VICTORIA FLYING CLUB

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- Bookings, Questions

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# Instrument Flying

- Review Instruments and Human Limitations
- Definition and Motivation
- *Basic* **Instrument Flying**
- **Full Panel**, **Partial Panel**, **Unusual Attitudes**
- *Basic* **Radio** and **Satellite Navigation**
- Summary and Questions
- Pre-Flight Briefing

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# Review Human Limitations

- How do visual, vestibular and kinesthetic senses provides us with cues for orientation?
- Explain the mnemonic IMSAFE and how individual components affect our flying performance?
- How does hypoxia affect our flying performance and what can be contributing factors?

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# Definition and Motivation

- Flying by **reference** to **instruments** *only*
- Human **senses** are prone to **miss-interpretation**
- Instrument flying overcomes human limitations
- Essential skill for higher ratings and flight in IMC

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# Basic Analog Instruments








- **Control** Instruments – Pilot **Input** (Attitude & Power)
- **Performance** Instruments – Aircraft **Response**
- *Attitude plus Power equals Performance*
- **Navigation** Instruments – **Lateral** and **Vertical**

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# Glass Cockpit Instrumentation

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# Radial Scan


- Adjust **attitude** and **power** for *estimated* **performance**
- *Always* reference **attitude indicator** *while* <u>*changing*</u> attitude
- Scan **performance** instruments for *actual* response *with* <u>*established*</u> attitude
- Re-adjust and **trim** controls and continue to **scan** *systematically*

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# Attitudes and Movements


changing

changing

constant


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# Review Instruments

- Which are the standard instruments that are driven by gyroscopes and how do gyroscopic instruments they operate?
- What errors can be expected with gyroscopic instruments and how do they occur?
- Which are the standard instruments that rely on air pressure and how do they operate?
- What errors can be expected with pressure instruments and how do they occur?

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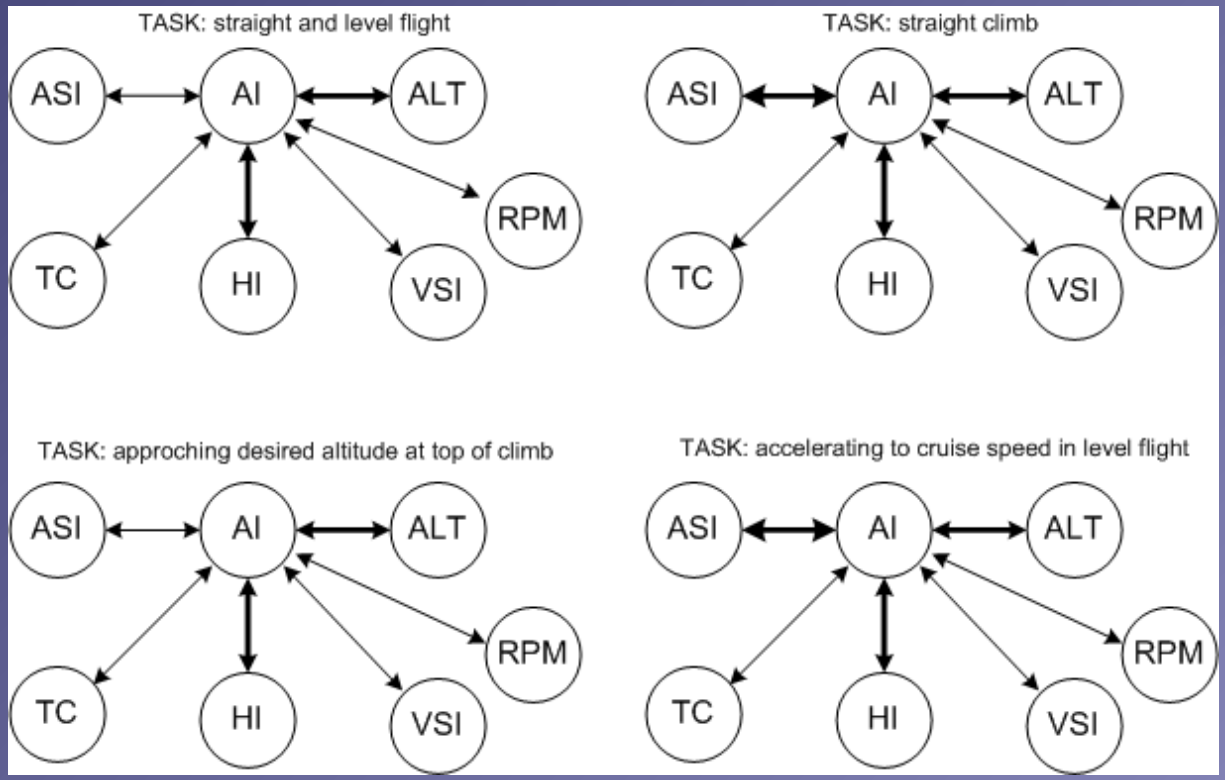
# Selective Radial Scan – Definition




- Each maneuver requires a *particular* **performance**
- **Attitude indicator** remains the primary instrument *while changing* attitude
- **Scanning** pattern should **prioritize** *accordingly with established* attitude
- *Selective* scan should *not* lead to **fixation**

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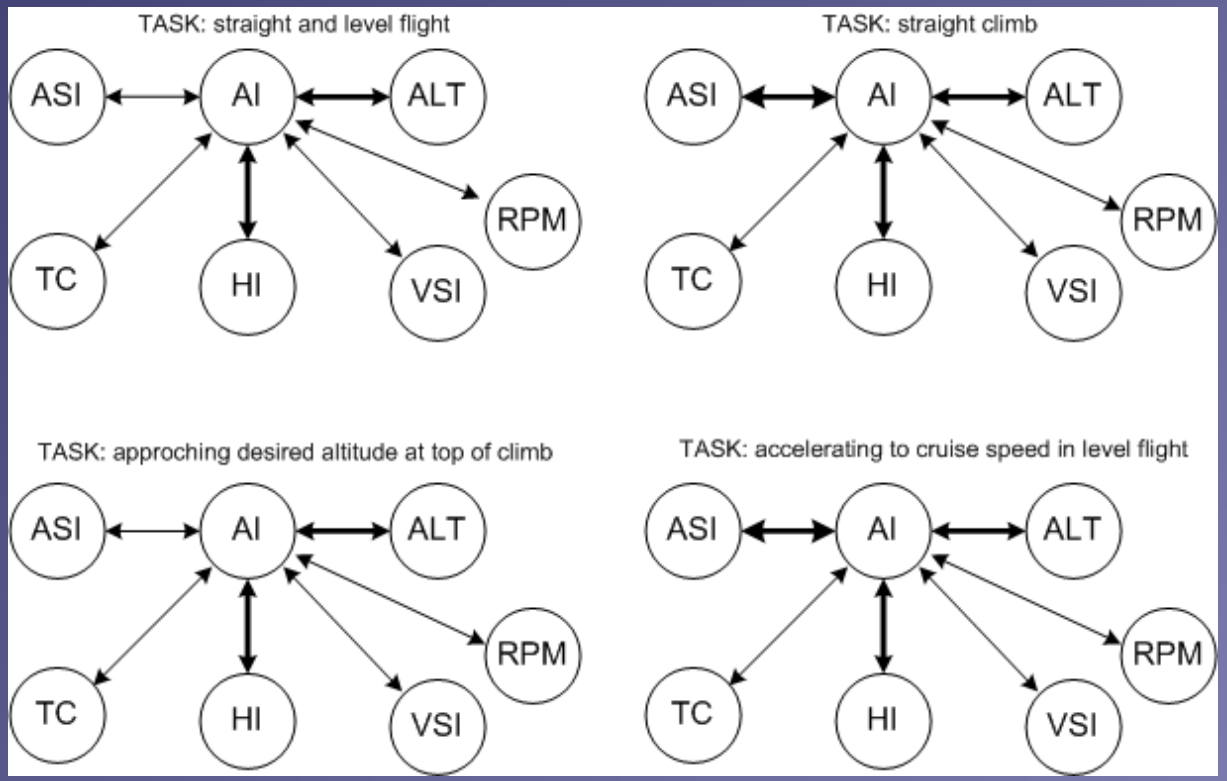
# Selective Radial Scan – Method




- What **information** do I require?
- Which **instruments** provide me with the required **information**?
- Is the information *reliable*?

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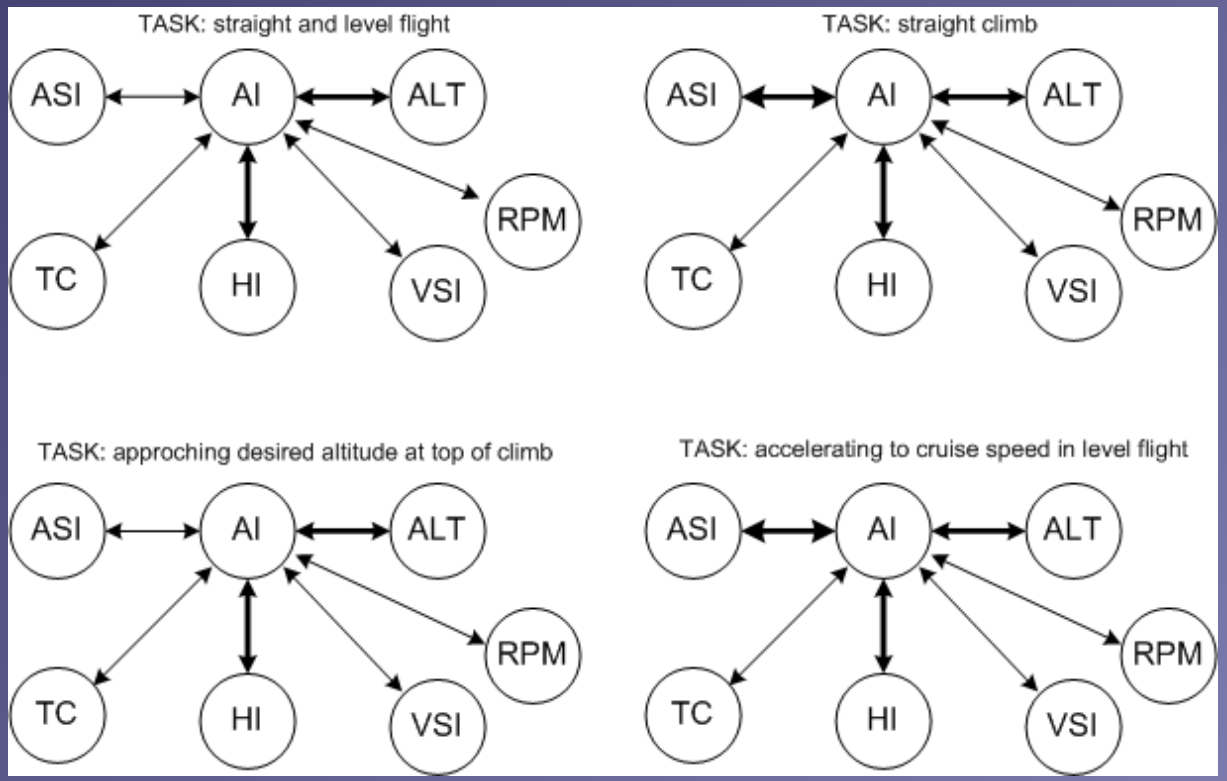
# Selective Radial Scan – Method




- Which instruments need to remain *constant*?
- Scan *constant* instruments *more frequently* to maintain **performance**
- Which instruments need to *change* and at what **rate**?
- Which instrument **lag** can be expected?

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# Straight and Level Flight


- *Attitude plus Power equals Performance*
- Remember the **power curve** for adjustments
- Scan **altitude** and **heading indicators** *more frequently*

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# Climbing and Descending


*Straight Climb / Descent*


- Climb – **attitude**, **power**, **trim** (**APT**), Descend – **power**, **attitude**, **trim** (**PAT**)
- **Attitude indicator** remains the primary instrument *while <u>changing</u>* pitch attitude
- Scan **airspeed** and **heading indicators** *more frequently with <u>established</u>* attitude

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# Leveling Off



- Scan **altitude** and **heading indicators** *more frequently* when *approaching* desired altitude
- Increase **airspeed indicator** scan *during transition* to straight and level flight - anticipate level-off ***10% VSI***

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# Turns



- **Attitude indicator** remains the primary instrument *while changing* bank attitude
- Scan **turn coordinator** and **altitude indicator** *more frequently with established* attitude
- Perform *standard* – **rate one** – turns at ***3 °/s***
- Establish and adjust bank angle at ***IAS / 10 + 7***
- Anticipate and lead the desired heading using ***half bank angle***

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# Safety Considerations

- Check **airspace clear** with instructor *before* maneuvers
- Particularly ensure clear during instrument turns
- Student: *“All clear left (right)?”*
- Instructor: *“All clear left (right)!”*

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# Full Panel – Summary / Quiz

- What instrument *directly* indicates an immediate attitude change?
- How do the altimeter and airspeed indicators *indirectly* indicate nose-up / down attitude changes? Why do these instrument not serve as primary indicators for attitude changes?
- How does apparent precession affect the heading indicator and how does it have to be corrected?

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# Partial Panel

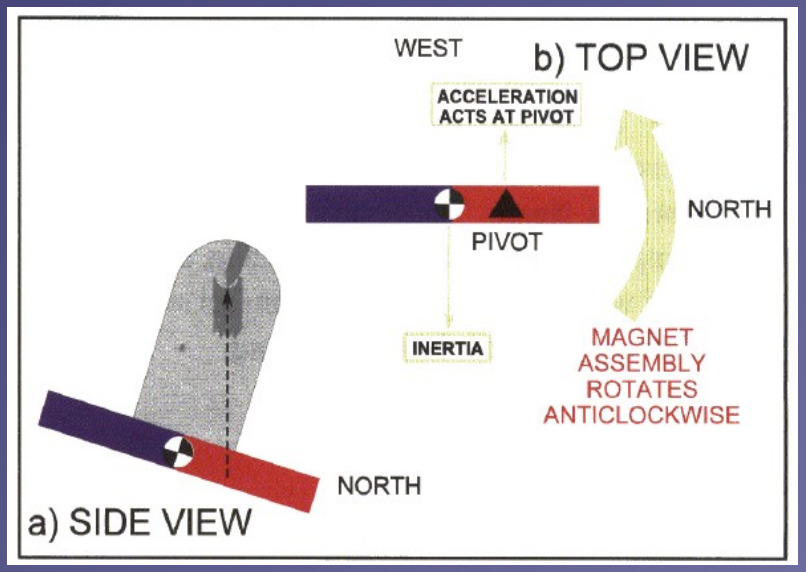


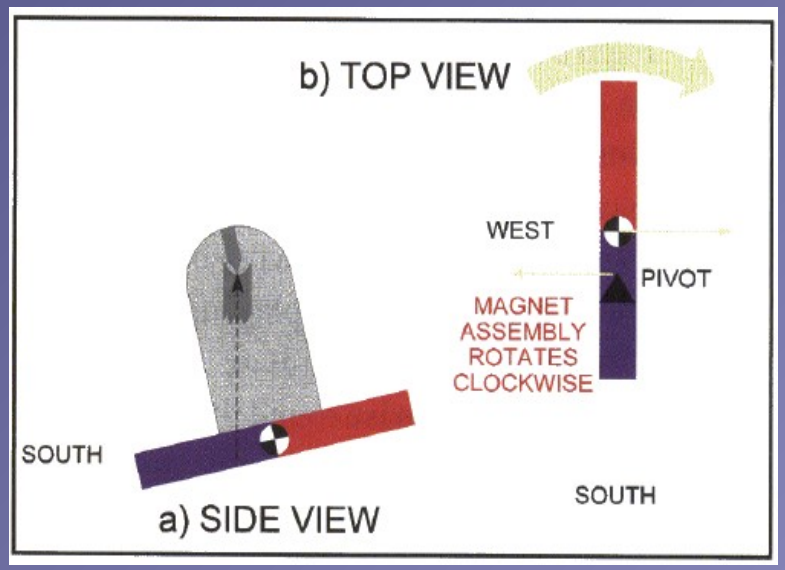




- **Attitude** and **heading** indicators *not available*
- Situation: vacuum system failure – annunciator panel and vacuum gauge
- *Indirect* attitude indication from and more attention to **TC** / **TBI** and **MC**
- Necessary **timing** during turns due to **magnetic dip** errors

# Magnetic Dip




- Magnetic dip is the reason for dip errors
- Acceleration, deceleration and turning
- Magnetic dip offsets the **pivot point** from the magnet's **center of gravity**
- More pronounced towards the magnetic poles
- Opposite effects on northern and southern hemispheres

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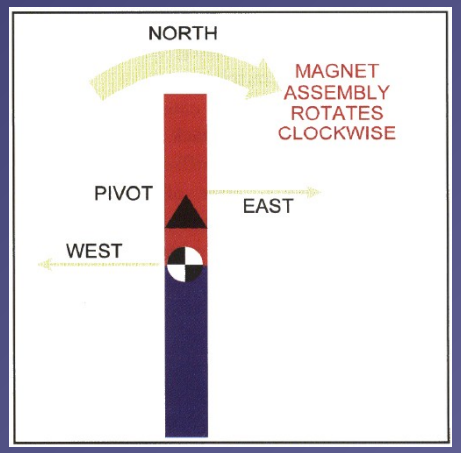
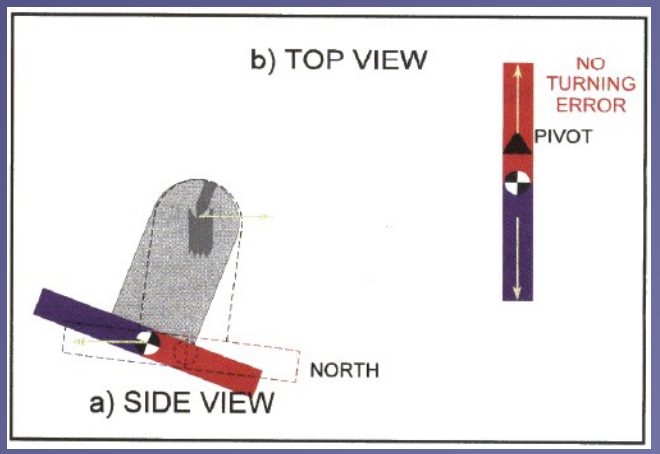
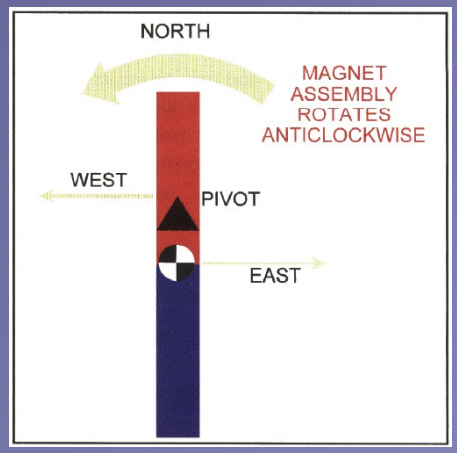
# Acceleration/Deceleration Errors




- ***A**ccelerate **N**orth **D**ecelerate **S**outh* (**ANDS**)
- *Opposite* behavior on the southern hemisphere
- *More* pronounced on easterly / westerly headings
- *Less* pronounced on northerly / southerly headings

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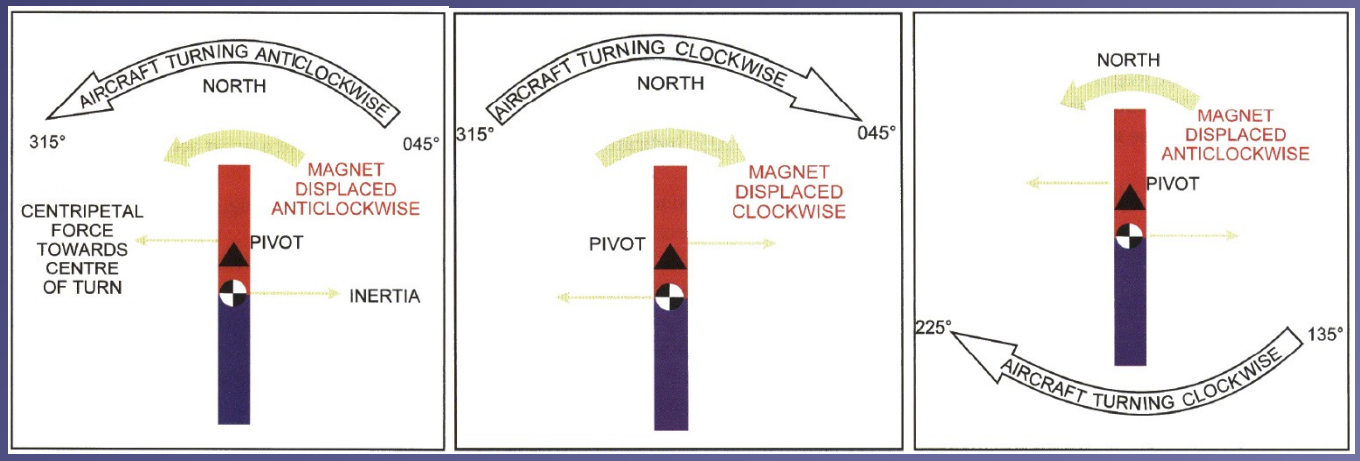
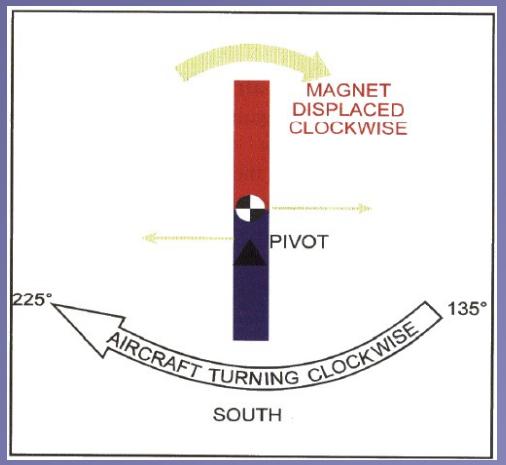
# Turning Errors




- ***U**ndershoot **N**orth **O**vershoot **S**outh* (**UNOS**)
- *Opposite* behavior on the southern hemisphere
- *More* pronounced on northerly and southerly turns
- *Less* pronounced on easterly and westerly turns

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# Partial Panel – Straight and Level


- Maintain *coordinated* and *straight* with **turn coordinator** and crosscheck **magnetic compass** *occasionally*
- Scan **altitude** and **vertical speed indicators** *more frequently* to maintain level flight

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# Partial Panel – Climbs and Descents


- Maintain *coordinated* and *straight* with **turn coordinator**
- Scan **airspeed indicator** *more frequently* to maintain a *stable* and *steady* climb or descent

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# Partial Panel – Leveling Off



- Maintain *coordinated* and *straight* with **turn coordinator**
- Scan **altitude indicator** *more frequently* (desired altitude)
- Increase **airspeed indicator** scan during transition

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# Partial Panel – Turns


- Scan **altitude** and **airspeed indicators** *more frequently*
- *Timed* **rate one** turns – ***3 °/s***, divide desired heading change
- ***360° → 120s***, ***180° → 60s***, ***90° → 30s***, ***45° → 15s***
- VOR indicator: set heading, determine direction and time: ***30° → 10s***, ***10° → 3s***

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# Partial Panel – Summary Quiz

- What instruments are not available in a partial panel and what type of error might be the cause?
- During a turn from south to east you notice what type of magnetic compass error and why?
- Mentally perform a straight climb with partial panel and describe all observations and required actions.
- Mentally perform a 90° coordinated rate one turn with partial panel and describe all observations and required actions.

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# Unusual Attitudes Recovery


- **Nose-Up Attitude**
  - *full* **power**
  - **pitch** *forward*
  - **roll** *wings level*


- **Nose-Down Attitude**
  - **power** *idle*
  - **roll** *wings level*
  - **pitch** *back*

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# Unusual Attitudes – Summary Quiz

- Which instruments should be disregarded during the recovery from unusual attitudes and why?
- Mentally determine and perform a recovery from an unusual nose-up attitude and state all observations and required actions.
- Mentally determine and perform a recovery from an unusual nose-down attitude and state all observations and required actions.

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# Review NDB Radio Navigation

- How do Non-directional Radio Beacons (NDBs) support en-route navigation?
- How do we determine whether or not a NDB station is serviceable?
- How do we determine whether or not the ADF receiver (needle) is serviceable?
- What errors can be expected when using NDBs?

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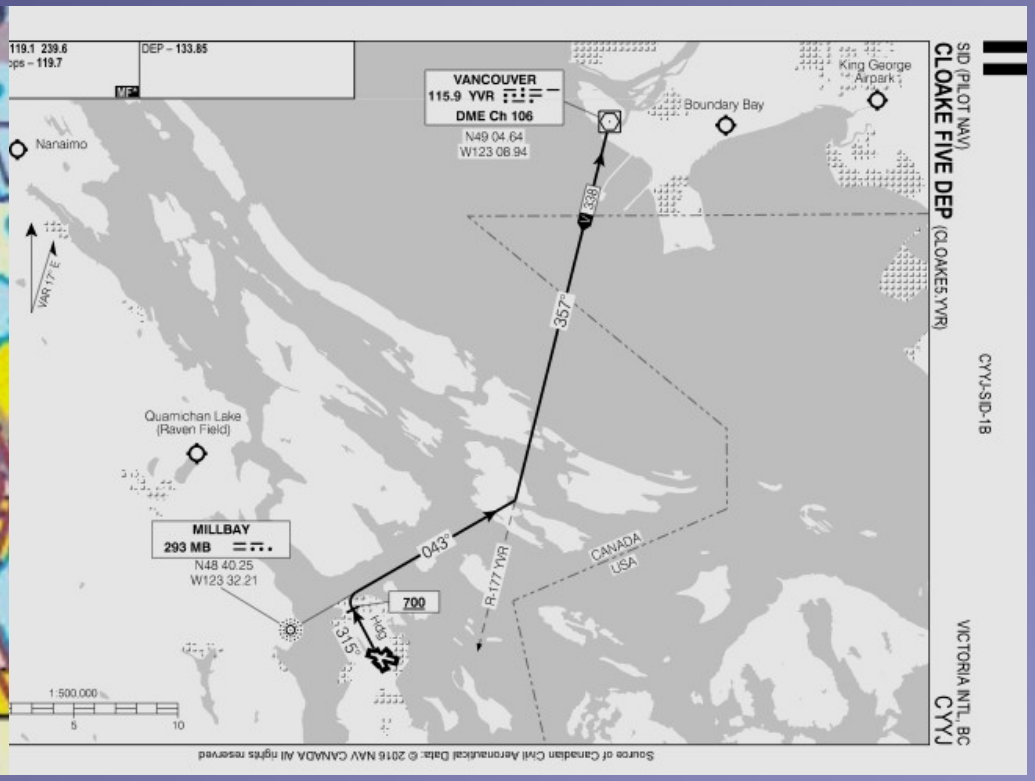
# Motivation


- Navigational support / backup and procedures
- *Homing*, *Tracking*, *Intercepts*
- **IFR** navigation: **SID**s, airways, air-routes, tracks, **STAR**s

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# Using the NDB Overview



- ***190*** to ***1750 kHz*** – LF/MF *non* line-of-sight propagation
- Sensitive to aircraft position and heading
- Indicates **relative bearing** on the *fixed card* **ADF**
- **Tune** in **frequency** and **identify** station **morse code**
- **Check** **relative bearing** to (**BTS**) or from (**BFS**) the station

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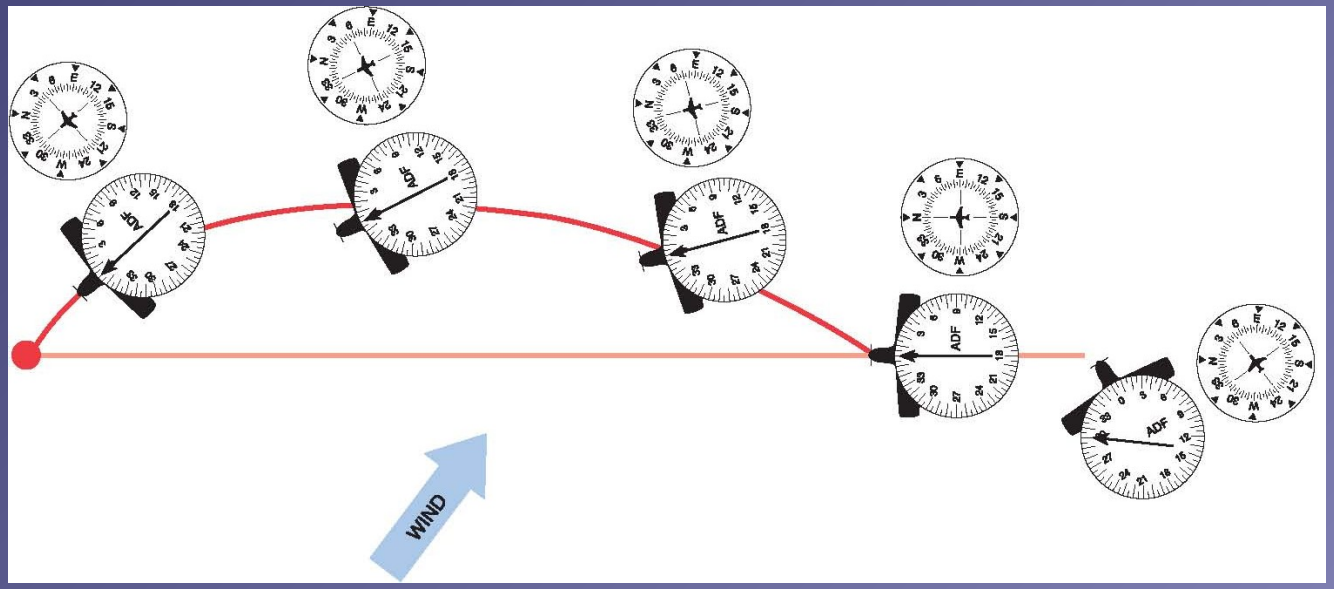
# NDB Homing




- **Tune** station **frequency**
- **Identify** station **morse code**
- **Turn** to (*RB = 0*) station (*MB = RB + MH*) – project onto HI
- **Correct** heading *as necessary* to maintain **relative bearing**
- *Chase the arrow*

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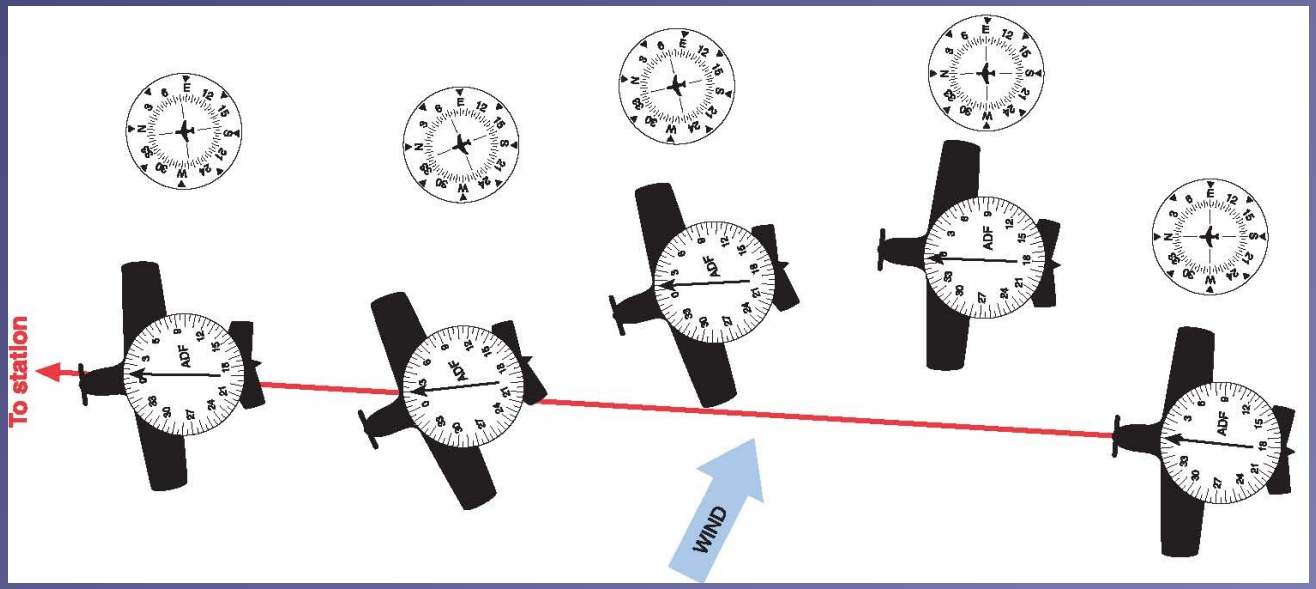
# NDB Tracking




- **Tune** station **frequency**
- **Identify** station **morse code**
- **Turn** to (*RB = 0*) / from (*RB = 180*) station (*MB = RB + MH*)
- **Correct** heading *as necessary* to *maintain* **magnetic bearing**
- *Push the arrow* (inbound), *pull the tail* (outbound)

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# NDB Intercepts

- **Tune** station **frequency**
- **Identify** station **morse code**
- **Confirm** desired **magnetic bearing** and feasibility
- **Determine** **intercept angle** and **heading**
- **Turn** to *desired* **intercept heading** (**BTS**, **BFS**)
- *Push the arrow* (inbound), *pull the tail* (outbound) to *desired* **magnetic bearing** using selected **intercept angle**
- **Turn** onto *desired* **magnetic bearing** and continue **tracking**

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# NDB Intercept Example Inbound



- *Intercept **BTS 090***
- Set present heading of ***360*** (movable card **ADF**)
- Visualize ***BTS 090*** and confirm *feasibility inbound* (head)
- Select *feasible* **intercept angle** (***060***) and **heading** (***150***)
- Turn to selected **intercept heading** to *push the head*

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# NDB Intercept Example Outbound



- *Intercept **BFS 270***
- Set present heading of ***360*** (movable card **ADF**)
- Visualize ***BFS 270*** and confirm *feasibility outbound* (tail)
- Select *suitable* **intercept angle** (***060***) and **heading** (***210***)
- Turn to selected **intercept heading** to *pull the tail*

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# NDB Intercept 180 BTS Inbound

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# NDB Intercept 360 BFS Outbound

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# Review VOR Radio Navigation

- How do VHF Omnidirectional Radio Ranges (VORs) support en-route navigation?
- How do we determine whether or not a VOR station is serviceable?
- What errors can be expected when using VORs?

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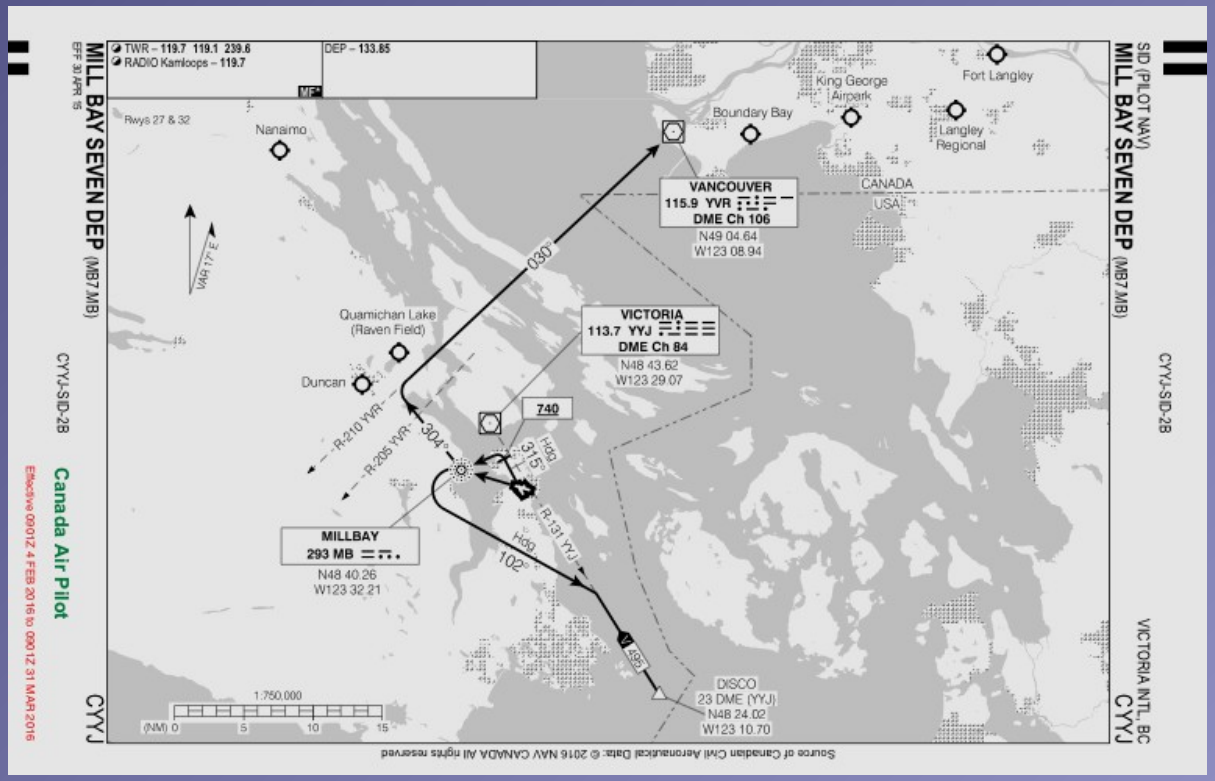
# Motivation


- Navigational support / backup and procedures
- *Tracking*, *Intercepts*
- **IFR** navigation: **SID**s, airways, air-routes, tracks, **STAR**s

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# Using the VOR Overview




- ***108.1*** to ***117.95 MHz*** – VHF line of sight propagation
- Sensitive to aircraft position but *not* aircraft heading
- Indicates *angular* deviation and sector – **CDI**, **TO/FROM/OFF**
- **Tune** in **frequency** and **Identify** station **morse code**
- **Select** desired (magnetic) **radial** (track) using the **OBS**

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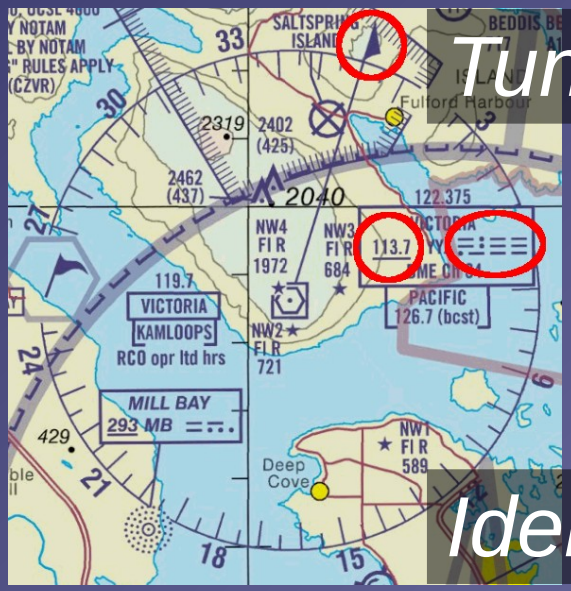
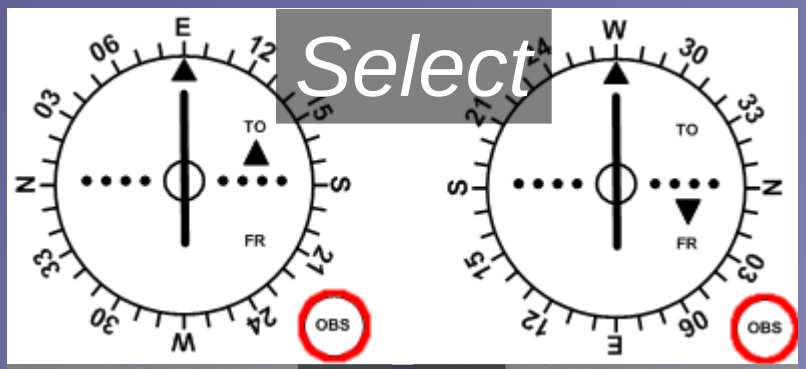
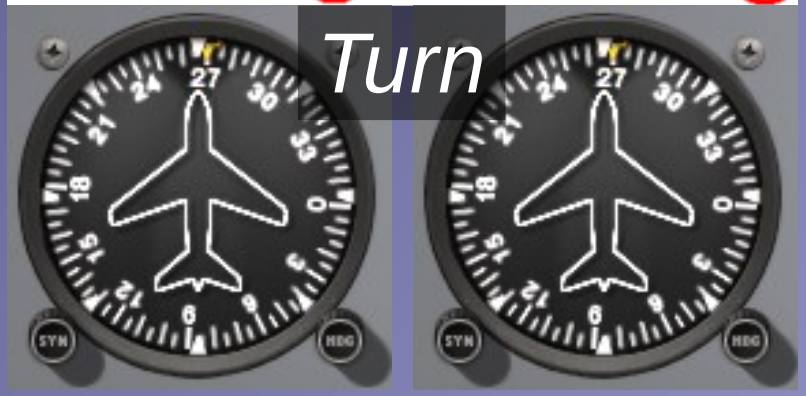
# VOR Tracking






- **Tune** station **frequency**
- **Identify** station **morse code**
- **Select** **OBS radial** for *centered* **CDI** with **TO** / **FROM** indication
- **Turn** to / from station using found **OBS radial** *inbound* / *outbound*
- **Correct** for wind and establish wind correction angle for **tracking**

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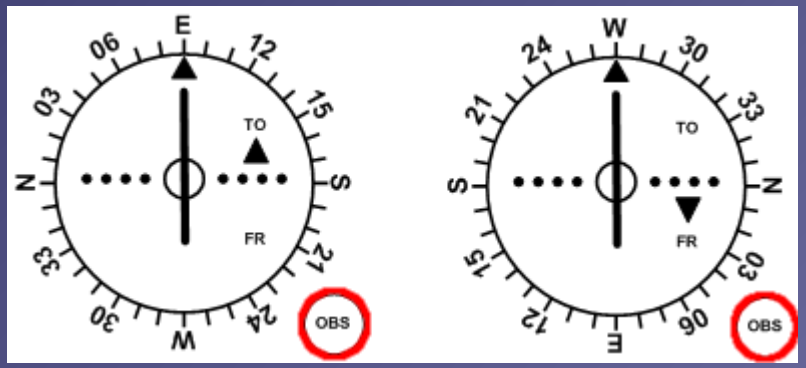
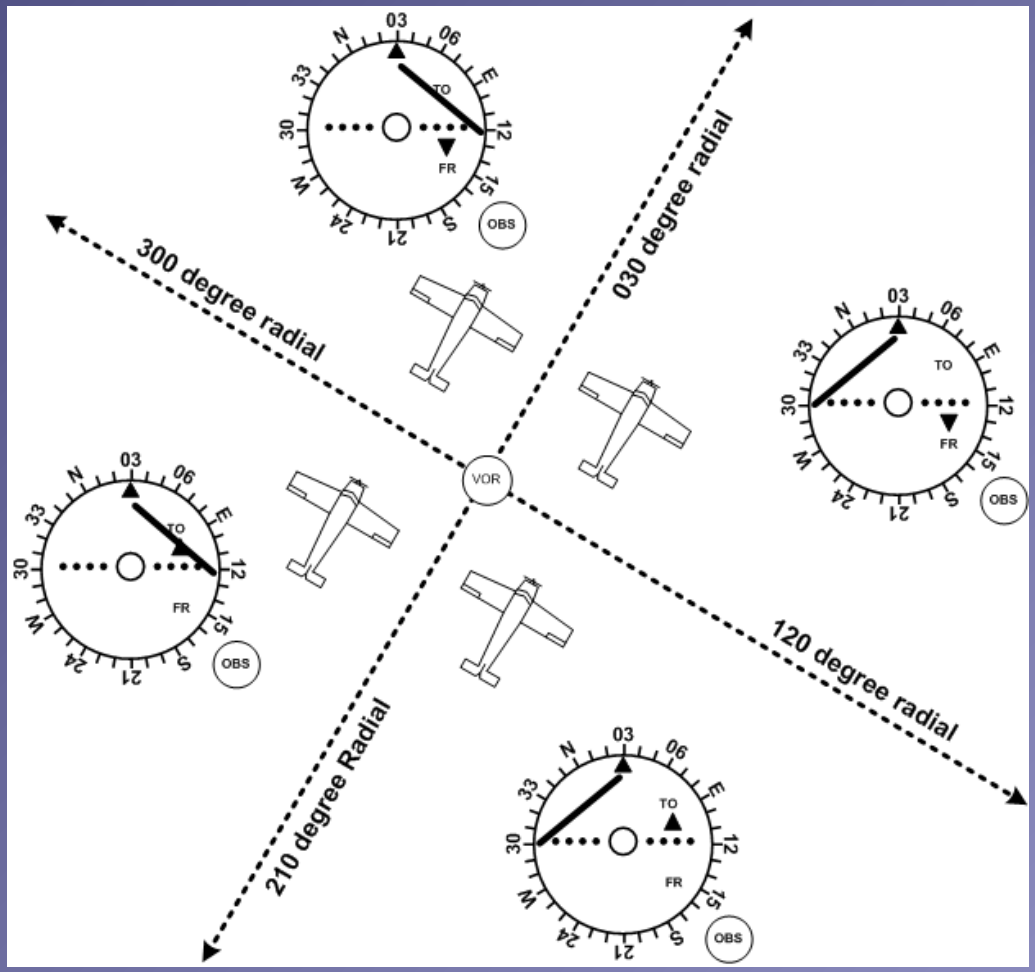
# VOR Intercepts




- **Tune** station **frequency**
- **Identify** station **morse code**
- **Select** **OBS intercept radial** and confirm *inbound* or *outbound*
- **Check** **CDI** *left* or *right* and *subtract* or *add* **intercept angle**
- **Turn** to **intercept heading**
- **Check** **CDI** *alive* and anticipate **turn** onto **intercept radial**

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# VOR Intercept Example Outbound



- *Intercept **Radial 180** outbound*
- Set ***radial 180*** *outbound* on the *top* of the **VOR** using the **OBS**
- Confirm **FROM** flag to verify ***feasible outbound*** intercept
- Select *suitable* **intercept angle** (***045***) and **heading** (***225***)
- Turn to selected **intercept heading** and wait for **CDI** *alive*

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# VOR Intercept Example Inbound



- *Intercept **Radial 360** inbound*
- Set ***radial 360*** *inbound* on the *bottom* of the **VOR** using the **OBS**
- Confirm **TO** flag to verify ***feasible inbound*** intercept
- Select *suitable* **intercept angle** (***045***) and **heading** (***225***)
- Turn to selected **intercept heading** and wait for **CDI** *alive*

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# VOR Intercept Radial 360 Inbound

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# VOR Intercept Radial 180 Outbound

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# Satellite Navigation



- Modern **GNSS** receivers provide *many* functions – always consult the applicable user manual
- **Direct-To**, **Flight Planning**, **Reversal**, **Tracks**
- Always ensure recent **database** and correct **navigation source** for your navigation instruments

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# G530 Direct To Function (1)

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# G530 Direct To Function (2)

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# G530 Direct To Function (3)

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# G530 Direct To Function (4)

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# G530 Direct To Function (5)

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# G530 Direct To Function (6)

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# G530 Flight Planning (1)

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# G530 Flight Planning (2)

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# G530 Flight Planning (3)

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# G530 Flight Planning (4)

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# G530 Flight Planning (5)

# G530 Flight Planning (6)

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# G530 Flight Planning (7)

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# G530 Flight Planning (8)

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# Learn and Practice

- Get NAV/GNSS **simulators** and learn playing with the features – *www.garmin.com*
- Knowing the features makes you a more proficient pilot and causes *less* **distraction** in the cockpit
- Let NAV/GNSS *support* you *not distract* you
- Visual navigation remains your primary means of navigation – *always* maintain VFR

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# Satellite Navigation – Summary / Quiz

- What are the most common functions of a GNSS user interface?
- Why has the database of a GNSS receiver to be up-to-date?
- The GNSS user interface can be complex and distracting. What are the consequences for using it as a navigational aid?
- How do we check and predict the GPS integrity?
- Why is it important to always check the correct navigation source?

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# Pre-Flight Briefing

- Exercise
- Training Area
- Departure and Arrival Procedures
- Weather Briefing / NOTAMs
- Aircraft and Documents
- Time and Fuel Requirements
- Safety Considerations and Responsibilities

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# Additional Materials

- Additional materials for Instrument Flying
- Flight Instructor Guide – Exercise 24