

NAV CANADA ► PROPRIETARY

# Implementing EoR in Canada

ICAO APAC  
PBNICG/10, April 20<sup>th</sup> 2023

Garnet Miller  
Manager, Airspace Modernization



Serving a world in motion  
[navcanada.ca](http://navcanada.ca)





In 1996, NAV CANADA became the world's first fully privatized ANS

# Facts and Figures

We are a private, non-share capital company, managing one of the largest regions of airspace in the world.



ACC Traffic

2.9 million flights

Total IFR Flight Hours: 3.2 million  
FY22



Tower, FSS and RAAS Traffic

5.6 million movements

FY22



18 M

square kilometres of  
airspace managed by  
NAV CANADA



100+

staffed sites



4,500+

employees across the  
country



50,000+

customer accounts

A large blue gear-like graphic on the left side of the slide, with a circular cutout showing two flags: the NAV CANADA logo flag (blue with white text) and the Canadian national flag (red and white with a maple leaf).

# 25 Years of Innovation and Achievement

World-leading safety record

First to:

- Fully privatize a country's civil air navigation services
- Deploy Space-based ADS-B domestically
- Develop and transition to electronic flight data strips
- Develop and deploy common oceanic air traffic system
- Introduce Established on RNP-AR

# A timeline of EoR in Canada

- Initial Concept Development
- Regulatory Process
- Design Considerations
- Operational Considerations
- Safety Aspects
- Additional Deployments

# EoR Concept Development

## Milestones

- Original Concept of Operations for NAV CANADA was drafted based on conceptual idea by a Boeing engineer
- NAV CANADA led work through SASP by developing and maturing the idea into a viable concept for ATC operations
- Concept was presented to ICAO, led by NAV CANADA with collaboration from Boeing, Airservices Australia, EUROCONTROL, DFS, DSNA, FAA
- Standard incorporated into PANS-ATM Nov 8, 2018

# Why we established EoR in Canada

## Major support from Industry

- Air Canada, WestJet, Jazz and Encore participated in development and safety activities
- **Increase use of existing RNP AR APCH procedures**

## RNP AR approach track containment

- No increased risk to safety
- Potential to reduce use of parallel visual approaches

## Environmental benefits

- Reduces the requirement for low altitude level segments on downwind
- Overall community noise benefit
- Overall reduction in GHG

# Implementing EoR in Canada

## Why Calgary first?

2006

- WestJet publishes proprietary RNP AR APCH approaches
- 737NG only

2014

- NAV CANADA publishes public RNP AR APCH approaches
- Average 1000 RNP AR APCH per month

2018

- September: Modified RNP AR APCH with EoR design considerations
- November: EoR separation standard implemented

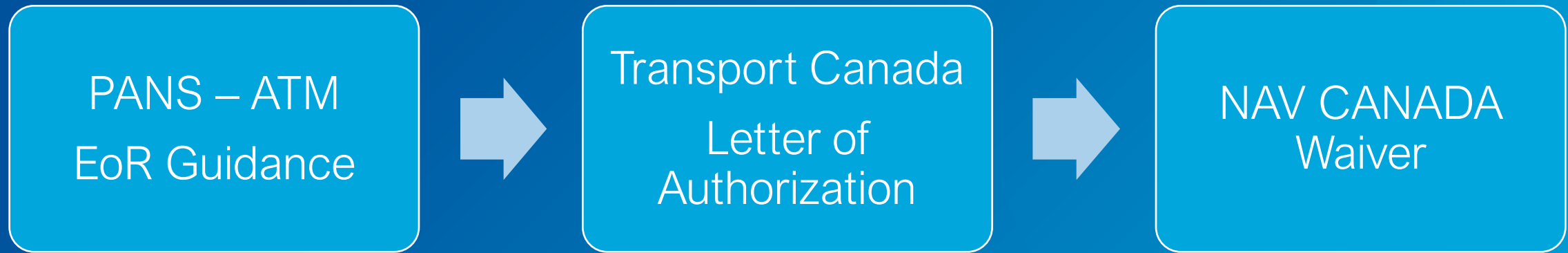
# Establishing EoR in Canada

Why Calgary first?



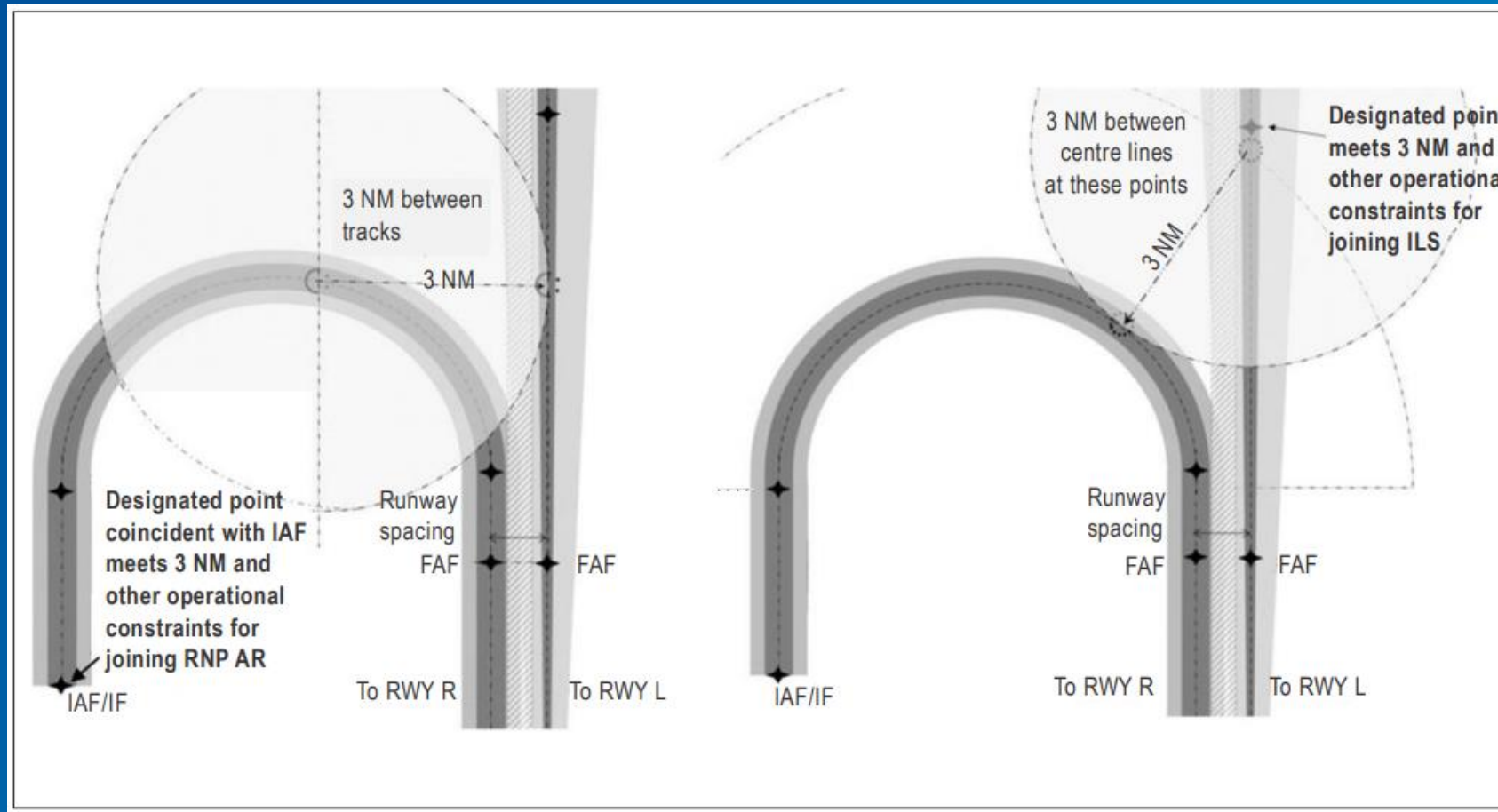
# EoR Concept Development

## Regulatory Process



# Established on RNP Guidance

PANS ATM Doc 4444 – 6.7.3.5



# Transport Canada

## Regulator Approval

### Canadian Aviation Regulations (CAR)

- "Letter of Authorization" required to permit EoR operations


### Requirements

- Hazard Identification and Risk Assessment (HIRA)
- Safety Management Plan (SMP)
- Training plan
- Inter-unit agreements
- Airspace use assessment
- Mandatory Verbal Briefing
- Post implementation monitoring
- Aeronautical Information Circular (AIC)

# NAV CANADA

## Waiver - Director, ATS Standards

- Permitted Calgary Terminal controllers to conduct Simultaneous Independent Parallel Operations in accordance with the Transport Canada Letter of Authorisation in the application of ICAO PANS -ATM Standards at Calgary International Airport – RNP AR APCH



FMP : 2018-XX  
Effective / En vigueur : 2018-11-08

## Waiver **ATS** Dérogation

(La version française se trouve à la suite.)

### Waiver to MATS ACC – Separation – Simultaneous Dependent Parallel ILS Approaches and Simultaneous Independent Parallel ILS Approaches

**SUBJECT: Established on RNP AR during Simultaneous Independent Parallel Approaches – CYYC**

This memorandum applies to the Edmonton ACC, Calgary Terminal specialty. It permits Calgary Terminal controllers to conduct Simultaneous Independent Parallel Operations in accordance with the Transport Canada Letter of Authorisation (LoA) in the application



# A Focus on Value for all Stakeholders

We collaborate closely with key stakeholders to ensure our services add value. With a greater understanding of their needs through consultations and regular feedback, we target gains in efficiencies, cost savings and technological advancement while striving to minimize our environmental impact.

# Implementing EoR in Canada

Collaborative Industry support

- Air Canada, WestJet, Jazz, WestJet Encore participated in development and all safety activities
- Provided simulators for Human in the Loop (HITL) breakout development
- Participated in Hazard Identification and Risk Assessments (HIRA)
- Initial procedure FMS validation
  - ▶ Test data base prior to AIRAC



# Design Considerations

## EoR

### STAR designs prioritises RNP AR APCH

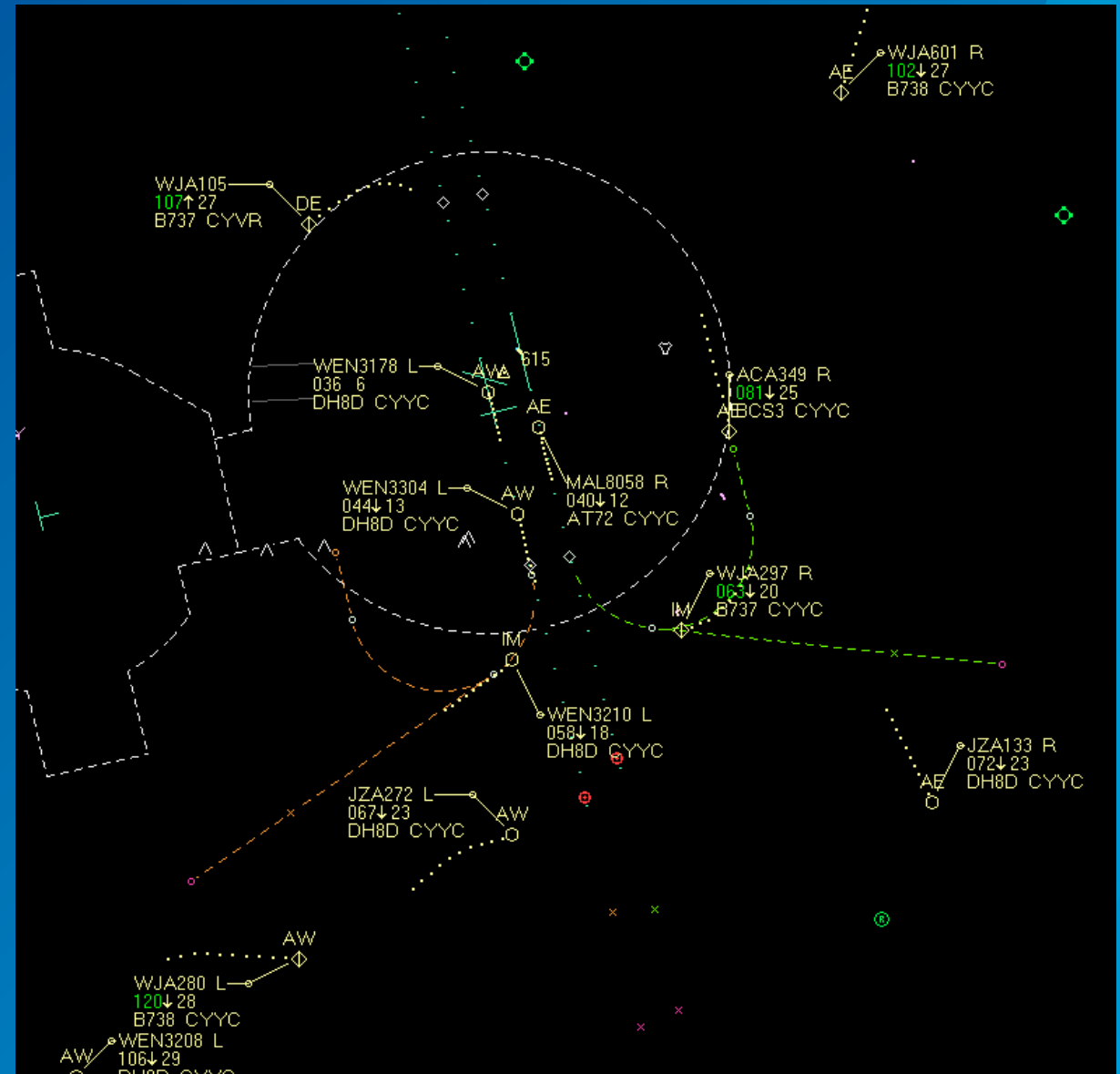
- Allow for mixed mode ops
- Facilitate effective Arrival Manager (AMAN) usage

### Approach designs capture prevailing traffic flow

- Transitions from downwind and “tangent”

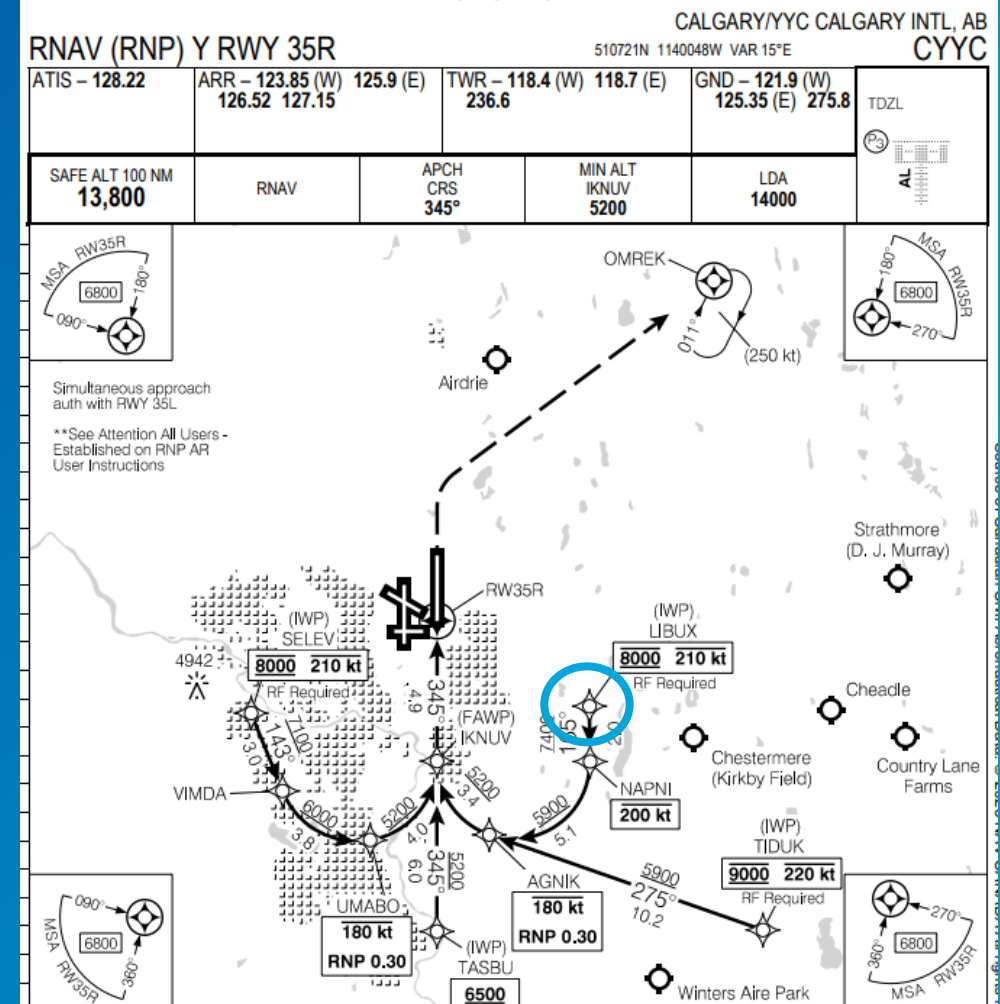
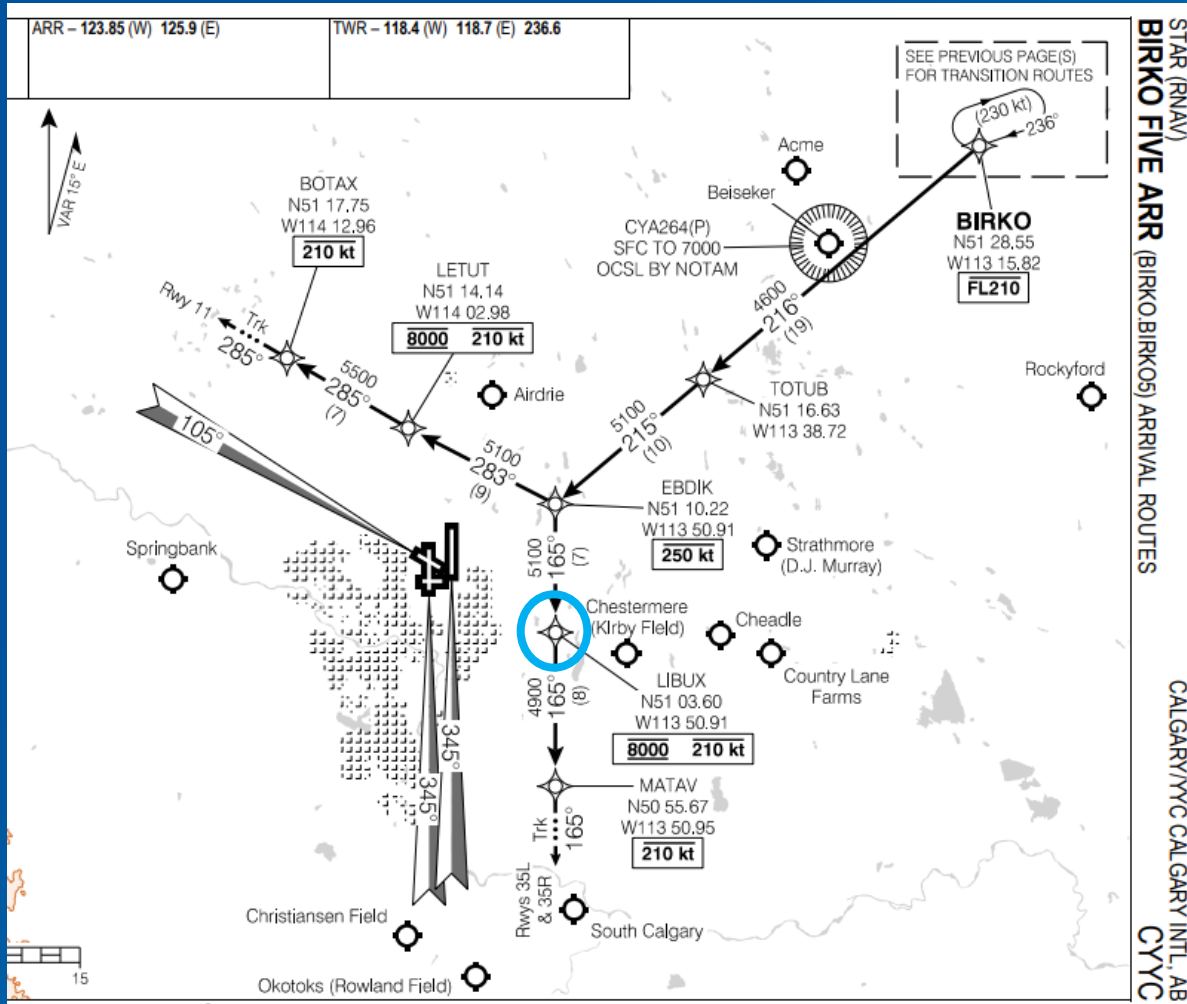
### Maintain or increase the level of safety

- Crossovers



# Design Considerations: STARs

## RNP AR APCH Approach Connection



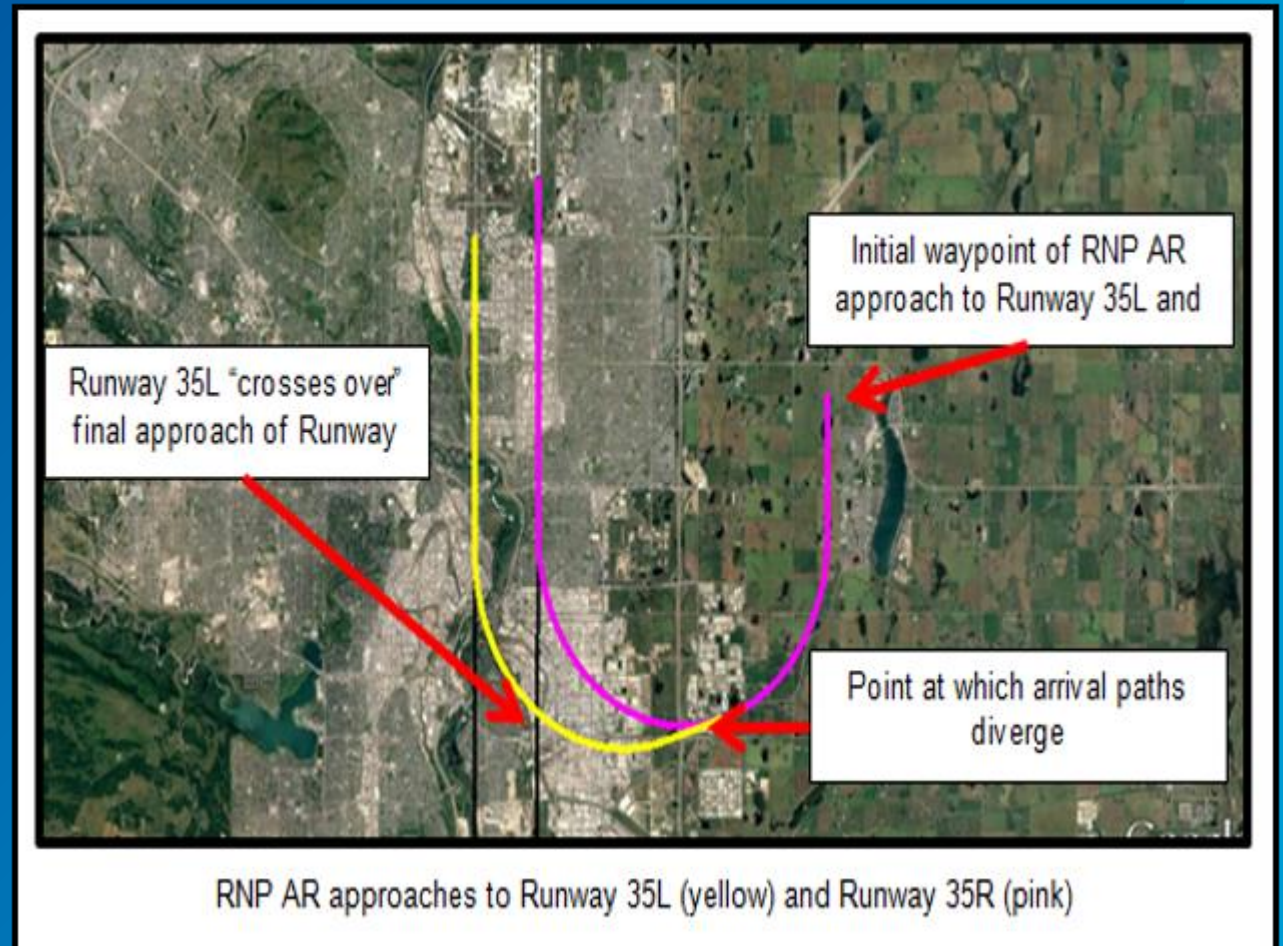
# Design Considerations: Crossovers

Published transition from right downwind to left runway or left downwind to right runway

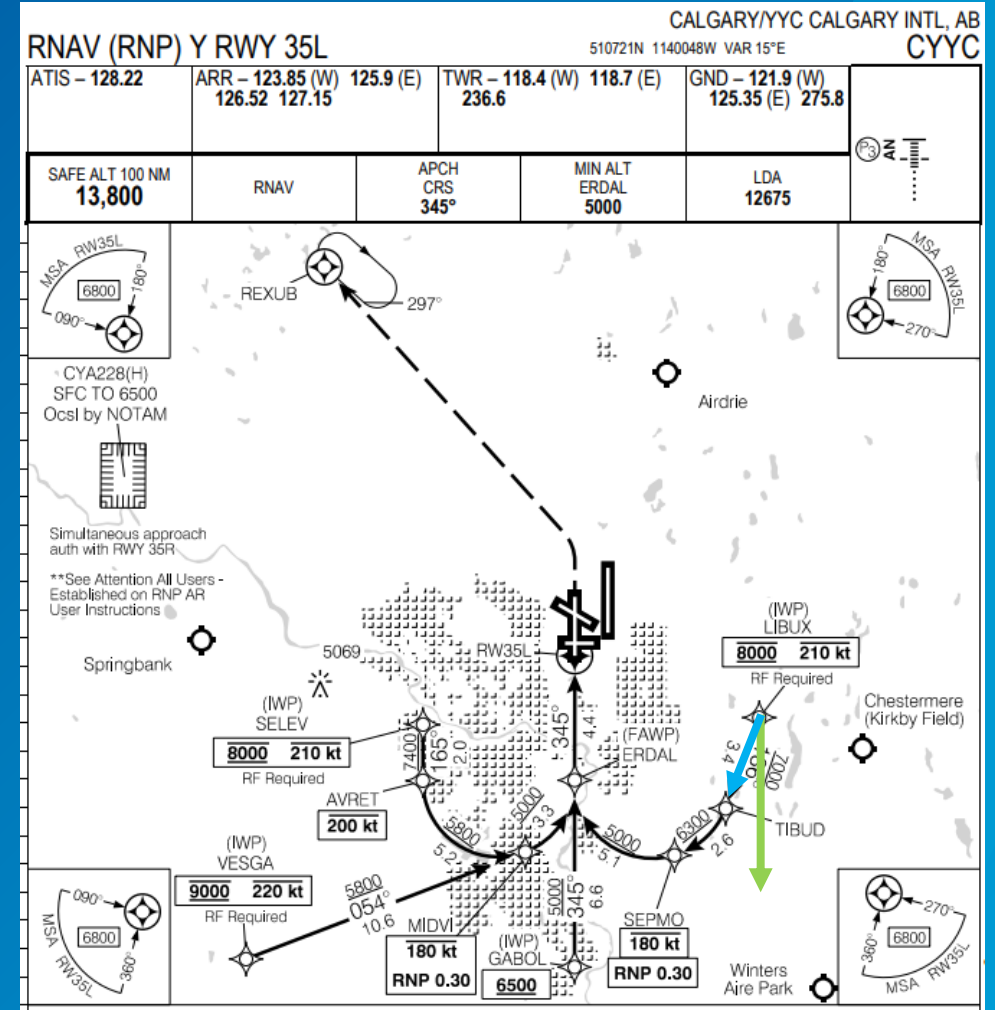
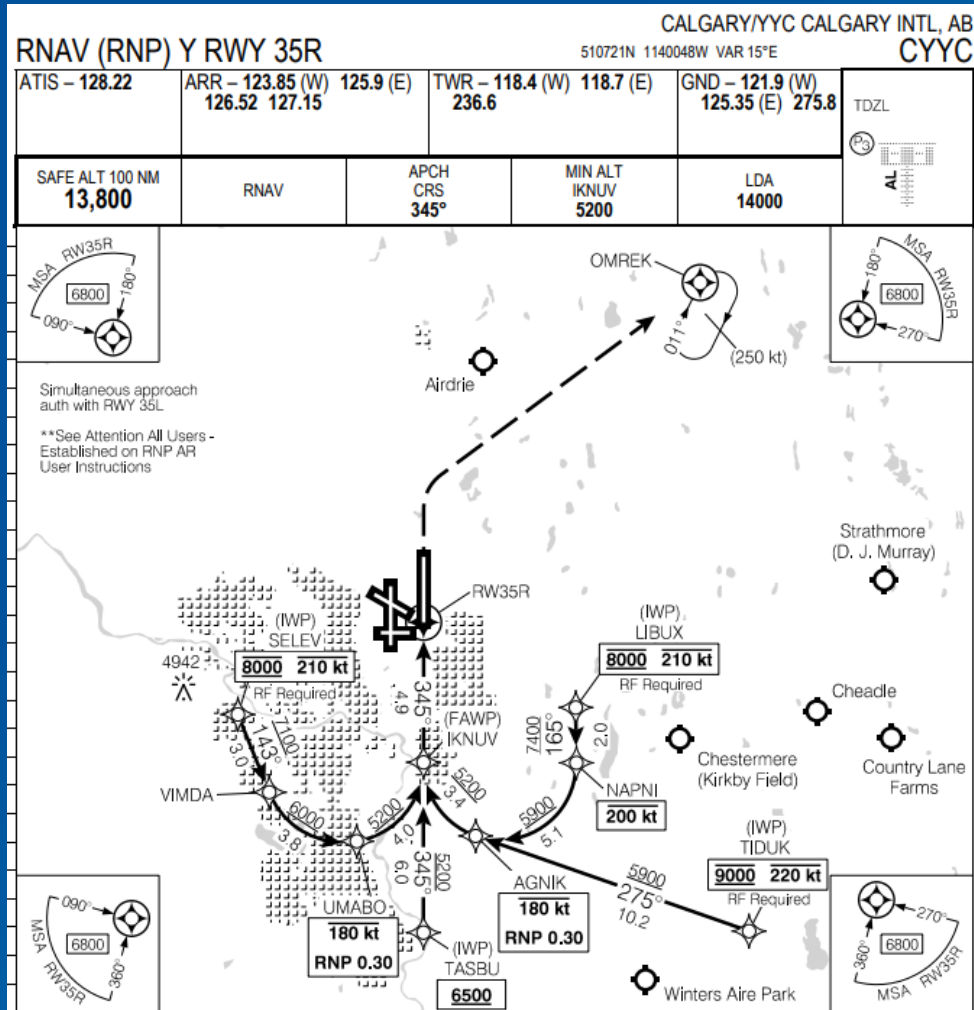
- “Crossover” final approach to opposite runway

Procedures required mitigations to identify incorrect runway selection

- Allow time for ATC to identify and correct improper runway selection



# Design Considerations: Crossovers



# Design Considerations: Crossovers

Airspace Warning Filter (AWF)



# Design Considerations: Tangents

Tangent transitions designed to capture additional traffic flows

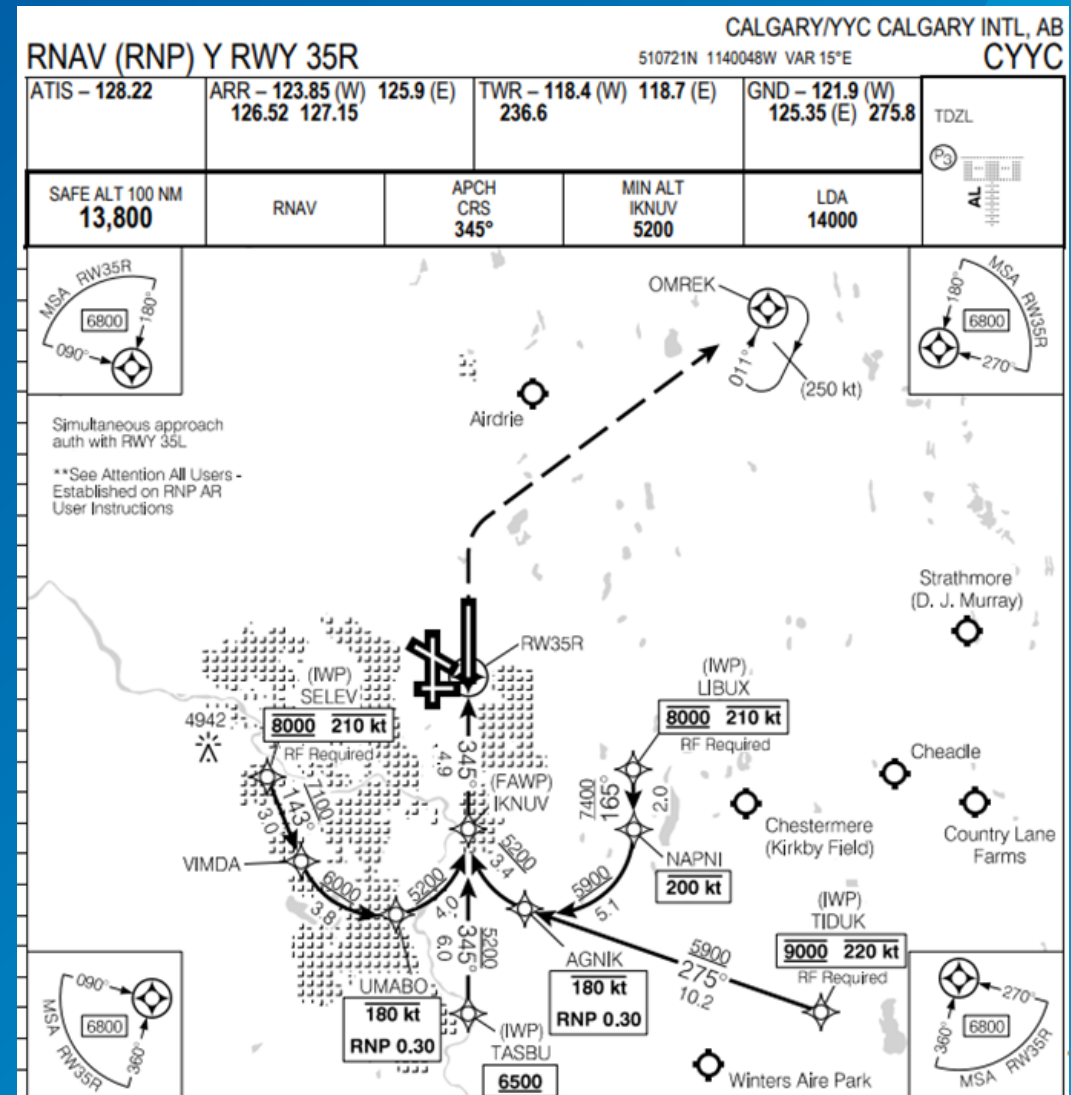
- Added to increase usage
- 'Tangent' transitions do not have crossover transitions to the opposite runway

October 2017

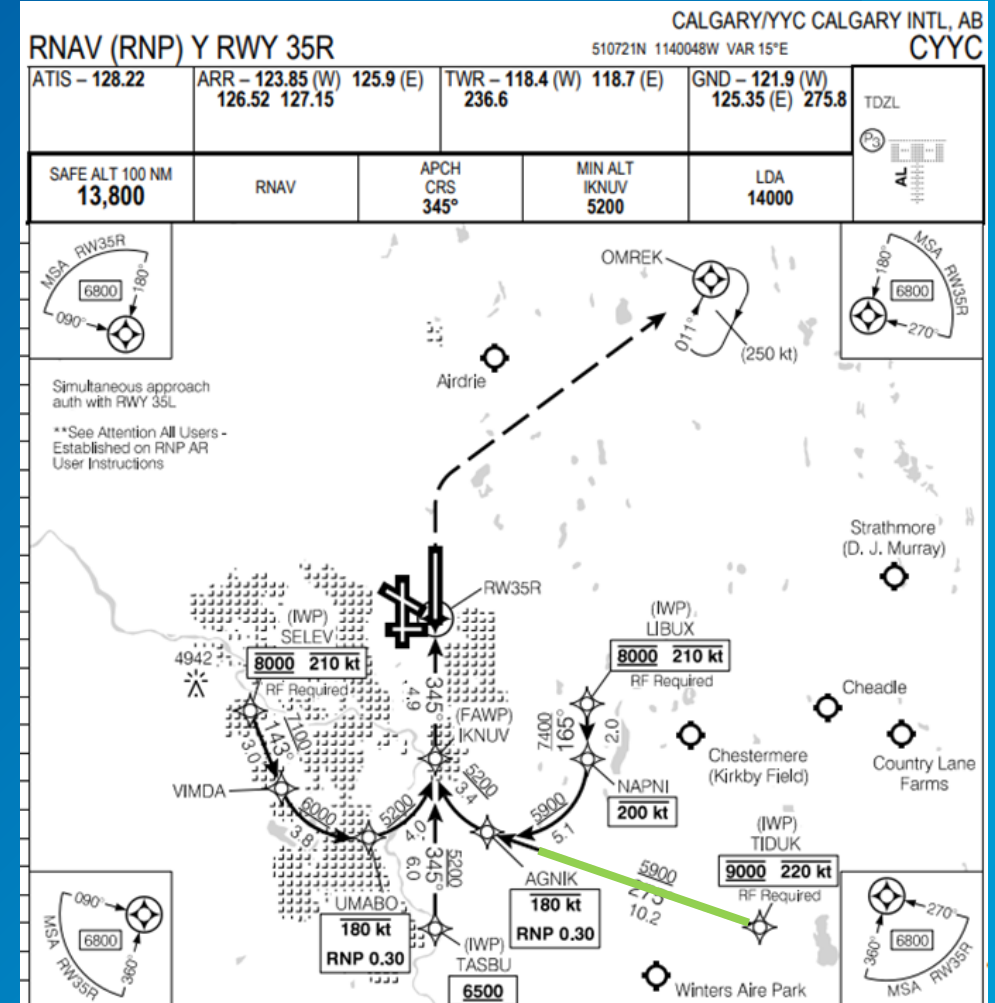
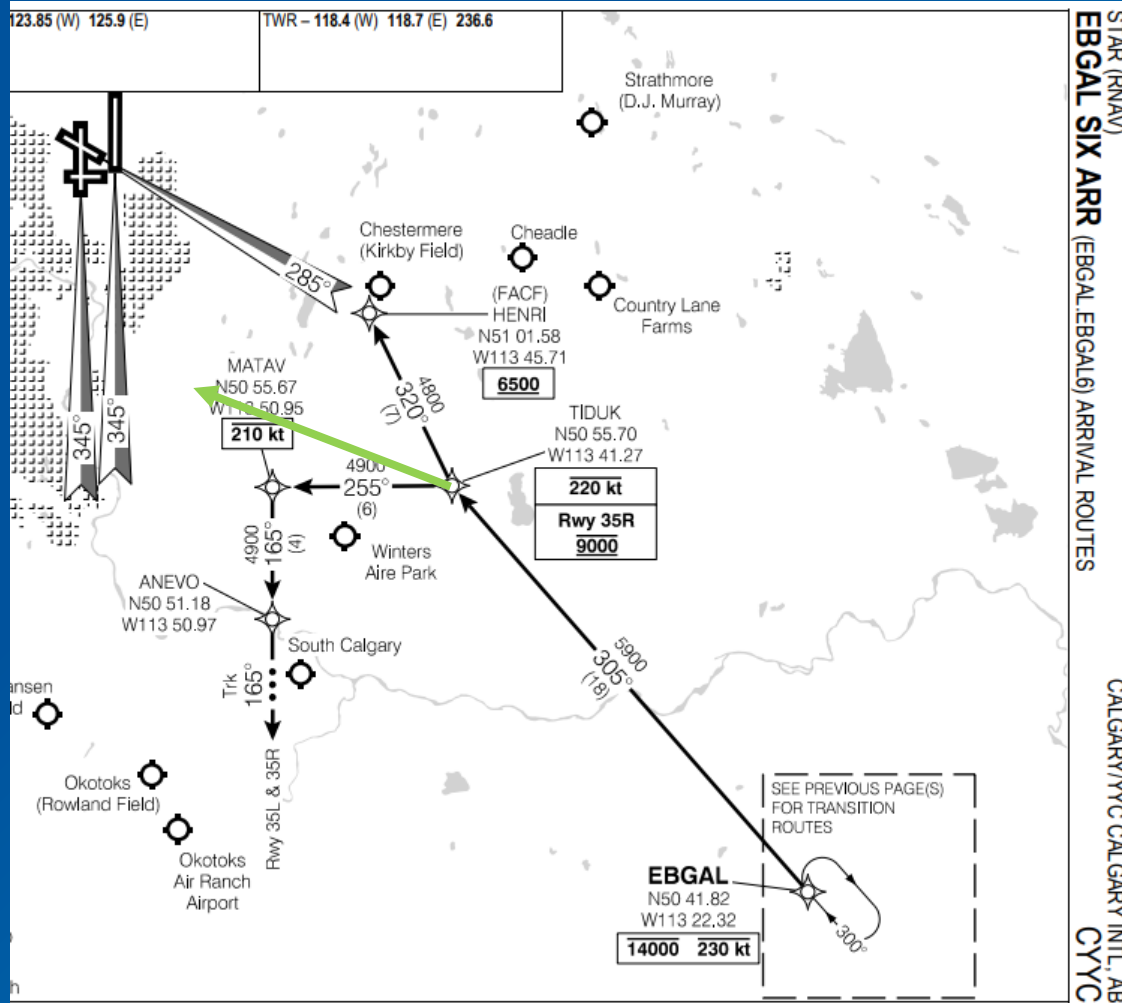
- 947 RNP AR APCH

October 2018

- 1850 RNP AR APCH



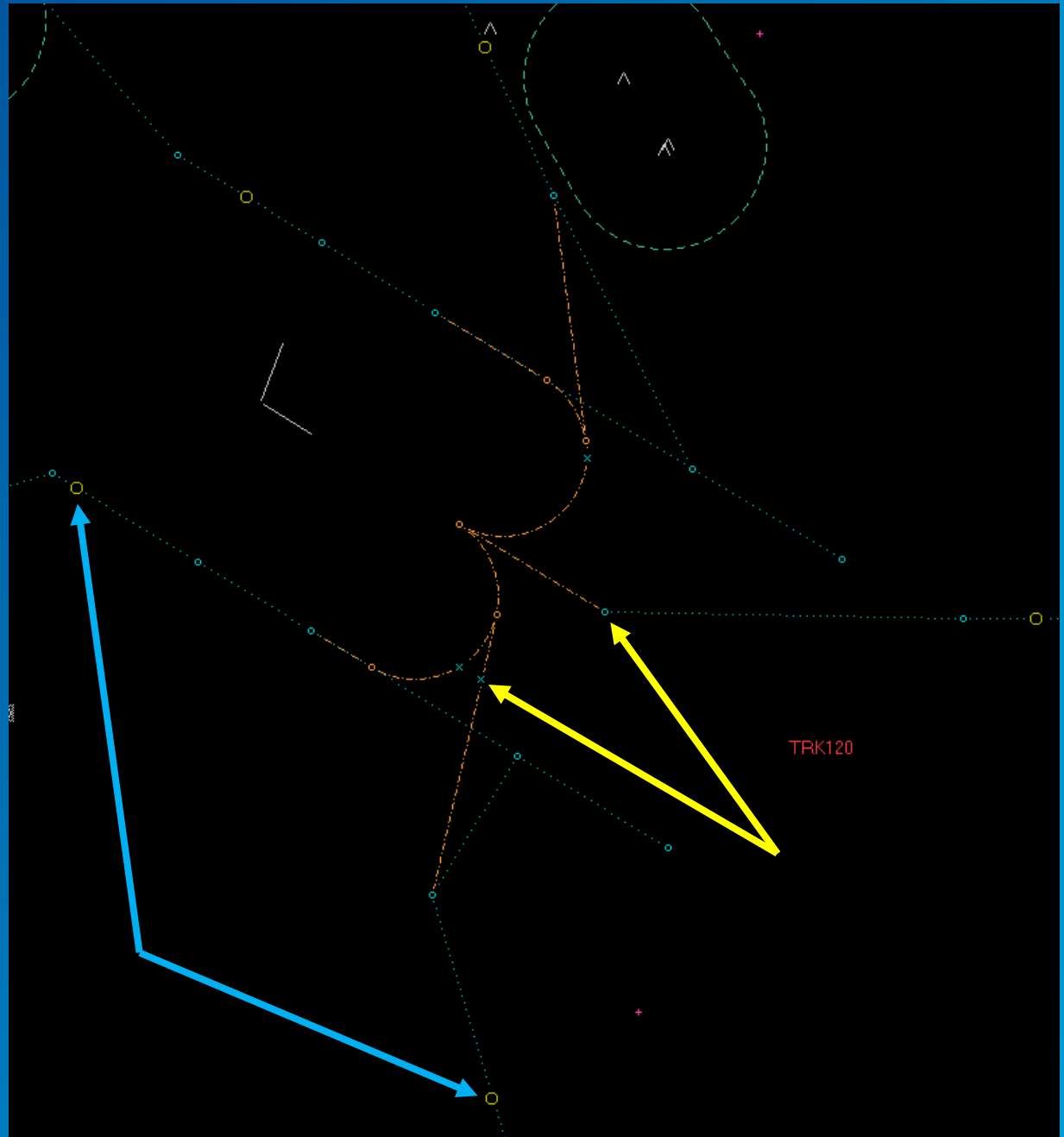
# Design Considerations: Tangents



# Operational Considerations

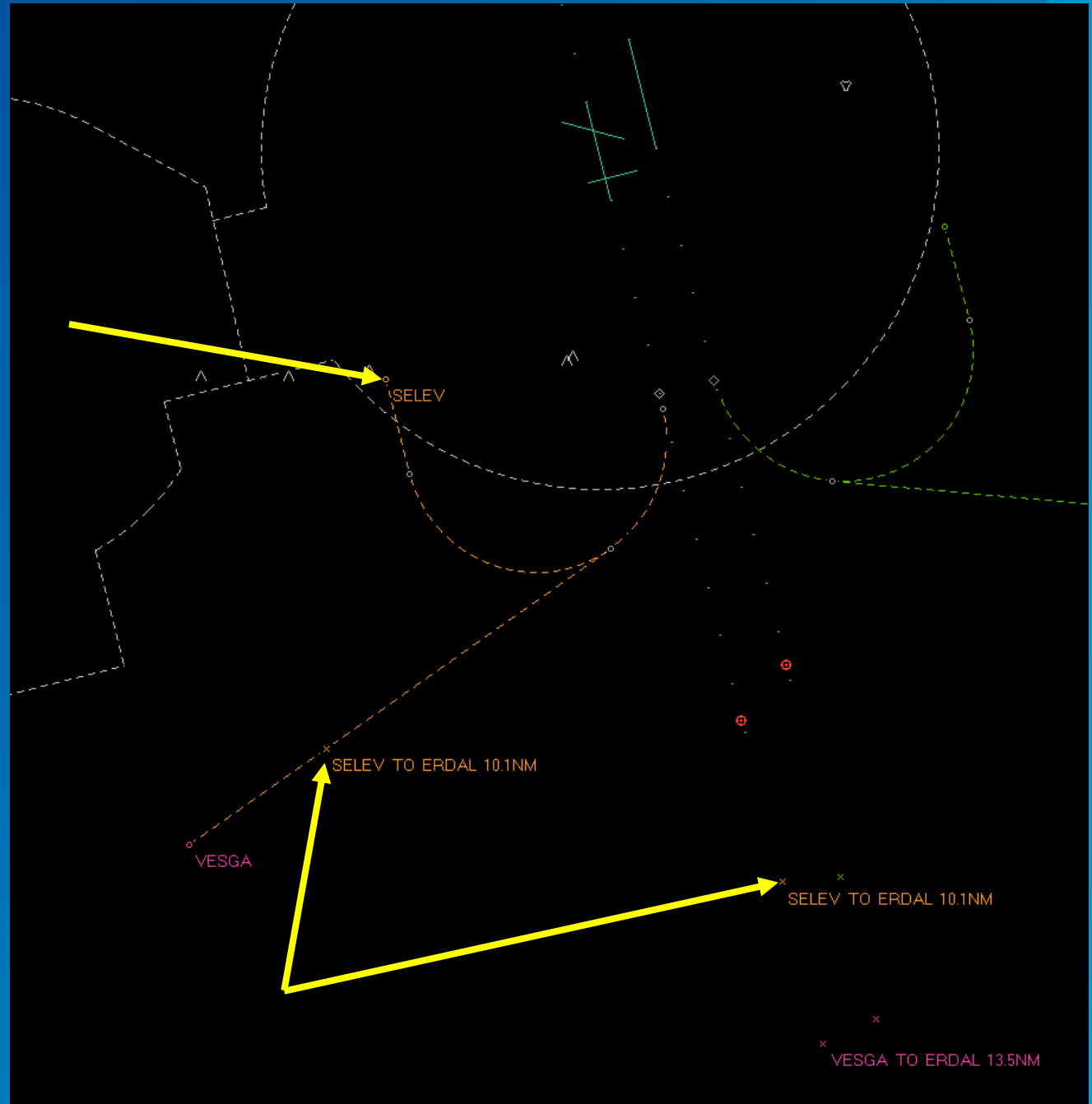
## ATC Spacing

Spacing tools to help spacing of multiple transitions and the ability to vector non-RNP AR APCH aircraft to final



# Operational Considerations

## ATC Spacing



# A Culture of Safety

Safety is why we exist

- Our commitment to safety is shared at every level
- We are industry leaders in establishing a company-wide Safety Management System
- As a result, our safety record is regarded as one of the best in the world



# EoR – Additional Safety Aspects

## Instrument Approach Procedure Naming Convention

- All RNP AR approach procedures = RNAV (RNP) Y
- ATC will specify the name of the specific transition to be flown

## Phraseology

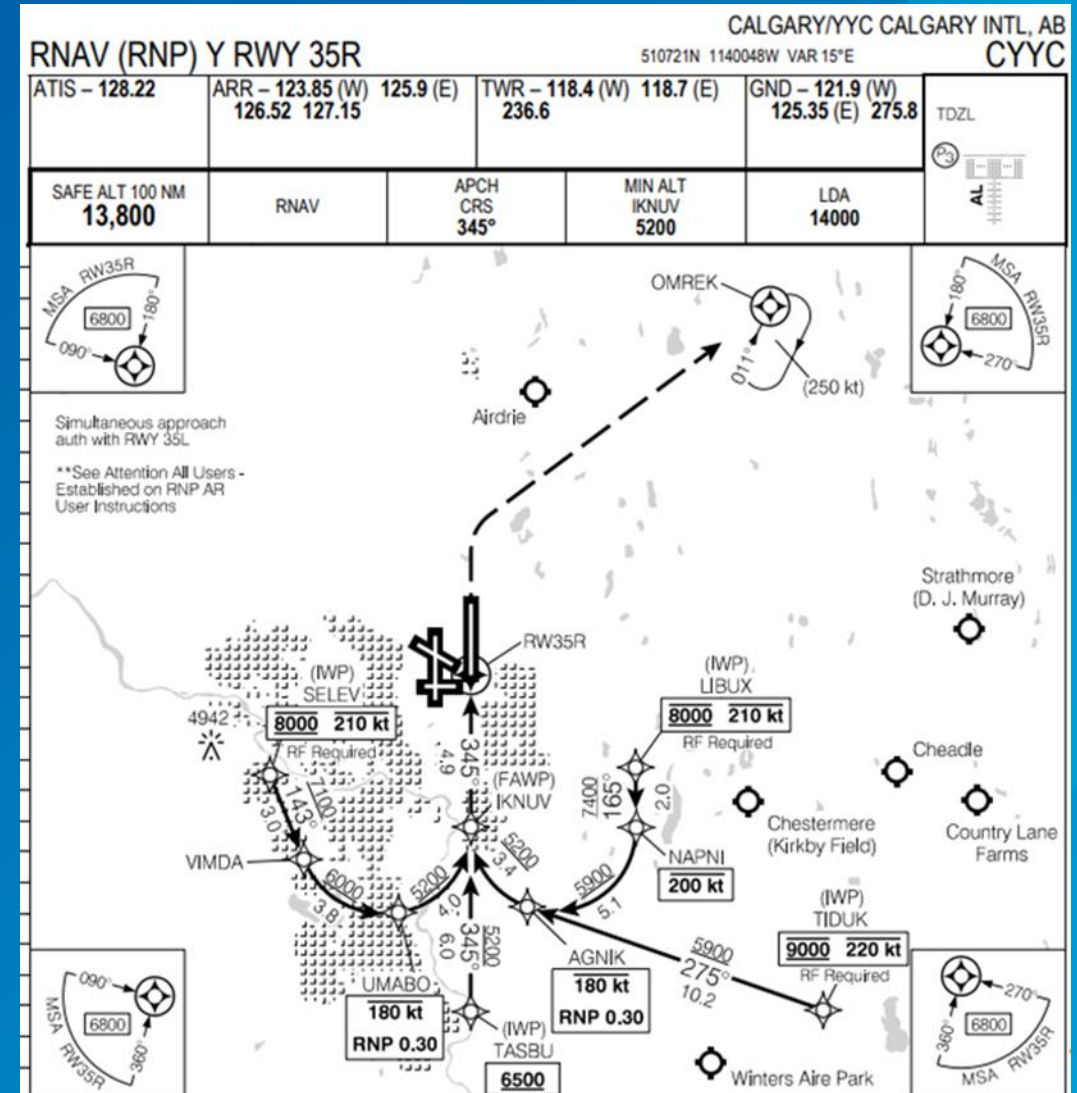
- Approach information, clearance, and breakout

## Use of autopilot during EoR

- Mitigate inadvertent break-out – controllers accustomed to strict track conformance
- AAU directs pilots to use autopilot to FAWP

## Breakout Procedures

- Expectations and actions of ATC and flight crew in the event of a breakout



## AERONAUTICAL INFORMATION CIRCULAR 31/18

### ESTABLISHED ON RNP AR (EoR): IMPLEMENTATION AT CALGARY INTERNATIONAL AIRPORT (CYJC)

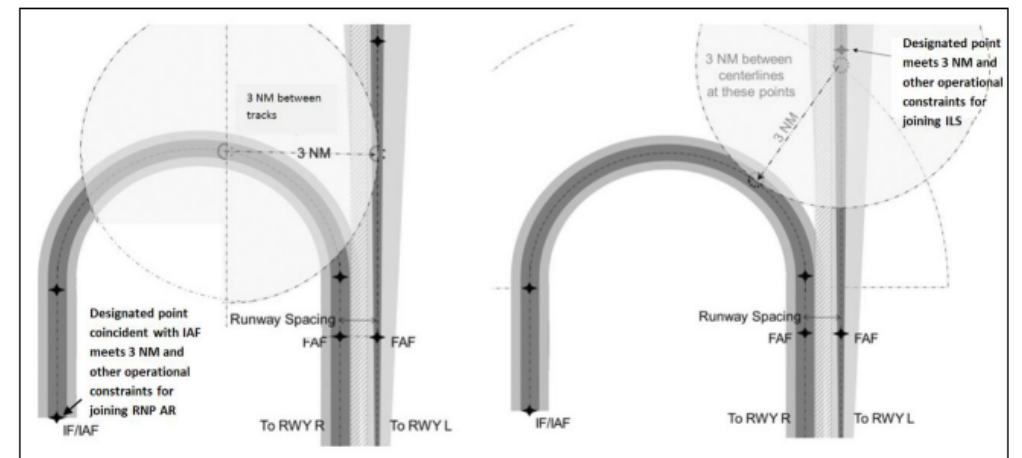
#### Introduction

On 8 November 2018 the International Civil Aviation Organization (ICAO) will implement separation standards related to Required Navigation Performance Authorization Required (RNP AR) approaches in Document 4444, Procedures for Air Navigation Services – Air Traffic Management (PANS ATM), Section 6.7.3.5, "Determination that an aircraft is Established on RNP AR APCH." NAV CANADA intends to incorporate the new separation standard "Established on RNP AR (EoR)" for parallel operations at Calgary International Airport (CYJC), effective 8 November 2018.

#### EoR Concept

Established on RNP AR (EoR) refers to a new separation standard used during simultaneous parallel runway operations, taking advantage of the benefits of RNP AR containment. For the purpose of simultaneous parallel approach separation, the operation considers aircraft that are stabilized on an RNP AR approach procedure to be similarly-established to aircraft flying a straight-in instrument landing system (ILS) procedure.

When an aircraft is cleared for an RNP AR approach and past the intermediate approach waypoint (IWP) (intermediate approach fix [IF]), the aircraft is deemed to be **established** on the approach. The 1,000 feet vertical or 3 nautical miles (NM) lateral separation standard is not required between an aircraft established on RNP AR approach and an aircraft established on the approach for the adjacent parallel runway by a designated point on the approach.



# EoR – Additional Safety Aspects

## Published Aeronautical Products

### Aeronautical Information Circular

- Published 56 days in advance of implementation
- Clear expectations of flight crew and ATC

### Attention All Users

- Published along with Approach Charts
- Describes operational requirements and breakout procedures



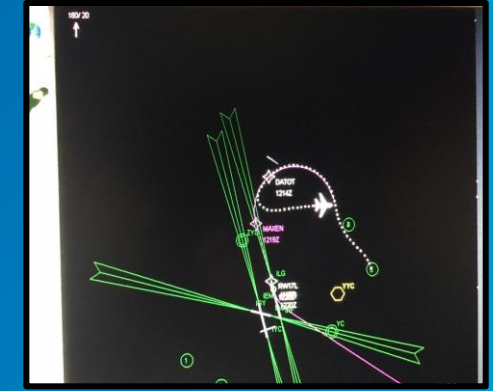
# Breakout development

## Breakout - Human in the Loop (HITL) trials

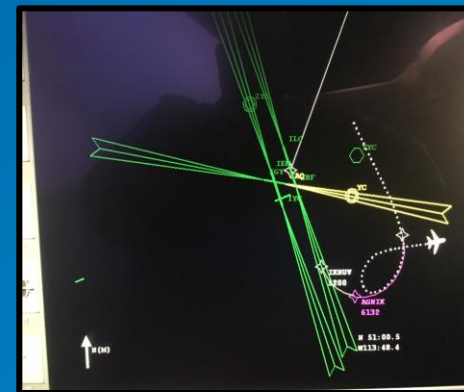
- In all scenarios, break-out instructions ensured protection of NTZ
- ATC trained to provide breakout instruction in “same direction” as RF turn



Strong tailwind “away” from C/L



Strong headwind



Subsequent instruction after initial breakout



Turn “counter to RF leg

# Attention All Users

## Operational Requirements and Breakout Procedures

- Chart note included directing pilots to AAU/User instructions

**\*\*See Attention All Users -  
Established on RNP AR  
User Instructions**

- Use of RNP AR APCH during simultaneous parallel operations
- Guidance on autopilot usage (based on HITL simulation)
- Best practices in the event of an abnormal situation
- Phraseology examples provided

ATTENTION ALL USERS CALGARY/YYC CALGARY INTL, AB  
CYYC

**Established on RNP AR User Instructions**

Established on RNP AR is a procedure applied by Calgary terminal air traffic controllers to aircraft conducting RNP AR approaches. Established on RNP AR safely permits reduced vertical separation between aircraft, during ATC-monitored simultaneous independent parallel approaches. Refer to Noise Abatement Procedures for additional requirements.

**Operational Requirements**

- Established on RNP AR will be used during simultaneous parallel runway operations, and ATIS shall indicate when simultaneous parallel runway operations are in effect
- Arrivals planning RNAV (RNP) approaches must make the request on initial contact with **Calgary Arrival** controller
- When cleared for an RNAV (RNP) approach, the aircraft is considered "established" on the approach procedure once it is on the defined lateral and vertical path and past the IWP(IF) for the procedure

**Due to the nature and proximity of simultaneous independent parallel approaches and procedures that commence at the same IWP(IF), incorrect runway selection will jeopardise separation and will likely require controller-initiated breakout intervention**

- The approach shall be flown using autopilot until the aircraft passes the final approach waypoint (FAWP)
- If unable to comply with an ATC clearance or conduct the cleared approach immediately advise the controller. **Do not** attempt to self-navigate or manually correct an RNP AR approach procedure deviation. Immediately advise the controller using the phraseology example below then comply with subsequent ATC instructions:  
**Pilot:** "UNABLE approach, REQUEST (proposed course of action)"  
Example: **Pilot:** "NAVCAN123 UNABLE MUPUV TRANSITION, REQUEST VECTORS TO FINAL"

**Break-out Instructions**

**When issued break-out instructions, reaction time may be critical. If expeditious compliance is required, an ATC break-out instruction may include the word IMMEDIATELY.**

- ATC shall issue any required break-out instruction by assigning a heading and/or altitude instruction:  
Example: **ATC:** "NAVCAN123, turn left immediately heading 310 degrees, climb to 7 000"
- Established on RNP AR break-out procedures may be conducted with the autopilot on

# Breakout Procedure

Attention All Users

If unable to comply with an ATC clearance or conduct the cleared approach immediately advise the controller. ***Do not*** attempt to self-navigate or manually correct an RNP AR approach procedure deviation. Immediately advise the controller using the phraseology example below then comply with subsequent ATC instructions:

**Pilot:** “UNABLE approach, REQUEST (proposed course of action)”

Example: **Pilot:** “NAVCAN123 UNABLE MUPUV TRANSITION, REQUEST VECTORS TO FINAL”

## Break-out Instructions

**When issued break-out instructions, reaction time may be critical. If expeditious compliance is required, an ATC break-out instruction may include the word IMMEDIATELY.**

- ATC shall issue any required break-out instruction by assigning a heading and/or altitude instruction:

Example: **ATC:** “NAVCAN123, turn left immediately heading 310 degrees, climb to 7 000”

- Established on RNP AR break-out procedures may be conducted with the autopilot on

# RNAV Phraseology Guide

- Published through collaboration with major airlines and ATC
- Consistent phraseology will enhance safety for EoR operations
- Contains phraseology examples on
  - ▶ PBN SID and STAR usage
  - ▶ Approach clearance phraseology
  - ▶ “Unable RNAV”
  - ▶ Informing ATC of expected approach
  - ▶ Available at [navcanada.ca](http://navcanada.ca)



# RNAV Phraseology Guide

## Phraseology

STAR to approach



( aircraft id ) CLEARED ( RNAV approach name ) APPROACH ( runway id ) ( approach transition name ) TRANSITION

## Example

STAR to approach



*JAZZ ONE-TWO-THREE CLEARED RNAV ZULU RUNWAY ONE-EIGHT APPROACH,  
NAGEK TRANSITION.*



# RNAV Phraseology Guide

## Pilots Notifying ATC of an Inability to Conduct an Approach Procedure

If, at any stage of conducting an approach procedure, a flight is unable to comply with an ATC approach clearance due to an avionics malfunction, FMC input error, weather or other non-normal condition, crews must immediately advise ATC and request an alternate clearance or course of action.

### Pilot Actions

- Inform ATC if a flight is unable to conduct an approach procedure as cleared by ATC

### Pilot Phraseology



( aircraft id ) UNABLE ( approach ), REQUEST ( proposed course of action )

### Pilot Example



WESTJET ONE-TWO-THREE UNABLE MUPUV TRANSITION, REQUEST VECTORS TO FINAL.



# EoR – TCAS

## TCAS Assessment

- Assessment conducted of potential nuisance TCAS (TA and RA) during simultaneous RNP AR approaches
- Analysis evaluated simulated TCAS performance for ILS/RNP and RNP/RNP pairings
- Results identified ANPs consistent with the certified performance of current fleets (0.15 and less), potential nuisance activity effectively eliminated



# EoR Training for ATC

## EoR

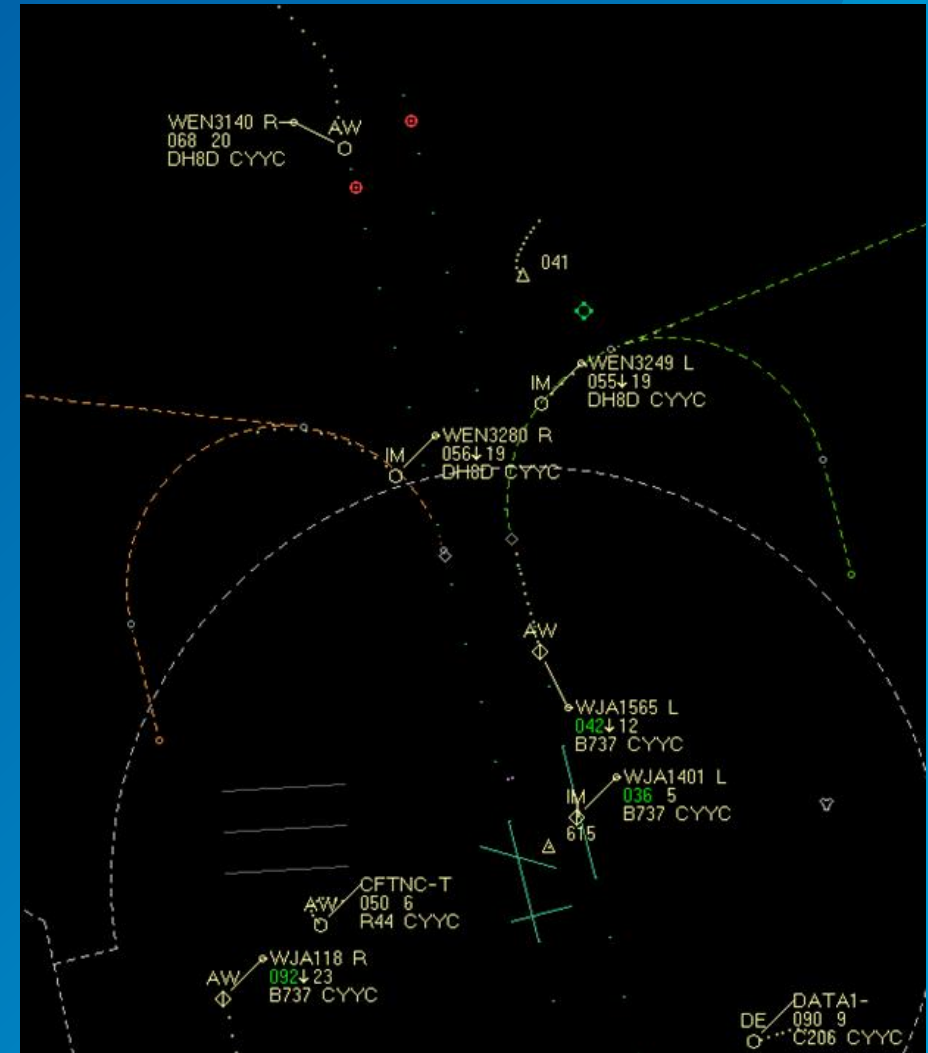
- Phraseology
- Control Transfer

## In-trail spacing

- Speed control vs vectoring
- Tangent and RF Leg
- Vector to final in front and behind aircraft on RNP AR APCH
- Mixed mode operation

## Breakout procedures

- Wrong runway identification
- Phraseology
- Issues with non-RNP AR aircraft



# EoR in Calgary

Maximising RNP AR APCH

Pre EoR

- October 2017 – **947**
- Average 32 per day

Implementation of RNP AR “Tangent Transitions”

- October 2018 – **1850**
- Average 62 per day

# EoR Highlights in Calgary (CYYC)

8 November 2018

- First year of EoR Operations = +35 000 approaches
  - ▶ Approach utilization up to 70% of T1 capable
- Reduction of 250 000 track miles
- Reduction of 4.1 million kg CO2 emissions
- Each RNP AR approach reduces flying time by 3-4 minutes over conventional “straight in”
  - ▶ Saving approx 10 track miles
- Reduction in flying time of more than 1400 hours



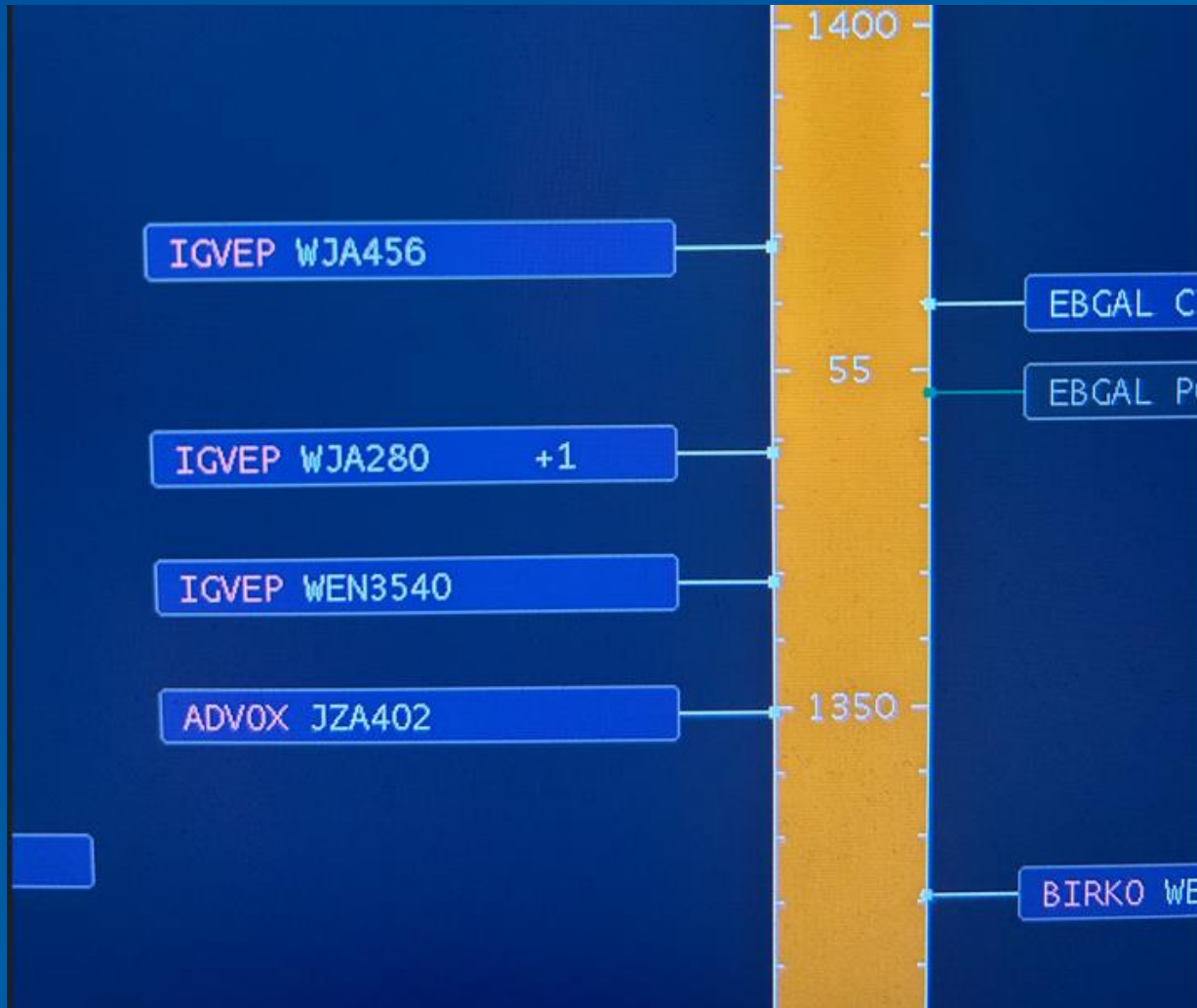
# Operational Considerations

- Arrival Manager (AMAN) adapted to recognize T1 in Field 18
  - Sequencing by Enroute sectors to deliver into Terminal area
- ATC sequencing techniques based more on tactical speed control
- CYYC arrival rates – 44 arrivals/hour in dual operation
  - T1 Arrivals will be grouped
  - Non T1 may be “moved” to opposite runway

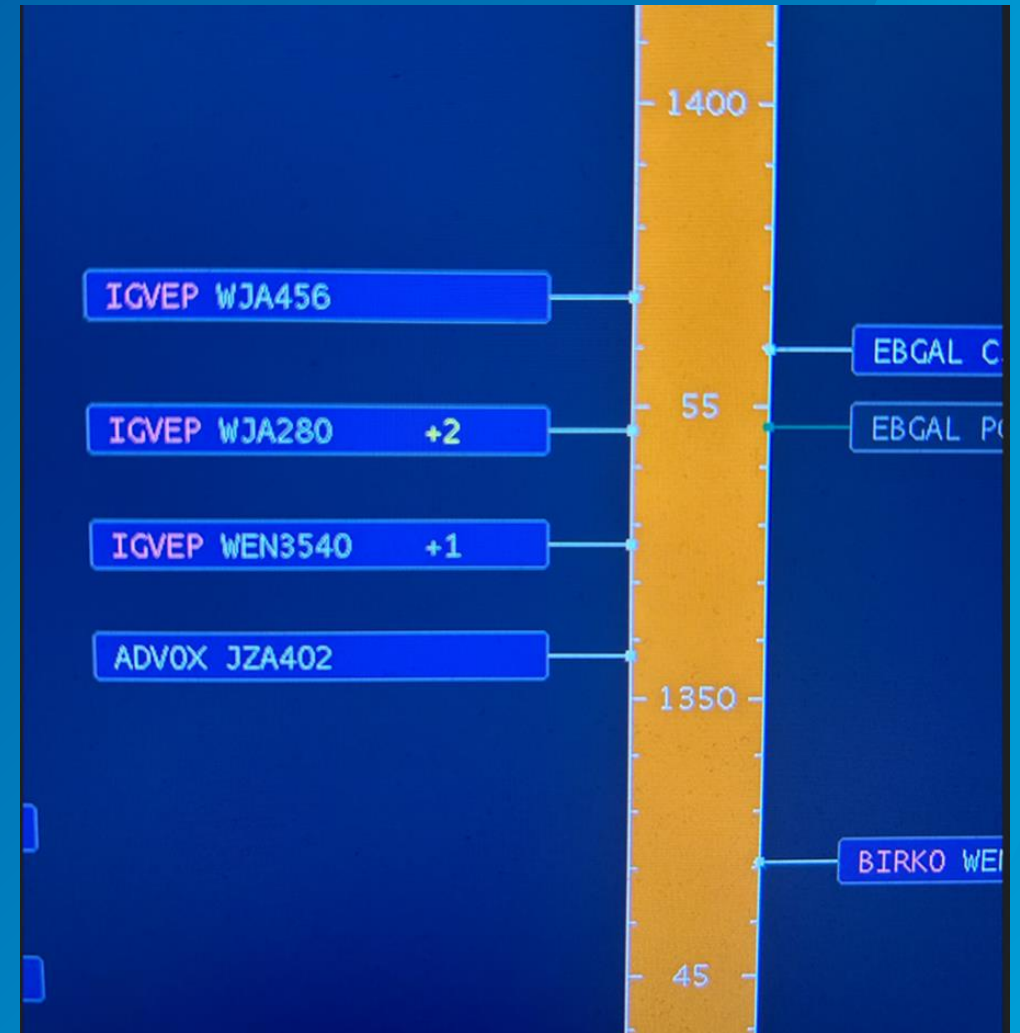


# Effect of "T1"

JZA402 (RNP-AR)

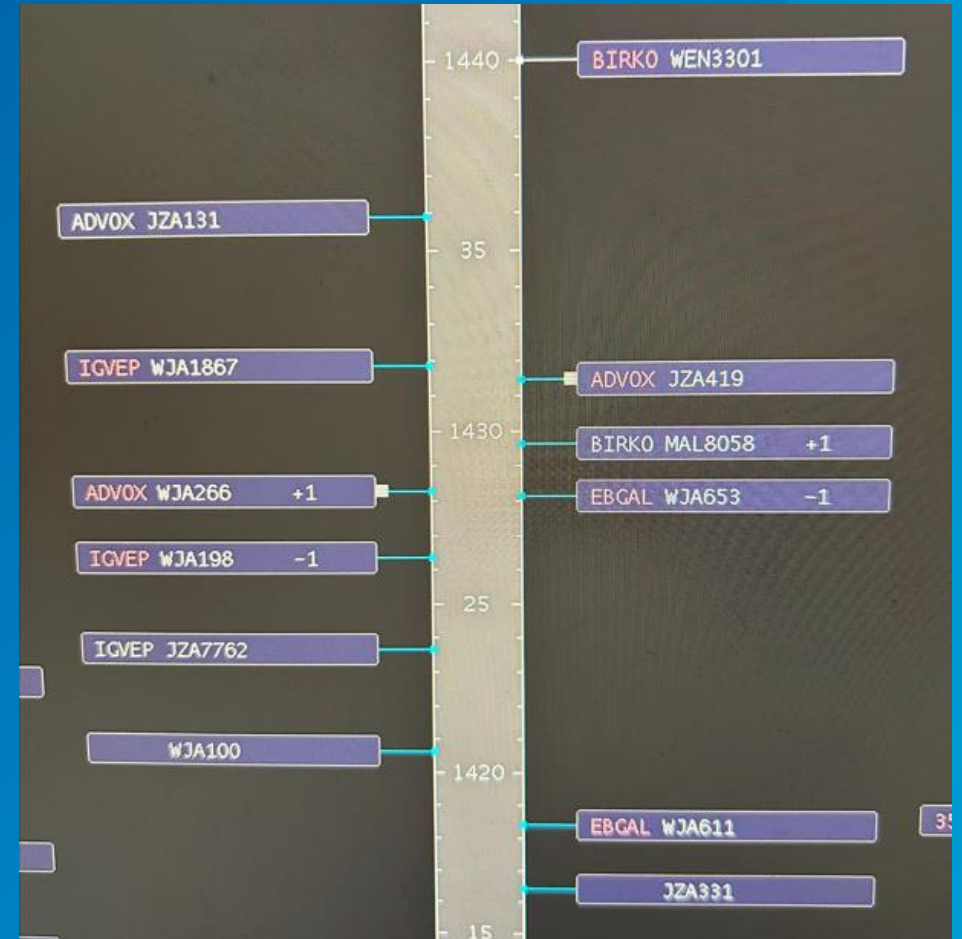
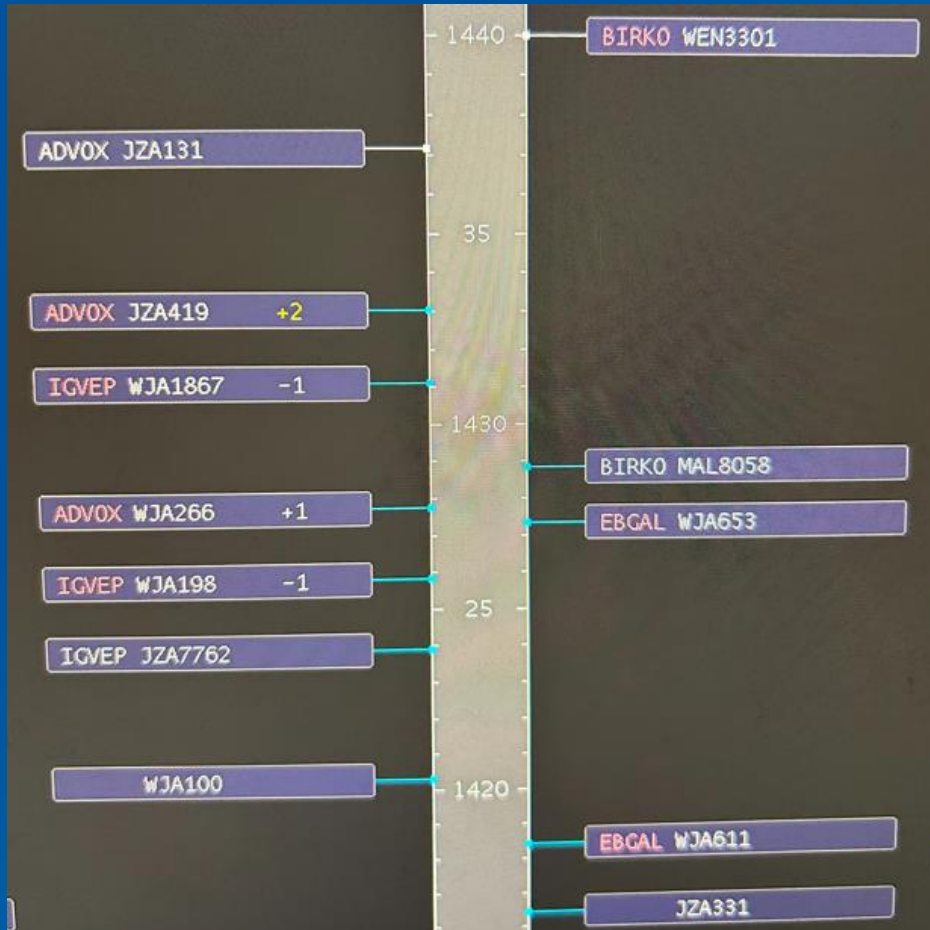


JZA402 (non RNP-AR)



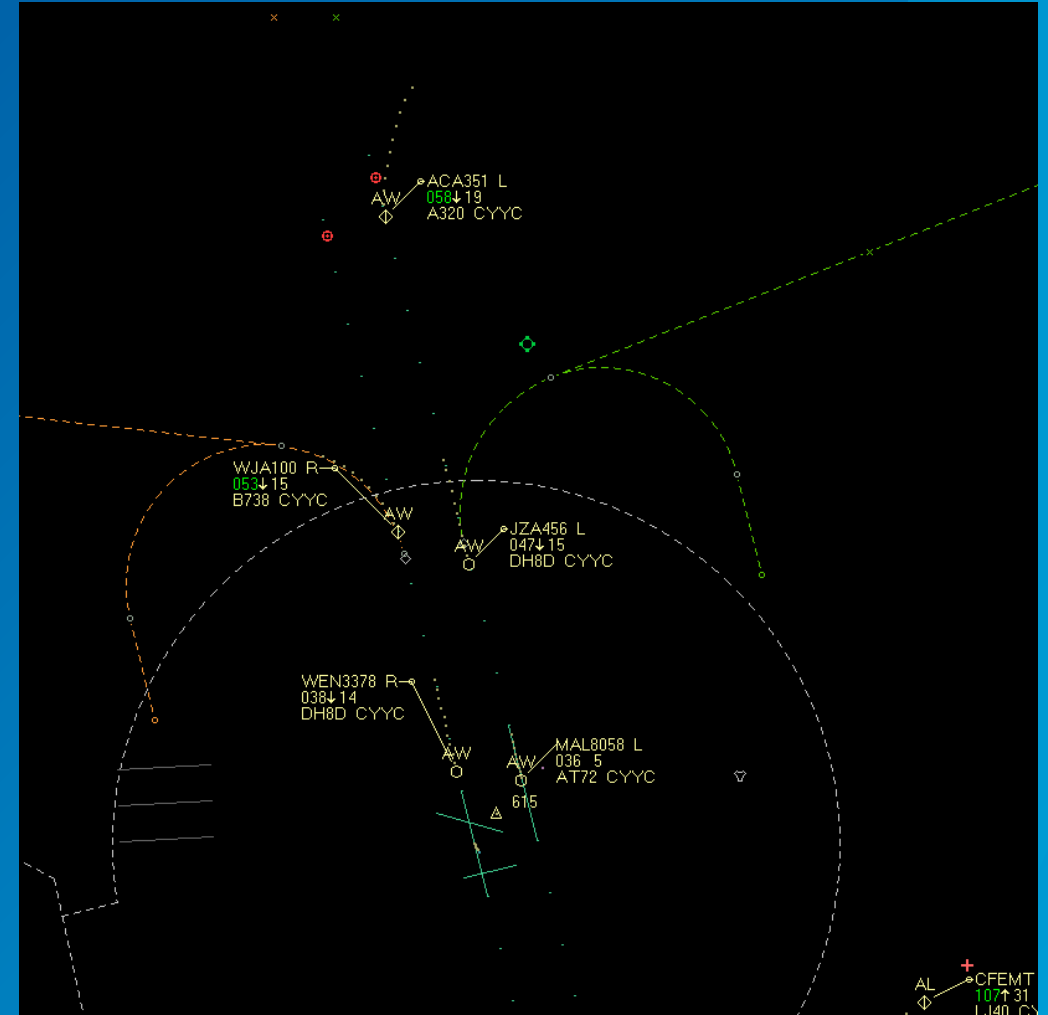
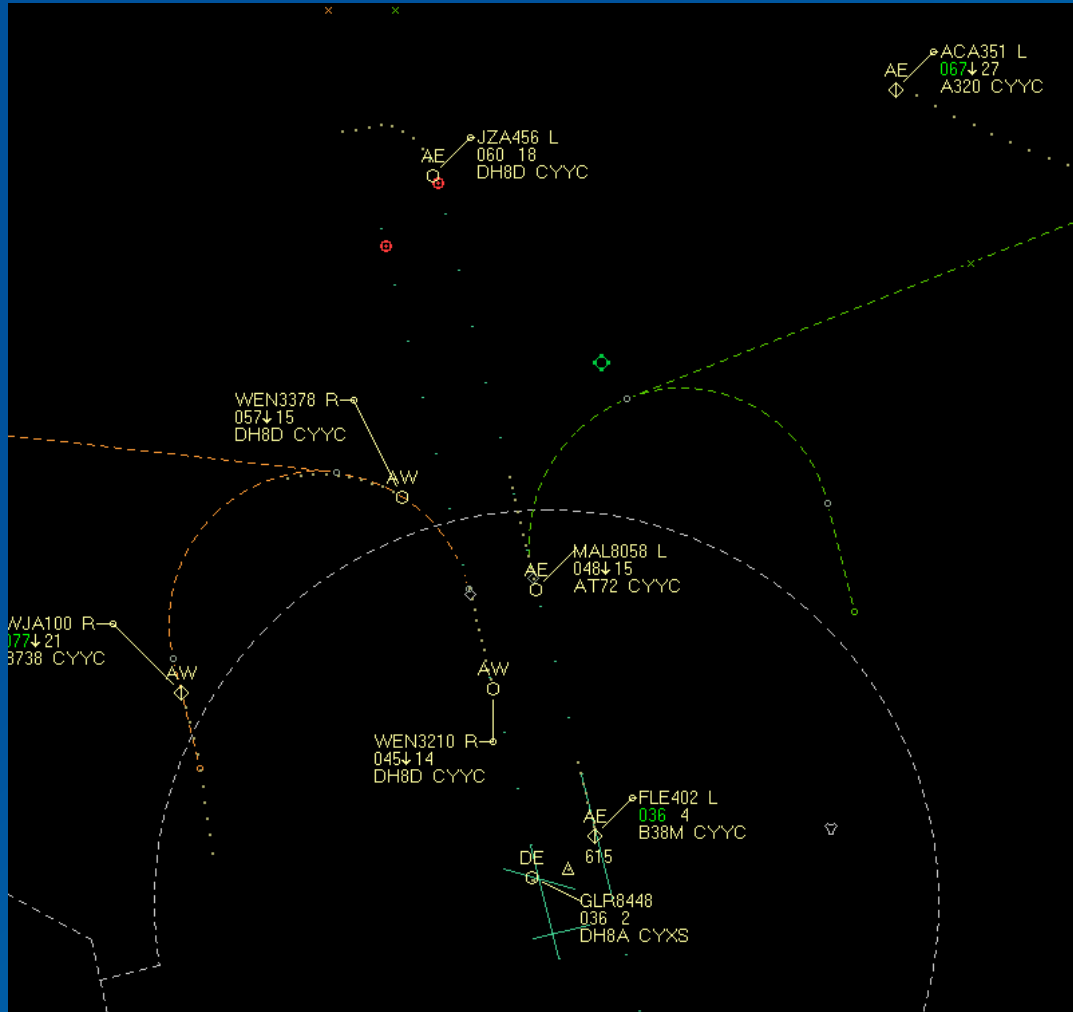
# Effect of "T1"

Arrival Manager (AMAN) considers EoR Standard



# Establishing EoR in Canada

Managing RNP AR APCH, RNP APCH, and ILS





# EoR in operation in Toronto

Toronto/Pearson (CYYZ)

## Lessons learned from CYYC

- Development based on CYYC ConOps
- Brand new procedures for CYYZ – positioning of IF/IWP in procedures development to facilitate Continuous Climb Operations (CCO)
- More content added to AAU – Operational expectations



Green = RNP AR  
Red = Conventional vectored ILS

## RWY05 HISTORICAL TRACKS



**RNP Approach and Historical Tracks -  
Approche RNP avec des routes  
historiques**  
**Runway 05 - Piste 05**  
**RNP Arc Overview - Aperçu de l'Arc RNP**

### Map / Carte

Region of Interest / Région d'intérêt



Runways / Pistes



Planned altitude above sea level



Altitude planifié au-dessus du niveau de la mer

Approach path centre line



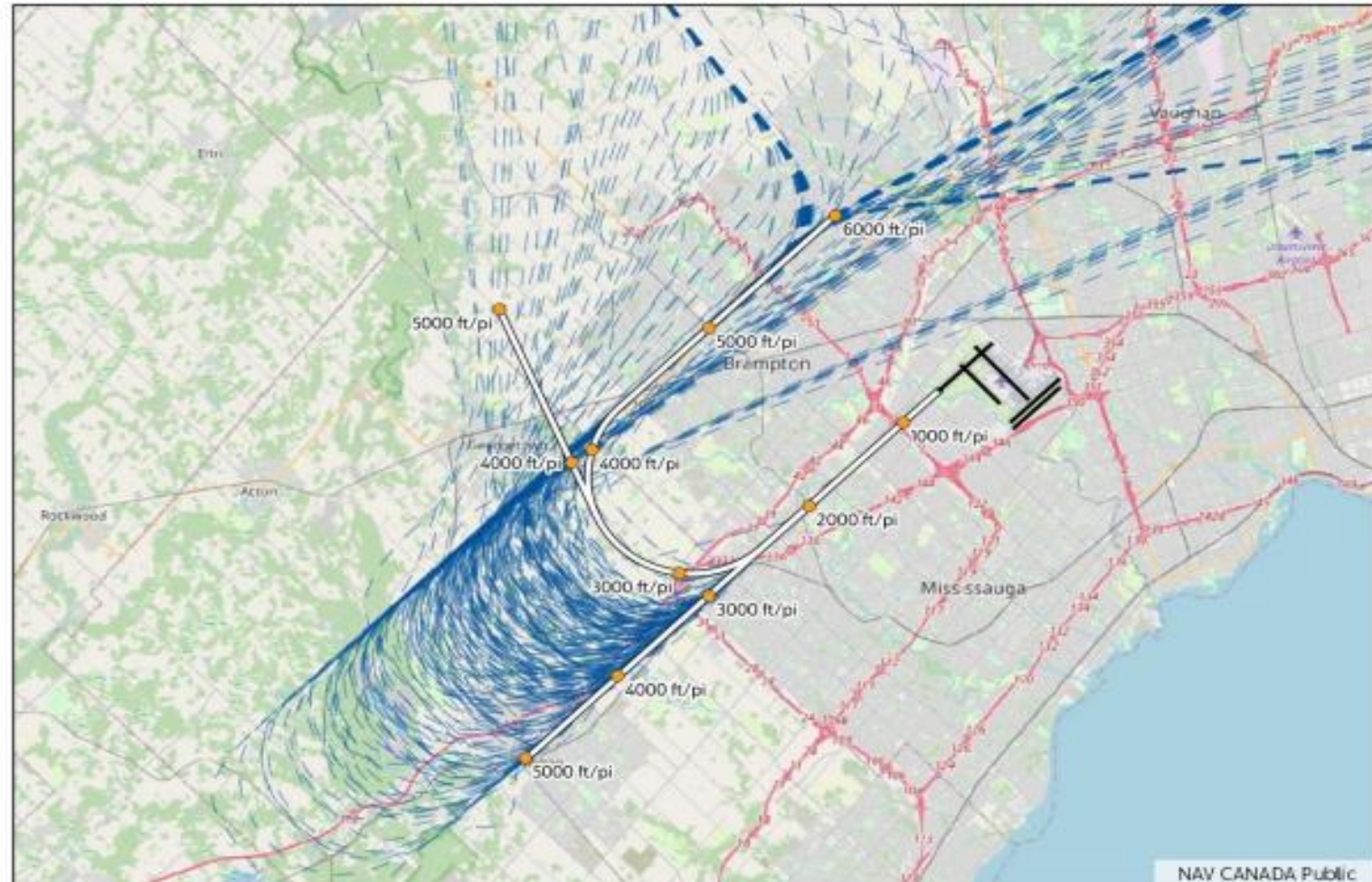
Axe de la trajectoire d'approche

Historical Tracks / Routes historiques



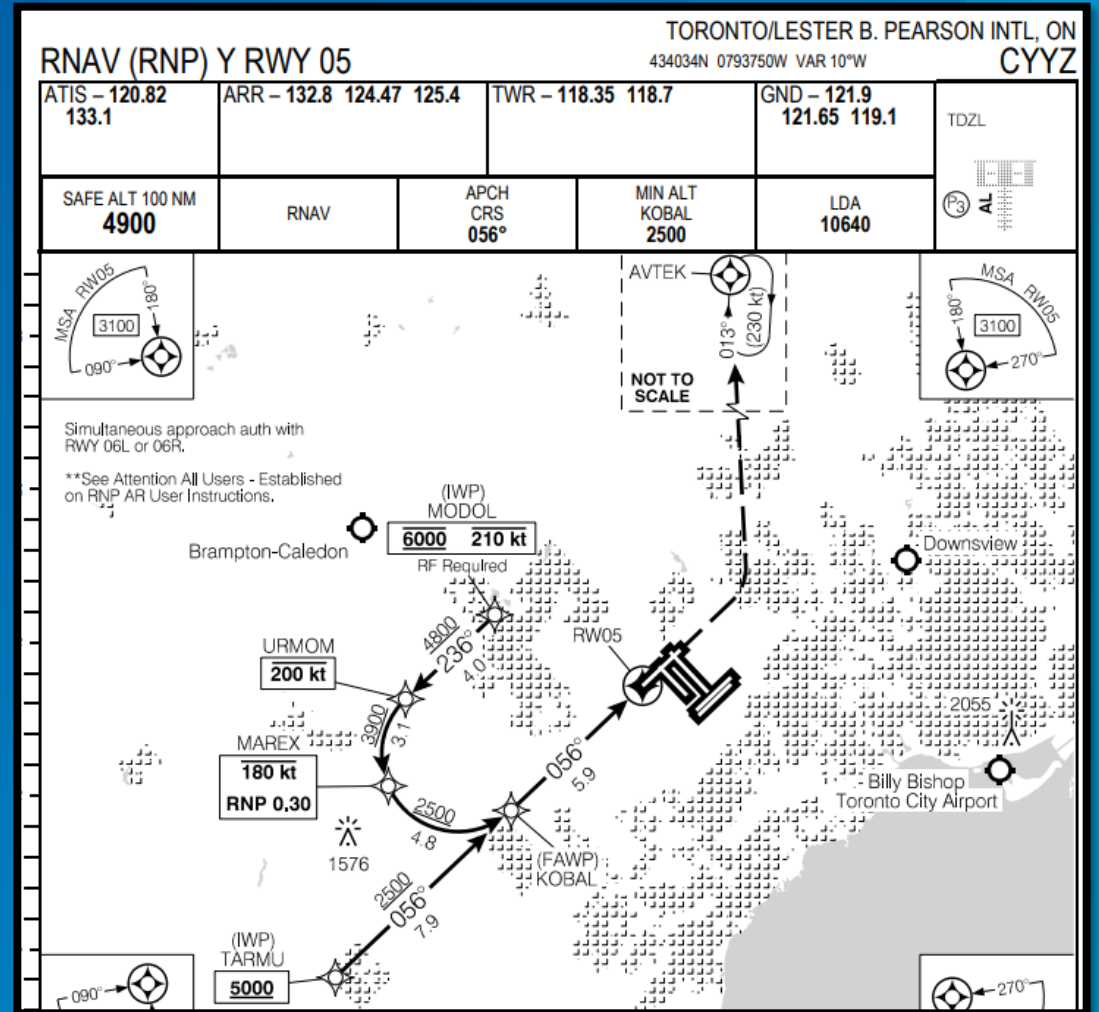
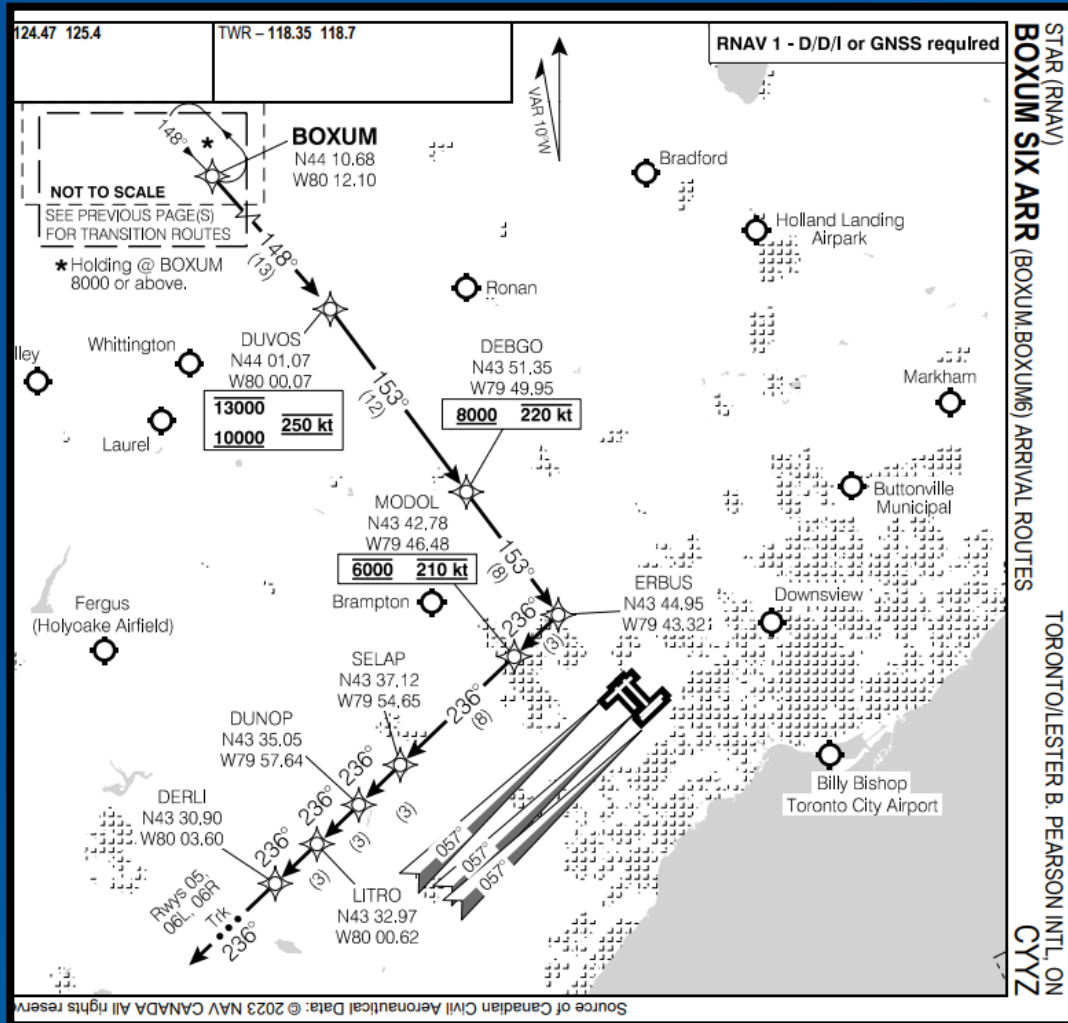
For additional information, visit  
[www.navcanada.ca/YZRNP](http://www.navcanada.ca/YZRNP)  
pour information supplémentaire

Updated October 2021  
Mis à jour en octobre 2021



NAV CANADA Public

# Implementing EoR at Toronto Pearson (CYYZ)



# EoR at Toronto Pearson (CYYZ)

Attention All Users

TORONTO/LESTER B. PEARSON INTL. ON  
CYYZ

ESTABLISHED ON RNP AR (EoR) USER INSTRUCTIONS

**Established on RNP AR (EoR) User Instructions**  
**ATTENTION ALL USERS OF EoR**

EoR is a procedure applied by Toronto Terminal air traffic controllers to aircraft conducting RNP-AR approaches (RNAV Y). EoR safely permits reduced vertical and lateral separation between aircraft, during ATC-monitored simultaneous independent parallel approaches.

**Operational Requirements**

- EoR will be used during simultaneous parallel runway operations, and ATIS shall indicate when simultaneous parallel runway operations are in effect.
- RNP-AR (RNAV Y) approaches are **ONLY** available to Runway 05 via the BOXUM/DUVOS/IMEBA/VIBLI STARs.
- RNP-AR (RNAV Y) approaches to Runway 23 are **ONLY** available via BOXUM/DUVOS/NUBER/NAKBO STARs.
- When an EoR operation is in use, RNAV Y will be the only advertised approach to RWY 05/23. RNP-AR capable aircraft that are assigned RWY 05/23 are expected to plan and fly the RNAV Y approach.
- Non RNP-AR aircraft assigned RWY 05/23 should anticipate radar vectors to an ILS approach.
- Aircraft that are RNP-AR capable but cannot fly the RNAV Y RNP-AR approach must inform ATC and can expect an ILS or visual approach.
- RNP-AR capable aircraft that are unable to be cleared using the RF transition will be advised by ATC to expect vectors to final. Aircraft should plan radar vectors to the RNAV Y straight-in transition.
- When cleared for an RNAV Y RNP-AR approach, the aircraft is considered "established" on the approach procedure once it is on the defined lateral and vertical path and past the IWP(IF) for the procedure.
- The approach shall be flown using autopilot until the aircraft passes the final approach waypoint (FAF).
- If unable to comply with an ATC clearance or conduct the cleared approach, for any reason, immediately advise the controller. **DO NOT** attempt to self-navigate or manually correct an RNP-AR approach procedure deviation. Immediately advise the controller using the phraseology example below then comply with subsequent ATC instructions:  
**Pilot:** "UNABLE [IWP Transition] transition, REQUEST (proposed course of action)"  
**Example:** **Pilot:** "NAVCAN123 UNABLE MODOL TRANSITION, REQUEST VECTORS TO FINAL"

**Break-out Instructions**

**When issued break-out instructions, reaction time may be critical. If expeditious compliance is required, an ATC break-out instruction may include the word IMMEDIATELY.**

- ATC shall issue any required break-out instruction by assigning a heading and/or altitude instruction:  
**Example:** **ATC:** "NAVCAN123, turn left immediately heading 330 degrees, climb to 3 000"
- Established on RNP AR break-out procedures may be conducted with the autopilot on

# EoR in operation in Toronto

Toronto/Pearson (CYYZ) International

Implemented = 28 November 2022

- Deployment to north runway 05/23
  - ▶ South runways = close-in parallel operation
- Estimate fleet equipage = 30-40%
- Leveraging non-residential land to the north, east and west of CYYZ
- Track mileage saving = 9-15 NM
  - ▶ 3-5 minutes flying time
- Estimated reduction of 178 000 metric tons of GHG in 1<sup>st</sup> 10 years



Green = RNP AR  
Red = Conventional vectored ILS

# EoR at CYYZ

## Runway Assignment

### **ATIS MESSAGES**

#### > **LAND AND OFFLOAD OPERATION**

- PRIMARY IFR APPROACH IS ILS OR VISUAL RUNWAY 24R (or 06L). SECONDARY IFR APPROACH IS RNAV Y RWY 23 (or 05)

#### > **DUAL OPERATION**

- IFR APPROACH IS ILS OR VISUAL RWY 24R (or 06L) AND ILS OR RNAV Y RWY 23 (or 05)

# EoR at Vancouver

Vancouver International (CYVR)

Further deployments under development

- Vancouver International (CYVR)



# Lessons Learned

Collaboration between all stakeholders is vital

- Airlines
- ATC
- Airport Authority
- Communities

Flight crews need more time to plan approach than we thought

- ATC plans based on a specific approach
- RNP AR APCH vs ILS or RNP APCH has a big impact on timing

# THANK YOU

Garnet Miller  
Manager, Airspace Modernization

[Garnet.Miller@navcanada.ca](mailto:Garnet.Miller@navcanada.ca)

