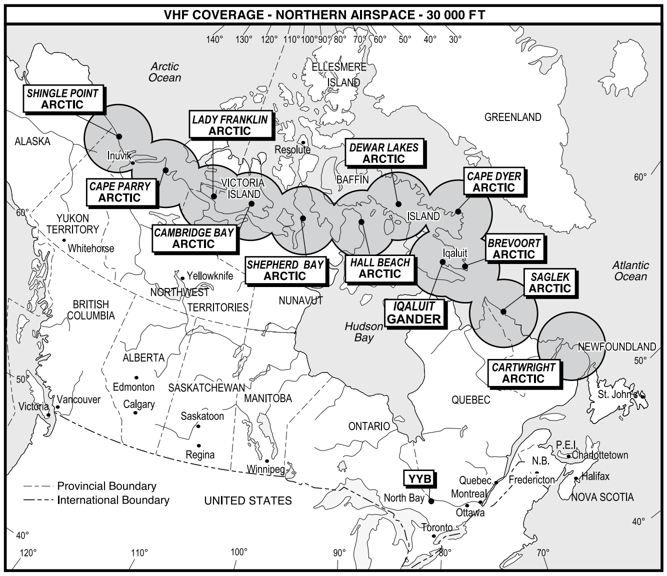
To contact Gander Radio by means of SATCOM voice, use the Inmarsat short code 431613 or the public switched telephone network (PSTN) number 1-709-651-5328

6.6.4 Canadian Northern Airspace—VHF Coverage

General purpose VHF communication services from NWS are provided from North Bay (Arctic Radio) and Gander Radio in order to supplement HF radio coverage in the Canadian northern airspace. General purpose VHF coverage is shown below. It should be noted that:

(a) the chart depicts approximate coverage area only; and

(b) coverage at lower altitudes will be less than depicted.



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COM ANNEX A — RADIO COMMUNICATIONS

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1.0 CANADIAN AVIATION REGULATIONS

Language Used in Aeronautical Radio Communications

602.133

English and French are the languages of aeronautical radio communication in Canada.

Locations Where Services are Available in English and French

602.134

(1) Any person operating an aircraft who wishes to receive the services referred to in this section in one of either English or French shall so indicate to the appropriate air traffic control unit or flight service station by means of an initial radiocommunication in English or French, as appropriate.

(2) Every flight service station set out in Table I and every air traffic control unit set out in Table III shall provide advisory services in English and French.

(3) Every air traffic control unit set out in Table III shall provide air traffic services in English and French.

(4) Every temporary air traffic control unit located in the province of Quebec shall provide air traffic services in English and French.

(5) Every flight service station set out in Table II shall provide, between any person operating an aircraft and any air traffic control unit set out in Table III, a relay service of IFR air traffic control messages in English or French, as indicated by that person.

Locations Where Services are Available in English

602.135

All air traffic control units and flight service stations shall provide aeronautical radiocommunication services in English.

TABLE I (Section 602.134)	
FLIGHT SERVICE STATIONS WHERE ADVISORY SERVICES ARE AVAILABLE IN ENGLISH AND FRENCH	
1.	Gaspé
2.	Gatineau
3.	Îles-de-la-Madeleine
4.	Kuujjuaq
5.	Kuujjuarapik
6.	La Grande Rivière
7.	Mont-Joli
8.	Montréal
9.	Québec
10.	Roberval
11.	Rouyn
12.	Sept-Îles
13.	Squaw Lake (seasonal station)
14.	Val-d'Or

TABLE II (Section 602.134)	
FLIGHT SERVICE STATIONS WHERE RELAY SERVICES OF IFR AIR TRAFFIC CONTROL MESSAGES ARE AVAILABLE IN ENGLISH AND FRENCH	
1.	Gaspé
2.	Gatineau
3.	Îles-de-la-Madeleine
4.	Kuujjuaq
5.	Kuujjuarapik
6.	La Grande Rivière
7.	Mont-Joli
8.	Montréal
9.	Québec
10.	Roberval
11.	Rouyn
12.	Sept-Îles
13.	Squaw Lake (seasonal station)
14.	Val-d'Or

TABLE III (Section 602.134)	
AIR TRAFFIC CONTROL UNITS WHERE ADVISORY SERVICES AND AIR TRAFFIC CONTROL SERVICES ARE AVAILABLE IN ENGLISH AND FRENCH	
	Area Control Centre
1.	Montréal
	Terminal Control Units
2.	Bagotville
3.	Montréal
4.	Ottawa
5.	Québec
	Air Traffic Control Towers
6.	Bagotville
7.	Montréal International (Dorval)
8.	Montréal International (Mirabel)
9.	Ottawa international/Macdonald-Cartier
10.	Québec/Jean Lesage
11.	St-Honoré
12.	St-Hubert
13.	St-Jean (Province of Quebec)

COM ANNEX B — USE OF PORTABLE PASSENGER-OPERATED ELECTRONIC DEVICES ON BOARD AIRCRAFT

1.0 General

After reports of interference to aircraft systems caused by portable electronic devices operated on board aircraft, the airline industry requested that the RTCA Inc. conduct an investigation into the problem. In 1988, RTCA Special Committee 156 (SC-156) completed its study of this interference problem and concluded that for interference to occur, at least eight conditions would have to occur simultaneously. These include:

(a) a portable device radiating over the limit at which receiver disruption can occur;

(b) a location in the worst-case position in the aircraft cabin (i.e., in a seat with a window near the aircraft antennas);

(c) the portable device is orientated to maximum peak radiation in direction for minimum path (signal) loss (i.e.,: normally out the window);

(d) reflection paths offered by objects outside the aircraft (i.e., wing, control surfaces, etc.);

(e) the frequency of emission from the portable device falls within the aircraft receiver system operational frequency band;

(f) the frequency of emission from the portable device falls within the receiver pass band;

(g) the characteristic of emission is suitable to cause receiver disruption which may or may not be observable by the flight crew; and

(h) a receiver system is operating at near its minimum signal level.

Because these conditions are independently variable, the RTCA concluded the chances of all occurring simultaneously are very low.

The vulnerability of aircraft radio-navigation and communications systems may be greatest during the takeoff, climb, approach and landing phases of flight. During these phases, the aircraft is at lower altitudes and may be in close proximity to numerous ground-based interference sources, which could increase the likelihood of disruptive interference due to combined interference effects.

1.1 Portable Two-Way Radiocommunication Devices

Portable two-way radiocommunication devices such as cellular phones are classified as transmitters. Transport Canada Civil Aviation is therefore concerned that passenger use of portable two-way radiocommunication devices on board aircraft may interfere with the safe operation of the aircraft radio navigation/radiocommunication systems and flight management systems.

Portable two-way radiocommunication devices include, but are not limited to, cellular phones, two-way radios, mobile satellite service handsets, personal communications services devices, etc.

NOTE: Radio telephones which are permanently installed in aircraft are installed and tested in accordance with appropriate certification and airworthiness standards. In the context of this document, these devices are not considered portable two-way radiocommunication devices.

2.0 Regulatory Requirement

The *Canadian Aviation Regulation* (CAR) 602.08(1) prohibits the use of a portable electronic device on board an aircraft where the device may impair the functioning of the aircraft systems or equipment.

The onus for determining if passenger-operated electronic devices will cause interference is placed on the operator of the aircraft because there are no airworthiness standards for the manufacture of passenger-operated devices, no maintenance standards and no performance standards in relation to their use on an aircraft. It is therefore the responsibility of the operator of the aircraft and/or the pilot to determine if these devices cause interference.

CAR 602.08(2) prohibits a person from using a portable electronic device on board an aircraft except with the permission of the operator of the aircraft.

CAR 703.38, 704.33, and 705.40 require air operators to establish procedures for the use of portable electronic devices on board aircraft that meet the Commercial Air Services Standards (CASS) and are specified in the air operator's company operations manual.

3.0 Operating Procedures

Operating procedures have been divided into two categories: Informing Passengers and Interference.

3.1 Informing Passengers

CARs 703.39 and 723.39; 704.34 and 724.34; 705.43 and 725.43, and 604.18 and 624.18 require passengers to be informed of the air operator's policy pertaining to the use of electronic devices during the preflight safety briefing.

Although not required to do so by regulatory requirement, we recommend that all other operators inform their passengers accordingly.

Prohibited Devices	Permitted Devices (if demonstrated acceptable) – With Restrictions	Permitted Devices – Without Restrictions
Any transmitting device which intentionally radiates radio frequency signals, such as citizen band (CB) radios and transmitters that remotely control devices such as toys.	(a) *Personal Life Support Systems*: Personal life support systems may be operated during all phases of flight, provided that these systems will not cause interference with the aircraft systems or equipment. (b) *Portable Two-Way Radiocommunication Devices*: Passenger use of portable two-way radiocommunication devices on board aircraft is prohibited at all times when the aircraft engines are running, excluding the auxiliary power unit (APU). If the preflight safety briefing and demonstrations begin prior to engine start, use of portable two-way communication devices must be terminated during the delivery of the safety briefing and demonstrations. Passengers may use portable two-way radiocommunication devices if the air operator has established procedures in the Operations Manual (and Flight Attendant Manual, if applicable): (i) to inform the passengers when the use of these devices is prohibited, and (ii) to ensure these devices are turned off and properly stowed: (A) during the delivery of the preflight safety briefing and demonstrations, and (B) while the aircraft engines are running. (c) *Other portable electronic devices* may be used except during takeoff, climb, approach and landing. Typically these phases of flight coincide with the “seat belt on” sign and the requirement to stow seat trays; Devices that may be used include, but are not limited to: (i) audio or video recorders, (ii) audio or video playback devices, (iii) electronic entertainment devices, (iv) computers and peripheral devices, (v) calculators, (vi) FM receivers, (vii) TV receivers, and (viii) electric shavers.	The following devices are permitted without any restrictions: (a) hearing aids; (b) heart pacemakers; (c) electronic watches; and (d) properly certified operator equipment, such as operator provided passenger air/ground telephone equipment operated in accordance with all other safety requirements.

3.2 Interference

In accordance with regulatory requirements, if interference from a portable electronic device is suspected, the operator of the aircraft shall prohibit the use of the device.

It is recommended that all operators implement the following suspected interference procedures and reporting interference procedures:

Procedures – Suspected Interferences	Reporting Interference
Where interference from a portable electronic device is suspected, crew members shall prohibit the use of the suspected device(s) by: (a) confirming passenger use of electronic device(s); (b) terminating the use of portable electronic device(s); and (c) rechecking the aircraft electronic equipment	The operator is responsible for reporting incidents of interference by completing a report form or by providing the following details: *Flight Information*: aircraft type, registration number, date and UTC time of incident, aircraft location (VOR bearing / DIST/LAT/LONG), altitude, weather conditions, pilot name and telephone number. *Description of Interference*: describe effects on cockpit indicators, audio, or systems, including radio frequency, identification, duration, severity and other pertinent information. *Action Taken by Pilot/Crew to Identify Cause or the Source of Interference.* *Identification of Portable Electronic Device*: description of device, brand name, model, serial number, mode of operation (i.e., FM radio), device location (seat location), and regulatory approval number (FCC/other). *Identification of User*: the name and telephone number of the passenger operating the device would be beneficial, if the passenger is willing to provide it. Additional Information: as determined by the crew. Reports of interference are to be submitted to: Transport Canada (AARQ) Director, Safety Services Ottawa ON K1A 0N8 Tel.:..613-990-1280 Fax:..613-991-4280

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