

NAV CANADA

# Moving From Magnetic to True North in Aviation

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President of NIN



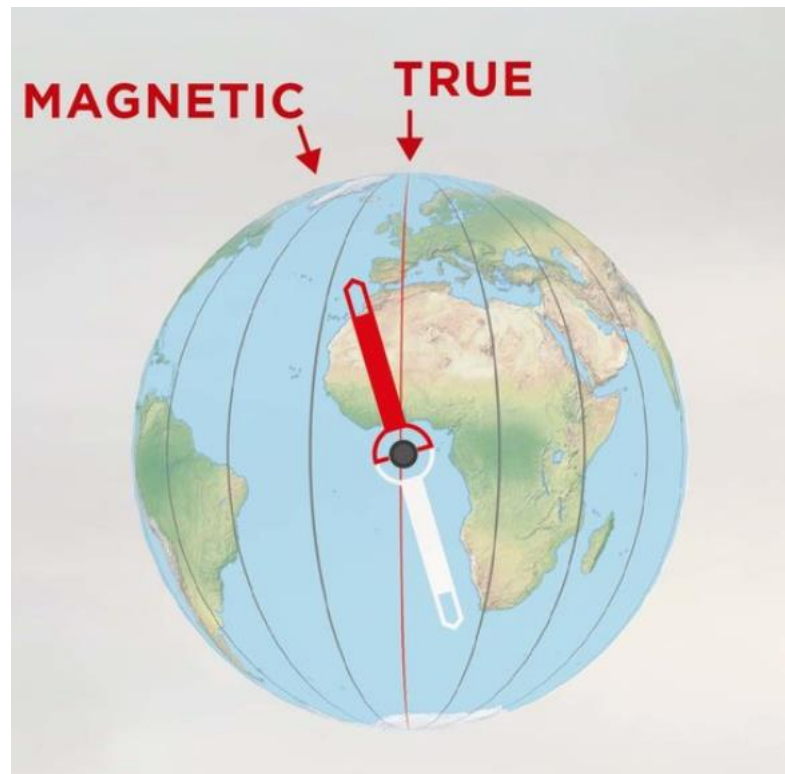
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# THE ISSUE

## Which way is North?

- › Modern aircraft, air traffic and IFR procedure design systems begin in TRUE
- › Tables are then devised to translate that data to magnetic for the user
  - Not all tables hold the same values
  - Older tables in systems may not be updated
  - Translations may not be matched
- › Much effort is and has been expended to manage MAG VAR
- › The questions should be:
  - Why do we still navigate by reference to Magnetic North? Why do we not switch to TRUE?



# CHANGING TO TRUE

## Education and support...

- › Working with the [International Association Of Institutes Of Navigation \(IAIN\)](#) to gain worldwide exposure
  - IAIN member briefings across various International Symposiums
- › We will consult with other ANSPs through CANSO based on support from the operator community.
- › Regional and light aircraft associations
  - Assist them in seeing the benefits of changing to AHRS units that do not rely on flux valves and magnetic alignment
- › Work with industry groups; IATA members, ICAO, CANSO

# BACKGROUND

## ANC 12, 13 and HLCC

- › Canada presented papers to the ANC detailing the change to switch to a True North Reference system in aviation
  - AN-Conf/12-WP/147
  - AN-Conf/13-WP/114
  - HLCC 2021-WP/150 SAF/115
  
- › Para 6.5.25 of the AN-Conf/12 report to Agenda Item 6 stated
  - ...The meeting noted the information and concluded that any States interested in the matter could conduct further studies of the technical and operational impact of the proposal, and of the expected costs and benefits to all aviation stakeholders
  
- › Para 3.44 of the AN-Conf/13 report to Agenda Item 3 stated
  - ...ICAO should investigate the technical and operational impact and/or merits, as well as the potential cost of the proposed change across the spectrum of aviation activities and across all regions prior to progressing on adoption of “True North” as a global reference.”
  - **Recommendation 3.5/4 — True North** *That ICAO conduct a detailed study into the technical, operational, and economic feasibility of changing to a “True North” reference system.*

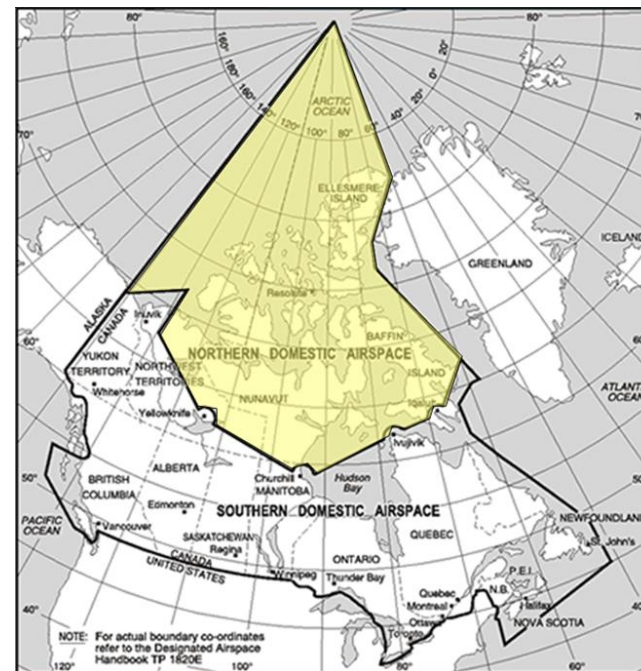
# BACKGROUND

## ANC 12, 13 and HLCC

- › HLCC 2021-WP/150 SAF/115
  - Informed readers of the progress in studies to date
  - In response to RECOMMENDATION 3.5/4 from AN-CONF/13
    - › A Canadian Working Group has been stood up to develop the CONOPS and transition plan for Canada with a target timeline of 2030 to effect the change
    - › Under the International Association of Institutes of Navigation (IAIN), the Attitude Heading Reference Transition Action Group (AHRTAG) has been active with monthly international meetings to study the change to True internationally
  
- › This presentation is meant to inform you of the work to date.

# CANADA'S EXPERIENCE

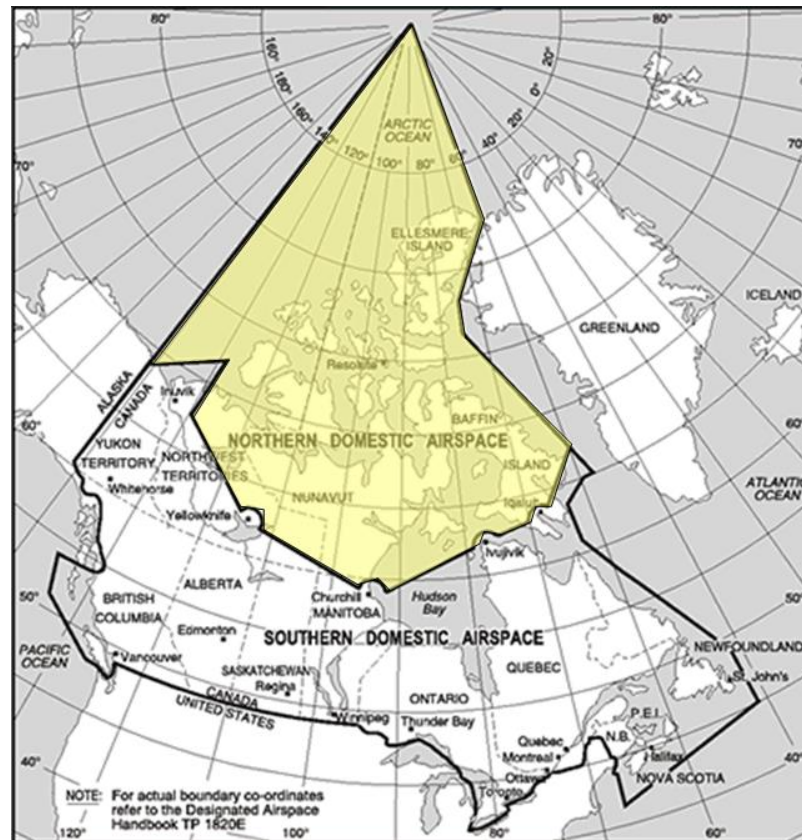
- › Canada has always operated with airspace referenced to True and Magnetic
  - Northern Domestic Airspace = True
  - Southern Domestic Airspace = Magnetic
- › In NDA all ILS, VOR and NDBs are set to TRUE with 0 degrees declination
- › All conventional and PBN airways are reference to True
- › All terminal procedures are referenced to True
  - ILS, LOC, NDB, TACAN
  - PBN – LNAV, LNAV/VNAV, RNP AR, LPV



# CANADA'S EXPERIENCE

## Southern Domestic MAG VAR Issues

- › In SDA all procedures are referenced to Magnetic. Mag Var is maintained:
  - ILS, NDB maintained within  $\pm 2^\circ$ 
    - › CAT II/III ILS maintained within  $\pm 1^\circ$
  - PBN, NDB airways/routes maintained within  $\pm 2^\circ$
  - PBN, NDB IAPs maintained within  $\pm 2^\circ$
  - VOR and TACAN technical alignment maintained within  $\pm 3^\circ$  for enroute and approach
  - Surveillance RADAR, ADSB, MLAT maintained IAW Mag Var tables reference date and time.
  
- › Hence we have the same issues in SDA as other ANSPs



# THE ISSUE WITH MAGNETIC VARIATION

Magnetic Variation doesn't have to be right – it does have to match

- › In the analogue world it was not as important. In the digital world it is.
  - Magnetic variation/station declination doesn't have to be right but it must match across databases
    - › Anchorage ILS CAT II/III issue - aircraft unstable in heading during approach
    - › Vancouver and St. John's CAT II/III issue same as Anchorage
    - › Autoland aircraft moving off the centreline when the aircraft enters the flare
  - Flight Management System flight path leg disconnects on non-RNAV IAP procedure legs
  - Synthetic Vision System and Enhanced Vision System images not aligned to the real world
    - › Runways not aligned with electronic images



# THE ISSUE WITH MAGNETIC VARIATION

Magnetic Variation doesn't have to be right – it does have to match

- › Sources of mag var on a modern aircraft and its use (at times they don't perfectly match)
  - IRUs – internal mag var tables
  
  - Flight Management systems
    - › Embedded base mag/var tables; VHF NAV aid reference mag var; Airport reference mag var; Procedure design mag var
  
  - Synthetic Vision, Enhanced Vision, and Head Up Guidance Systems can use different sources leading to mismatches
  
  - ANSPs and States update EPOC for procedure design every five years. Many aircraft use tables projected for 5 to 10 years or just do not update at all

# NEGATIVE OPERATIONAL IMPACT TO SAFETY

## Overview

- › Various mag values across platforms – **Systematic and Latent Errors**
  - Standby compass accuracy is regulated by states
  - No state regulation on application or use of Mag Var EPOCH validity in aircraft systems
- › This introduces cost and potential error into the system
  - › Updating aircraft FMS and IRU mag var tables every five to ten years
    - One carrier reported (2016) a cost of \$21m for 200 aircraft; another reported \$1.2m for one fleet type of 32 aircraft. Costs are aircraft age dependent (field loadable or repair facility). Nav Canada DH8-100 was \$500k USD.
  - › Updating IAPs, Enroute Charts (VFR & IFR) and rotating VORs
    - For Canada ~\$800k per year (~4504 Procedures, 119 VORs)
  - › Updating Airport data, runway numbering, signage for Mag Var Changes
    - Est. \$10,000 per hold line (Paint, Signs, Data) (L) CYYZ ~ \$1.1m, (M)CYHZ ~ \$150k, (S)CYDF ~ \$40k

# PROPOSED CHANGE TO TRUE

## Overview

- › Modern aircraft, surveillance systems, IAPs are all designed to function in true
  - Everything navigation system in a modern aircraft does the 'math' in True and then converts the information to magnetic for the pilot
  - All of Canada's surveillance systems operate in True and then add in magnetic variation to display to the controller
  - All IAPs in Canada are designed in True and then have magnetic variation/declination added to the design file for charting and nav databases
- › Develop a Canadian Con-ops to change to True and propose to ICAO
  - Con-Ops developed by a cross functional Canadian Aviation Team
  - Implementation Plan underway

# CANADIAN CON OPS – AREAS OF STUDY

## CON-OPS TOC

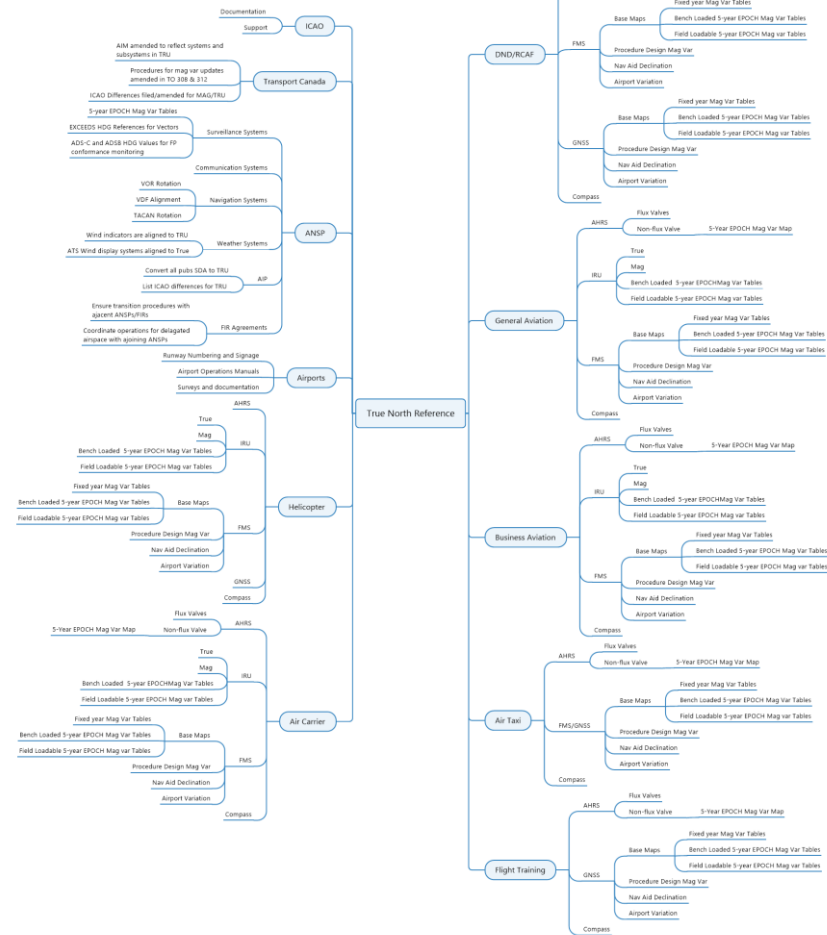
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# CANADA's WG MAKEUP

## Canadian Performance-based Aviation Action Team (CPAAT)

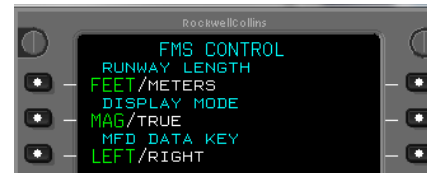
- True North Sub-working members:
  - Transport Canada
  - Nav Canada
  - Airlines
  - Business Aviation
  - General Aviation - COPA
  - Air Taxi
  - Flight Training
  - Airports
  - Helicopter Association
  - DND/RCAF



# CON OPS - CHANGING TO TRUE

## When and how?

- › Pick a date in the future (2030)
  - IRU equipped aircraft could go to True with MAG/TRUE switch
  - New AHRUs (Fibre Optic Gyro (FOG), Micro Electromechanical Systems (MEMS) technologies do not need flux valves for magnetic sense)
    - › Honeywell Super AH-2100; Northrop Grumman LCR-100, 110, 200, 300; Collins AHS-4000 (22k)
    - › Light aircraft GNSS equipped (GNSS functions in True)
  - Light aircraft can still use a magnetic compass and convert to True
    - › Set runway heading prior to take-off
    - › Add/subtract E&W variation after compass reading when setting Directional Gyro
    - › GPS/NDB Method

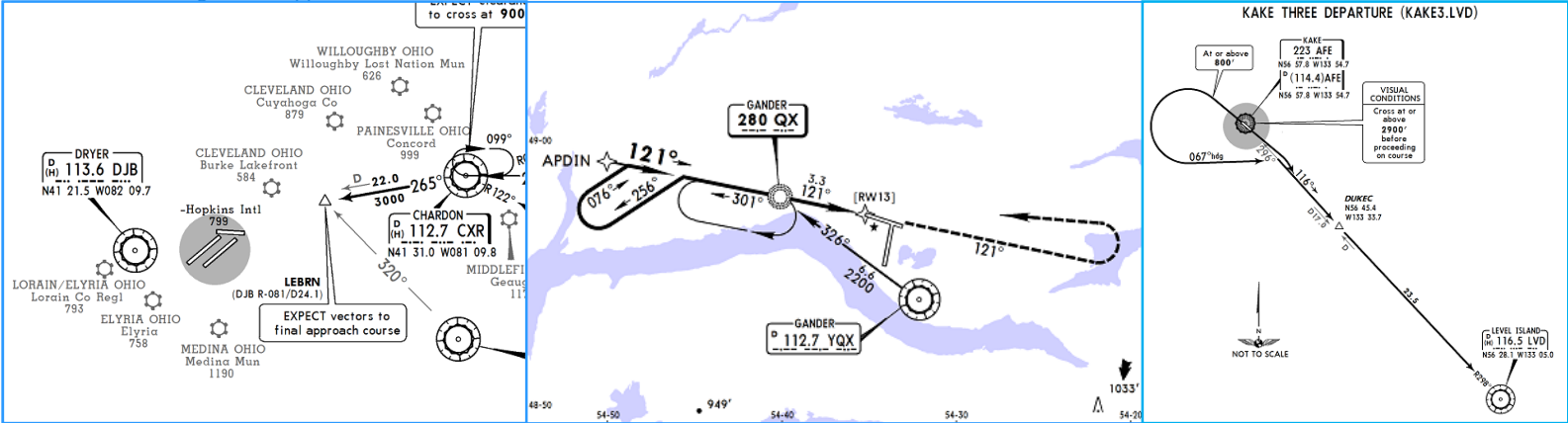


# CON OPS - THREE USER SEGMENTS

## General Aviation – Light Aircraft

- › VFR users technically still use track/drift lines on VFR 1:500000 Aeronautical Chart although most use some form of GPS and electronic moving map
- › IFR GA aircraft would need to have a procedure to deal with East/West variation between the heading observation from the wet compass to setting the HSI
  - Most procedures are now track based with the exception of vectors, NDB IAPs and heading based legs in vector SIDs and downwind legs on STARs

\*Note: Images are Jeppesen Charts



# CON OPS - THREE USER SEGMENTS

## General Aviation – Light Aircraft

- › VFR Use the True Heading from the VFR 1:500000 Aeronautical Chart
- › Read the magnetic heading from the Compass
- › ± the magnetic variation from the flight log to convert mag to true to set the directional gyro
- › The HDG (M) column would not be used during the planning stage

VFR FLIGHT LOG

DATE:		T/O:		LDG:			FLT TIME:						
FROM	TO	ALT/FL	SAFETY ALT	W/W	TAS	TK(T)	HDG(T)	VAR	HDG(M)	G/S	DIST	TIME	ETA
OXFORD	LUDLOW	2500	3100	180/10	103	302	297	4W	301	108	60	33	
LUDLOW	HAWARDEN	2500	3100	180/10	103	349	348	4W	347	112	49	26	
ALTERNATE													
HAWARDEN	LIVERPOOL	2000		180/10	103	026	028	4W	032	112	10	5½	

FUEL (U.S. GALLS)	
TO DESTINATION	10
TO ALTERNATE	1
10%CONTINGENCY	1.1
45 MIN HOLDING	7.5
MINIMUM RESERVE	5
TOTAL REQUIRED	25
TOTAL ON BOARD	55
ENDURANCE	5½ hrs

COMMUNICATIONS					
STATION	FREQ	STATION	FREQ	STATION	FREQ
OX TWR	125.325	OX	367.5		
BZN RAD	124.275	HAW	340.0		
SHOB	123.50	WPL	323		
WPL	128.0				
SHB RAD	120.775				
HWD TWR	123.35				
LVP TWR	119.85				



# CON OPS - THREE USER SEGMENTS

## Regional Aircraft

- › The challenge is most regional aircraft (<50 seats) use a magnetic sense to feed the AHRU
  - Regional airlines have been searching for new IRU like options based on AHRU obsolescence (AH-600) and repair costs.
  - Low wing aircraft (CRJs) have had issues with flux valves and interference from rebar in runways (KORD) where they have to depart in free gyro mode.
- › The addition of IRUs or North Seeking AHRUs to replace current AHRUs would also be the foundation for RNP operations
  - Assist them in seeing the benefits of changing to AHRUs that do not rely on flux valves and magnetic alignment, lower life cycle costs, additional operational capability
- › With an implementation date out to 2030 the regional carriers should be able to adapt
  - Lobby manufacturers to switch to non-magnetic AHRUs in new aircraft or new certifications
  - Avionics manufactures have products available, or, in development to meet the 2030 timeline
  - Low cost convertors to switch MAG to True at the AHRU

# CON OPS - THREE USER SEGMENTS

## Regional Aircraft

- › Airworthiness directives limiting operations for out of date magnetic variation are becoming more common.
  - Loss of CAT II/III operations in regional aircraft fleet
  - Airborne holding operations restricted if using the flight management system
  - Leads to navigation errors and an unsafe condition that must be managed by the flight crew



Transport  
Canada

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Canada

TP 7245E

1 of 2

AD Number: CF-2019-40

## AIRWORTHINESS DIRECTIVE

*This Airworthiness Directive (AD) is issued pursuant to Canadian Aviation Regulation (CAR) 521.427. No person shall conduct a take-off or permit a take-off to be conducted in an aircraft that is in their legal custody and control, unless the requirements of CAR 605.84 pertaining to ADs are met. Standard 625 - Aircraft Equipment and Maintenance Standards Appendix H provides information concerning alternative means of compliance (AMOC) to ADs.*

**Number:**

CF-2019-40

**Effective Date:**

15 November 2019

**ATA:**

34

**Type Certificate:**

A-131

**Subject:**

Navigation System – Flight Management System (FMS), Inertial Reference System (IRS) and Attitude and Heading Reference System (AHRS) – Outdated Magnetic Variation (MV) Tables

**Applicability:**

Bombardier Inc. model CL-600-2B19, CL-600-2C10, CL-600-2C11, CL-600-2D15, CL-600-2D24 and CL-600-2E25 aeroplanes, all serial numbers.

**Compliance:**

As indicated below, unless already accomplished.

**Background:**

Outdated MV tables inside navigation systems can affect their performance and result in the presentation of misleading magnetic heading references on the Primary Flight Displays (PFDs) and Multi-Function Displays (MFDs) positioning the aeroplane outside of the terrain and obstacle protection provided by instrument flight procedures and flight route designs. Some Bombardier Regional Jets have navigation units with MV tables that are obsolete which can lead to significantly inaccurate heading, course and bearings calculations.

This AD mandates the Airplane Flight Manual (AFM) update to the FMS, IRS and AHRS limitations to address the above mentioned unsafe condition.

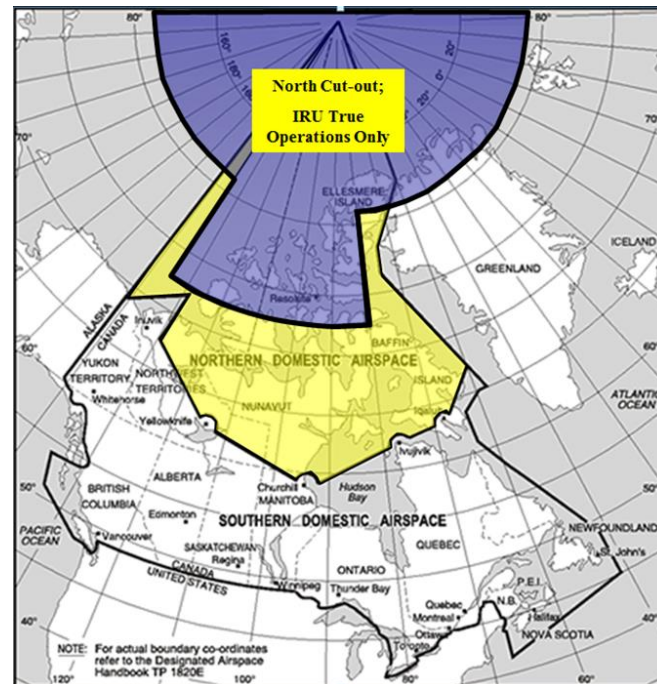
**Corrective Actions:**

1. Within 30 days from the effective date of this AD, amend the applicable Transport Canada (TC) approved AFM by incorporating the revision to the Chapter 02 – Limitations – Navigation System

# CON OPS - THREE USER SEGMENTS

## Airline Narrow Body and Wide-body Aircraft

- › Large aircraft generally have Inertial Reference Units on board today
- › Just need the ability to switch from MAG to TRUE to bypass the mag var values
- › Some operators indicate they operate in Oceanic Airspace in True
- › Operators on Polar Routes operate in the Keyhole in True but not necessarily in Canadian NDA in True
- › Savings to be had for air carriers/operators with the elimination of 5 years Epoch updates
  - Million's in savings based on 5 year EPOCH cycle if aircraft matched ANSP update cycle



# CON OPS - THREE USER SEGMENTS

## Airline Narrow Body and Wide-body Aircraft

- › Limitations to operations with out of date magnetic variation tables

### A319/A320/A321 AIRCRAFT TECHNICAL BULLETINS

#### ATB 271: OEB 151-ST JOHNS (CYT) IMMEDIATE RESTRICTIONS

06-12-12

EFFECTIVITY: AIRCRAFT [REDACTED]

In addition to Anchorage and Fairbanks, effective immediately, the autoland and rollout restrictions of OEB 151 will also be applicable to those aircraft operating into:

St Johns (CYT) without an updated ADIRU MAGVAR table.

SPECIFICALLY:

- Autoland is not allowed
- Roll out is not allowed
- CAT II approaches without autoland are still allowed

Affected aircraft will not be subject to the restrictions once their ADIRU MAGVAR tables are updated. These aircraft will be identified by a logbook sticker on the inside cover stating:

MAGVAR TABLE UPDATED - OEB 151 CANCELLED FOR THIS AIRCRAFT

It is expected that the ADIRU MAGVAR tables on the affected aircraft will all be updated by July 2008. Once all aircraft are modified, this ATB will be cancelled, a new ATB will be issued stating that all aircraft are modified, and all logbook placards will then be removed.

#### ATB 320 - NEW IRS LIMITATIONS - REVISED

2022-FEB-15

THIS ATB CANCELS AND SUPERSEDES ATB 312

The reason for revising this ATB is to identify aircraft fin [REDACTED] as being retrofitted with latest IRS MagVar tables.

The purpose of IRS limitations is to prohibit certain flight operations in geographic areas where the accuracy of the magnetic north-referenced parameters in older IRS MagVar tables are no longer sufficient to satisfy the airplane type design requirements. IRS MagVar tables are revised every 10 years.

The fleet is in process of being retrofitted with new IRS MagVar tables to remove the area and airport restrictions mentioned below. Currently, all 787-9s have been retrofitted but not all 787-8s. The retrofit completion of the 787-8s is expected in 2022. Once a specific aircraft has completed this retrofit, it will be identified on the OFP through a Crew Alert and this ATB will be revised.

AOM 1.01.34 P4 is revised as follows:

#### INERTIAL REFERENCE SYSTEM (IRS)

All flight operations based on magnetic heading or magnetic track angle are prohibited in geographic areas where the loaded IRS Magnetic Variation (MagVar) table errors are greater than 5 degrees. \*

\* To comply with this limitation, Flight Crew shall select HEADING REF switch to TRUE when operating north of 65N of latitude instead of 70N of latitude per FOM 8.9.2.4.

\*\* All aircraft are compliant with this limitation.

All autopilot/flight director ILS (excluding GLS) approach and landing operations that use magnetic north referenced courses or bearings are prohibited in geographic areas where the loaded IRS MagVar table errors are greater than 3 degrees. \*\*

\*\* To comply with this limitation, the following table lists the airports affected by IRS MagVar table errors greater than 3 degrees. Any ILS and LOC approaches are prohibited at these airports. All other types of approaches are not affected.

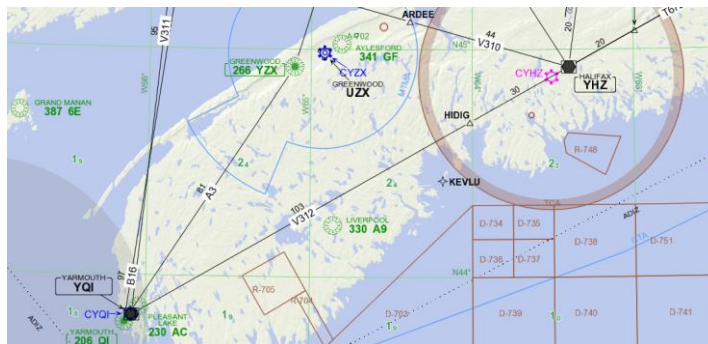
Airport code	Airport name and location
SFJ / BGSF	Kangerlussuaq, Greenland
KEF / BIKF	Keflavik, Iceland
YFB / CYFB	Iqaluit, Canada
YXY / CYXY	Whitehorse, Canada
LYR / ENSB	Longyear, Norway
EDF / PAED	Elmendorf AFB, USA
FAI / PAFA	Fairbanks, USA
AKN / PAKN	King Salmon, USA
ANC / PANC	Anchorage, USA

\*\* All aircraft are compliant with this limitation.

# CON OPS – HOW?

## Nav Canada conducted a Change Flight Test

- › Flight Test 'True' database
  - Jeppesen took all the data (flight test database) for airports, airways, IAPs and changed all the magnetic variation to '00' for a flight test area in eastern Canada
  - NAV CANADA flight test aircraft flew a mixed flight plan of V/J airways, PBN airways, NDB, VOR and PBN procedures in True Mode to see if switching the database would be that easy.
  - Flight Test was successful for all aircraft systems – conventional, PBN, EGPWS, EFB, HGS. No off nominal events observed.



# CON OPS – WEATHER

All weather wind reports are referenced to True

- › Pilots would no longer have to convert winds from True to Mag in printed weather
- › Tower systems to report wind for take-off and landing would not need to convert winds from True to MAG
- › ATIS and AWOS systems would not need updated magnetic variation to convert winds from True to Mag



Get Country Stats				Number of countries on screen = 40			Runways Requiring changes			
				Number of runways on screen = 7105			1759	2452	1417	54
				Number of runways missing coordinates on screen = 17			With True	With Mag	Current	Mag > True
Country 3 letter Ident	Country Name	World Region	Sub region	Total# of runways in country	Runways with coordinate	Runways without coordinate				
ALB	Albania	Europe	Southern Europe	4	4	0	0	0	0	
AUT	Austria	Europe	Western Europe	136	136	0	28	70	36	YES
BEL	Belgium	Europe	Western Europe	112	112	0	8	32	14	YES
BGR	Bulgaria	Europe	Eastern Europe	30	28	2	12	6	4	
BIH	Bosnia and Herzegovina	Europe	Southern Europe	40	24	16	10	6	2	
BLR	Belarus	Europe	Eastern Europe	16	16	0	14	0	0	
CHE	Switzerland	Europe	Western Europe	123	128	1	22	52	32	YES
CZE	Czechia	Europe	Eastern Europe	278	272	6	66	106	76	YES
DEU	Germany	Europe	Western Europe	1102	1098	4	170	403	176	YES
DNK	Denmark	Europe	Northern Europe	168	150	18	28	80	32	YES
ESP	Spain	Europe	Southern Europe	185	185	0	22	58	36	YES
EST	Estonia	Europe	Northern Europe	46	44	2	38	15	5	
FIN	Finland	Europe	Northern Europe	188	188	0	128	101	82	
FRA	France	Europe	Western Europe	1316	1314	2	53	358	164	YES
FRD	Faroe Islands	Europe	Northern Europe	2	2	0	0	0	0	
GBR	United Kingdom of Great Britain and N	Europe	Northern Europe	748	738	10	138	227	125	YES
GIB	Gibraltar	Europe	Southern Europe	2	2	0	0	0	0	
GRC	Greece	Europe	Southern Europe	120	120	0	28	20	14	
HRV	Croatia	Europe	Southern Europe	94	74	20	16	28	12	YES
HUN	Hungary	Europe	Eastern Europe	50	50	0	10	18	6	YES
RUS	Russian Federation	Europe	Eastern Europe	362	360	2	298	85	53	
IRL	Ireland	Europe	Northern Europe	62	62	0	30	30	16	
ISL	Iceland	Europe	Northern Europe	120	116	4	118	23	16	
ITA	Italy	Europe	Southern Europe	368	342	26	34	123	63	YES
LTU	Lithuania	Europe	Northern Europe	86	84	2	50	30	20	
LUX	Luxembourg	Europe	Western Europe	4	4	0	0	0	0	
LVA	Latvia	Europe	Northern Europe	18	16	2	12	10	6	
MDA	Moldova, Republic of	Europe	Eastern Europe	14	4	10	8	6	6	
MKD	North Macedonia	Europe	Southern Europe	4	4	0	0	0	0	
MLT	Malta	Europe	Southern Europe	4	4	0	0	0	0	
NLD	Netherlands	Europe	Western Europe	70	70	0	17	22	6	YES
NOR	Norway	Europe	Northern Europe	193	185	8	67	63	23	YES
POL	Poland	Europe	Eastern Europe	302	298	4	108	100	66	
PRT	Portugal	Europe	Southern Europe	82	78	4	38	36	23	
ROU	Romania	Europe	Eastern Europe	60	48	12	18	13	7	
SRB	Serbia	Europe	Southern Europe	66	60	6	24	16	10	
SVK	Slovakia	Europe	Eastern Europe	70	70	0	10	28	24	YES
SVN	Slovenia	Europe	Southern Europe	44	42	2	16	9	9	YES
SWE	Sweden	Europe	Northern Europe	358	338	20	90	247	203	YES
UKR	Ukraine	Europe	Eastern Europe	52	52	0	28	14	10	
<b>SUBTOTALS</b>				<b>7105</b>	<b>6928</b>	<b>177</b>	<b>1759</b>	<b>2452</b>	<b>1417</b>	<b>54</b>

7105 European Runways analyzed  
1417 are out of MAG alignment today

1759 would need to be renumbered in TRUE  
5346 would be left alone switching to TRUE

2452 would need to renumbered in MAG  
7105 will be renumbered over time in MAG



Get Country Stats				Number of countries on screen =58			Number of runways on screen =1666				Number of runways missing coordinates on screen =18			
Country 3 letter Ident	Country Name	World Region	Sub region	Total# of runways in country	Runways with coordinates	Runways without coordinates	Runways Requiring changes							
							822 With True	513 With Mag	321 Currently	54 Mag > True				
BFA	Burkina Faso	Africa	Sub-Saharan Africa	8	8	0	6	6	2					
SDN	Sudan	Africa	Northern Africa	32	32	0	6	2	0					
REU	Réunion	Africa	Sub-Saharan Africa	6	6	0	6	0	0					
DZA	Algeria	Africa	Northern Africa	96	96	0	4	15	7	YES				
CAF	Central African Republic	Africa	Sub-Saharan Africa	16	16	0	4	6	4	YES				
SWZ	Eswatini	Africa	Sub-Saharan Africa	4	4	0	4	3	1					
SHN	Saint Helena, Ascension and Tristan da C	Africa	Sub-Saharan Africa	4	4	0	4	2	2					
ESH	Western Sahara	Africa	Northern Africa	6	6	0	4	2	0					
COM	Comoros	Africa	Sub-Saharan Africa	6	6	0	4	0	0					
MUS	Mauritius	Africa	Sub-Saharan Africa	4	4	0	4	0	0					
LYB	Libya	Africa	Northern Africa	80	70	10	2	16	10	YES				
CMR	Cameroon	Africa	Sub-Saharan Africa	22	22	0	2	8	2	YES				
TUN	Tunisia	Africa	Northern Africa	22	22	0	2	6	0	YES				
BEN	Benin	Africa	Sub-Saharan Africa	4	4	0	2	2	0					
GNB	Guinea-Bissau	Africa	Sub-Saharan Africa	2	2	0	2	2	0					
STP	Sao Tome and Principe	Africa	Sub-Saharan Africa	4	4	0	2	2	0					
TGO	Togo	Africa	Sub-Saharan Africa	4	4	0	2	2	2					
UGA	Uganda	Africa	Sub-Saharan Africa	18	18	0	2	2	2					
GMB	Gambia	Africa	Sub-Saharan Africa	2	2	0	2	0	0					
MYT	Mayotte	Africa	Sub-Saharan Africa	2	2	0	2	0	0					
IOT	British Indian Ocean Territory	Africa	Sub-Saharan Africa	2	2	0	2	0	0					
ETH	Ethiopia	Africa	Sub-Saharan Africa	40	40	0	1	6	6	YES				
TCD	Chad	Africa	Sub-Saharan Africa	28	28	0	0	8	6	YES				
COG	Congo	Africa	Sub-Saharan Africa	10	8	2	0	2	0	YES				
RWA	Rwanda	Africa	Sub-Saharan Africa	12	12	0	0	2	2	YES				
SOM	Somalia	Africa	Sub-Saharan Africa	16	16	0	0	2	2	YES				
BDI	Burundi	Africa	Sub-Saharan Africa	6	6	0	0	0	0					
DJI	Djibouti	Africa	Sub-Saharan Africa	2	2	0	0	0	0					
ERI	Eritrea	Africa	Sub-Saharan Africa	6	6	0	0	0	0					
GNQ	Equatorial Guinea	Africa	Sub-Saharan Africa	6	6	0	0	0	0					
NER	Niger	Africa	Sub-Saharan Africa	20	20	0	0	0	0					
SYC	Seychelles	Africa	Sub-Saharan Africa	4	4	0	0	0	0					
<b>SUBTOTALS</b>				<b>1666</b>	<b>1648</b>	<b>18</b>	<b>822</b>	<b>513</b>	<b>321</b>	<b>54</b>				

1666 African Runways analyzed  
321 are out of MAG alignment today

822 would need to be renumbered in TRUE  
844 would be left alone switching to TRUE

513 would need to be renumbered in MAG  
1666 will be renumbered over time in MAG

GET COUNT

### Country Selection

WORLD

Runway Length categories			Requiring changes		
From	To	# of RWY's	With True	With Mag	Now with Mag
0 ft	4000 ft	8133	4826	2622	2046
4000 ft	6000 ft	8144	4902	2717	1822
6000 ft	8000 ft	3867	2082	1165	791
8000 ft	10000 ft	3183	1499	890	561
10000 ft	12000 ft	1633	774	411	271
12000 ft	14000 ft	698	287	217	153
14000 ft	16000 ft	68	40	20	10
16000 ft	25000 ft	6	6	2	2
Total		25732	14416	8044	5656

KML Point Color	Category
TEXT	HARD
TEXT	SOFT
TEXT	WATER/ICE/SNOW

GENERATE GLOBAL KML  
AIRPORT FILE

25732 World-wide hard surface runways analyzed  
 8044 would need to be renumbered in MAG  
 11316 would be left alone switching to TRUE

14416 would need to be renumbered in TRUE  
 5656 are out of MAG alignment today  
 25732 will be renumbered over time

**GET COUNT**

Navaid Type	Country Code
ALL	WORLD

**Country Selection**

WORLD

**Mag var Reference**

2030

Magnetic Variations from True North using 2030 model		
From	To	# of NAVAIDS
0.0 deg	4.0 deg	1431
4.1 deg	5.0 deg	289
5.1 deg	10.0 deg	1343
10.1 deg	360.0 deg	923
Total		3986

**NOTE:** The term "NAVAID" [here](#) refers to one or all of the following facility types;  
**VOR**  
**VOR-DME**  
**TACAN**  
**VORTAC**

KML Point Color	Category
	VOR
	VOR-DME
	TACAN
	VORTAC

**GENERATE GLOBAL KML NAVAID FILE**

**GET COUNT**

Navaid Type	Country Code
ALL	USA

**Country Selection**

United States of America - USA

**Mag var Reference**

2030

Magnetic Variations from True North using 2030 model		
From	To	# of NAVAIDS
0.0 deg	4.0 deg	324
4.1 deg	5.0 deg	68
5.1 deg	10.0 deg	376
10.1 deg	25.0 deg	361
25.1 deg	359.9 deg	0
Total		1129

**NOTE:** The term "NAVAID" [here](#) refers to one or all of the following facility types;  
**VOR**  
**VOR-DME**  
**TACAN**  
**VORTAC**

KML Point Color	Category
	VOR
	VOR-DME
	TACAN
	VORTAC

**GENERATE GLOBAL KML NAVAID FILE**

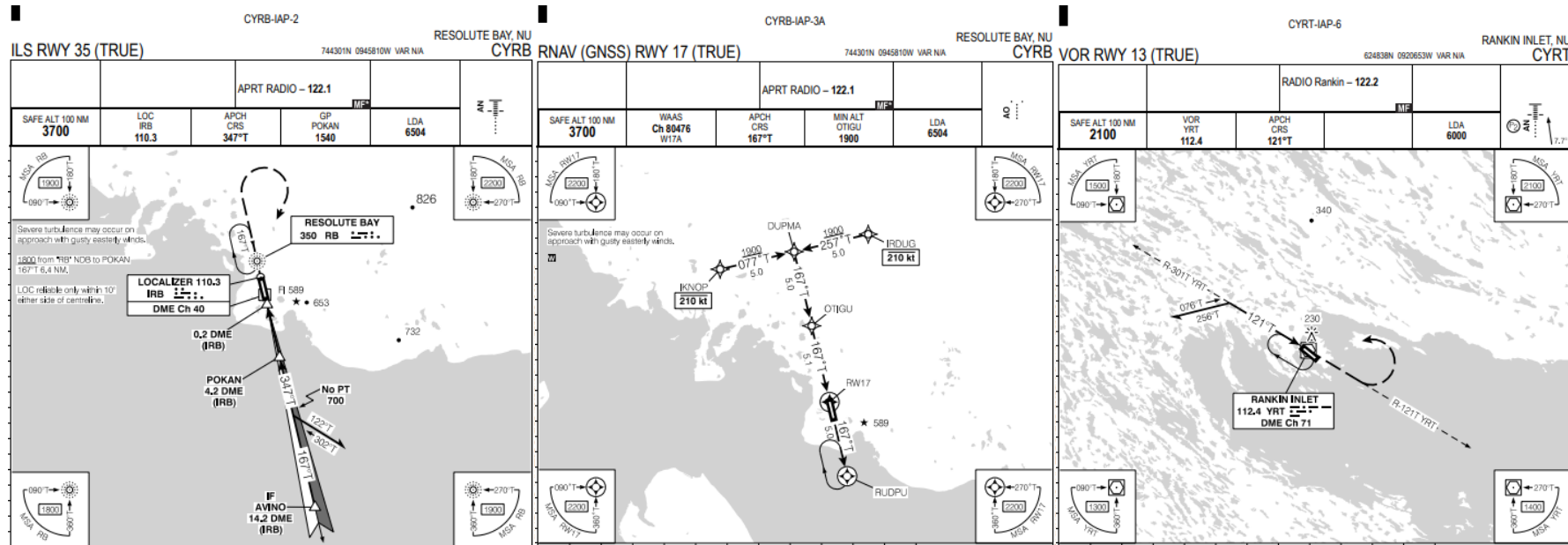
3946 World-wide VORs analyzed  
 289 are between 4° and 5° of True Today

1431 are within 4° of True Today  
 1343 are between 5° and 10° of True Today

New VORs rotated electronically. Older VOR systems typically limited to 8-10° of electronic rotation. TACANs generally a physical rotation.

# CHARTING IN TRUE

Canada does this today.

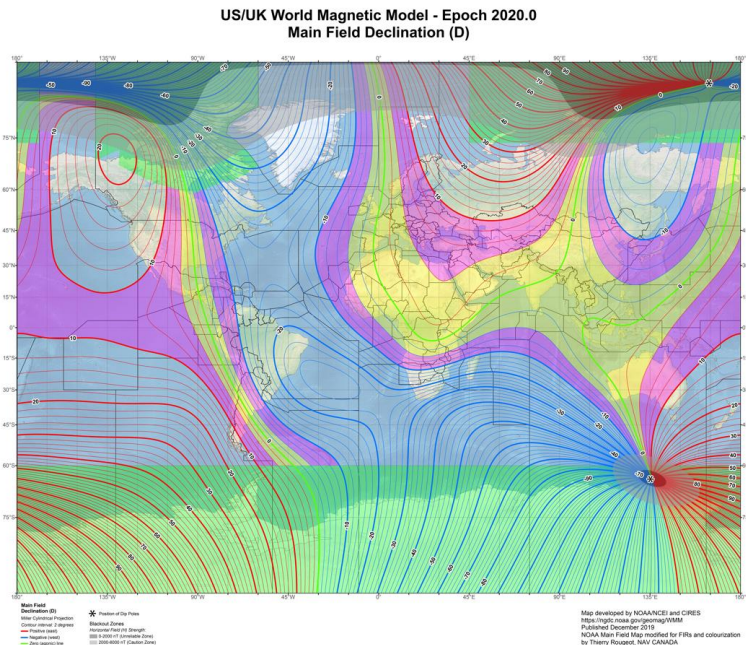




# IMPLEMENTATION PLAN - CHANGING TO TRUE

## Canada's Proposed

- › Prior to 2030 provide charting with MAG and (TRUE)
- › Airports – areas within  $\pm 10^\circ$  can plan runway numbering change at a convenient time in the future. Other airports would plan for a change date within  $\pm 2$  years of the change date
- › VORs would be rotated to True blocks by:
  - Declination within  $\pm 5^\circ$  of True
  - Enroute VORs
  - VORs with Approach Radials
- › ANS Equipment mag variation is table driven and can change on the AIRAC date of change
- › After the change, MAG values would be removed from charts during normal revision cycles



# STATE INTERESTS

## ICAO Annex Impact

- › Canada has filed minimal ICAO differences for its long standing True North Operations
  - 1 difference in Annex 5
  - 1 difference in Annex 15
  - 6 differences to PANS-AIM
  
- › A thorough review of all ANNEXs has found minor areas of amendment to ANNEX 2, 4, 5, 6, 10, 11, 12, 14, 15 with the majority in Annex 4 regarding the charting of bearings and tracks I.E.
  - ANNEX 4, Chapter 7. ENROUTE CHART – ICAO
    - › iii. 7.8 Bearings, tracks and radials
      - › 1) 7.8.1 Bearings, tracks and radials **shall** be magnetic, *except as provided for in 7.8.2*. Where bearings and tracks are additionally provided as true values for RNAV segments, they shall be shown in parentheses to the nearest tenth of a degree, e.g. 290° (294.9°T).
      - › 2) 7.8.2 Recommendation.— *In areas of high latitude where it is determined by the appropriate authority that reference to Magnetic North is impractical, another suitable reference, i.e. True North or Grid North, should be used.*

# ICAO INTERESTS

## Considerations

### › Safety Impact - Positive.

- ANSP data and charts will match the FMS database, procedure design file, ATS systems. Everyone will have the same data instead of dealing with differences as described in FAA INFO LETTER 12009 (06/26/12) excerpt
  - › *It is important to understand, however, that RNAV systems, (with the exception of VOR/DME RNAV equipment) navigate by reference to true north and display magnetic course only for pilot reference. As such, a **properly functioning** RNAV system, containing a **current and accurate navigational database**, should still fly the correct ground track for any loaded instrument procedure, despite any differences in magnetic course that may be attributed to magnetic variation application.*
- Accuracy Example Honeywell LaseRef V

#### Magnetic Mode

Between 50°S and 50°N	±2°
Between 50°N and 73°N	±3°
Between 73°N and 79°N	±5°
Between 79°N and 82°N	±8°

#### True North Mode

Worldwide	±1°
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# ICAO INTERESTS

## Considerations

- › Financial Impact – Positive for aircraft, airports and ANSPs in the long term.
  - Airports and ANSPs will have a ONE TIME charge to make the change to True that can be managed. Data and signage will not need to change for mag var again.
  - Aircraft operators with IRUs would need to enable the MAG/TRUE functions if not currently active.
  - Aircraft operators with mag seeking AHRUs would have a one time charge for north seeking AHRUs or low cost converters.
  - Light aircraft without a slaved system would use a cost neutral procedural method.
  - No more working groups to look at Magnetic Variation issues – PARC, RTCA, State WGs, AIM data processes
  - Simplification of avionics design and procedure design in the long term

# ICAO INTERESTS

## Considerations

- › Security Impact - Neutral
- › Environmental Impact – Positive
  - Less energy of all types expended for mag var updates
  - GHG reduced to 0 for VOR Rotation flight checks after mag var changes
- › Efficiency Impact – Positive
  - No loss of services due to procedures notam'd out of service for mag var issues
  - No loss of CAT II/III services due to mar var differences
  - ANSPs can focus on new procedure development instead of procedure churn to correct mag var on current procedures (reduced procedure maintenance)
- › Expected Implementation Time – Positive
  - 2030 to allow ANSPs to enact a plan and for aircraft operators with slaved gyro's to replace obsolete units with non-magnetic north seeking units.

NAV CANADA • PROPRIETARY

# Thank You



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