

# Hold

Boston Virtual ARTCC Ground School

March 4, 2019



## **SIMULATION USE ONLY**

These materials are provided for discussion and use in online flight simulation on VATSIM. They are not suitable for real-world flight.

# Objectives

The Holding Procedures ground school is designed to help pilots understand the construction of holding patterns and the proper technique for flying holds.

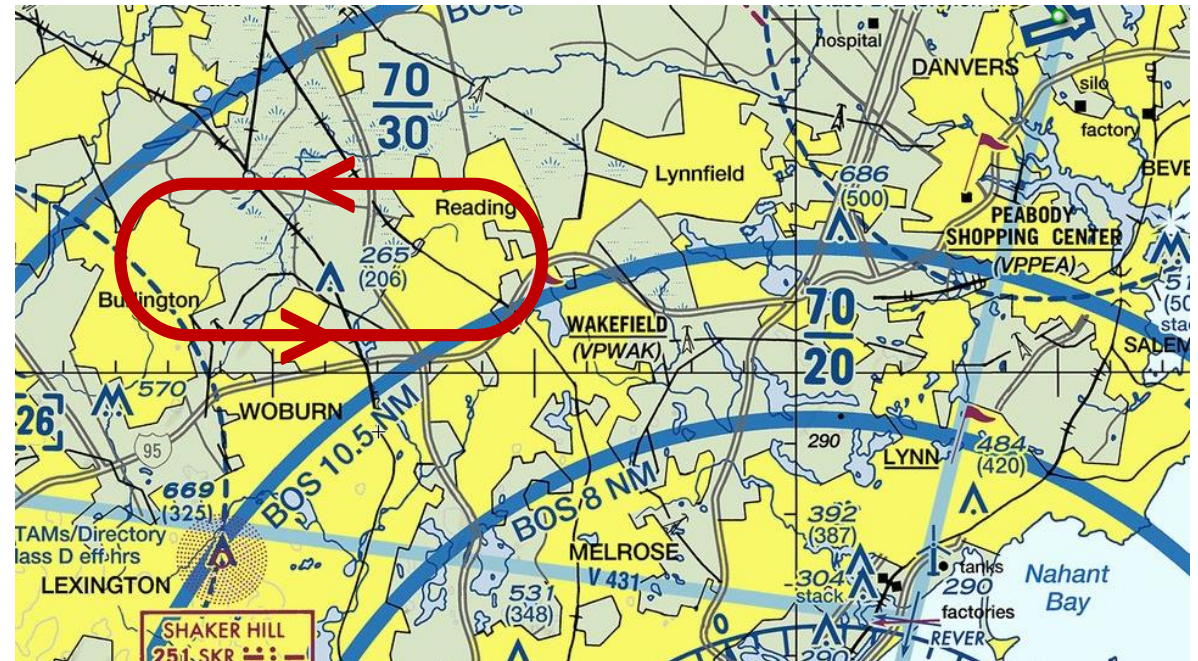
Tonight's session will cover:

- VFR/Visual Holds
- Holding Pattern Construction
- Outbound Wind Correction
- Holding Pattern Entries



## VFR Holds

- When VFR, holding can be as simple as circling over a visual reference
- Could happen because of
  - Traffic Conditions
  - Inability to enter Airspace
  - Weather
- Flown by either picking a point, or being assigned a point by ATC, and making a “racetrack” pattern over it, making sure the point is always in sight



## IFR Holds

IFR holds are assigned by ATC like any other IFR instruction. Could be assigned or requested for a variety of reasons:

- Traffic Density
- Uncontrolled Airports
- Weather
- Equipment Troubleshooting
- Course Reversal (Discussed in future “Instrument Approach Procedures” Ground School)



## What is a holding pattern?

- An instrument hold is a maneuver used to keep an aircraft within a limited amount of airspace until another clearance can be issued
- All holding patterns are defined by:
  - A fix
  - An inbound leg
  - An outbound leg



# Holding Pattern Construction

- The Fix
  - VOR
  - NDB
  - Intersection
  - DME Fix
  - RNAV Waypoint



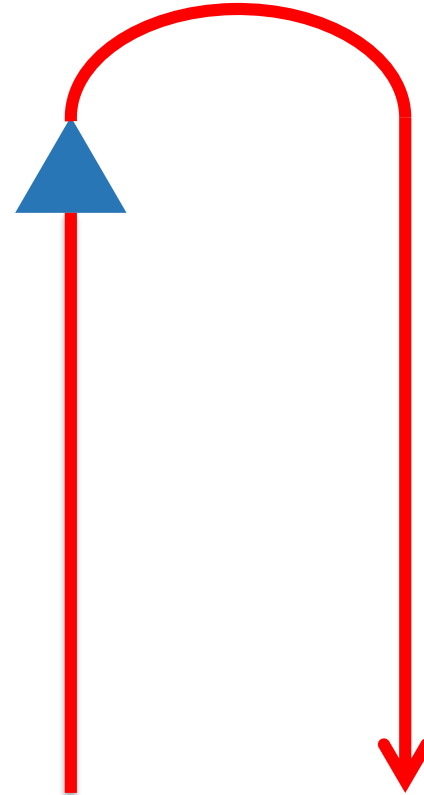
# Holding Pattern Construction

- The Fix
- The Inbound Leg
  - Always fly TO the fix on the inbound leg
  - The inbound leg always has navigational guidance



# Holding Pattern Construction

- The Fix
- The Inbound Leg
  - Always fly TO the fix on the inbound leg
  - The inbound leg always has navigational guidance
- The Outbound Leg
  - On the outbound leg, the aircraft is flying away from the fix
  - The outbound leg is flown by dead reckoning; there is no navigational guidance





# Holding Pattern Specifications

- Turn Direction
  - Standard holding patterns are flown with right turns. If no direction is given in the holding clearance, you are expected to fly the hold with standard turns
  - ATC may assign “non-standard” or “left” turns
- Inbound Time
  - 14000’ or below: 1 minute
  - 14001’ or above: 1.5 minutes
- Speed Limits
  - 6000’ or below: 200 KIAS
  - 6001’-14000’: 230 KIAS
  - 14001’ or above: 265 KIAS



## Holding Clearances

- Fix
- Cardinal Direction
- Radial/course
- Turn Direction (if non-standard)
- Inbound Leg Length (if non-standard)
- Expect Further Clearance (EFC) Time

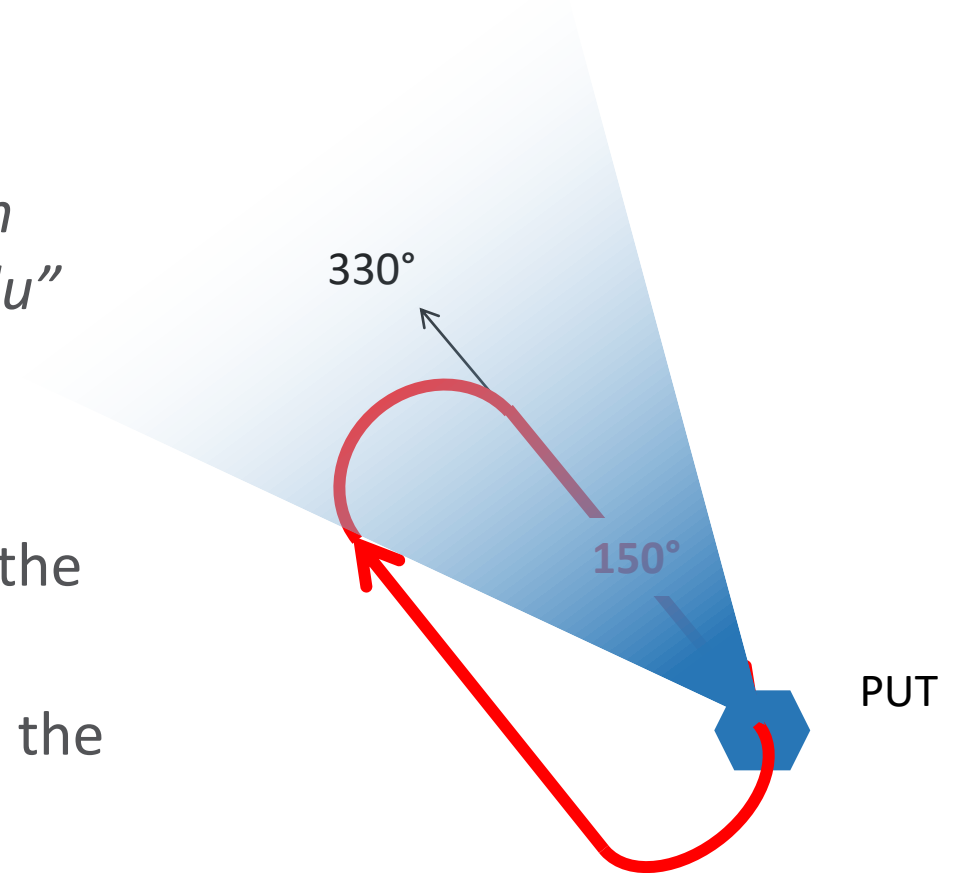
*“Cessna 5GR, cleared to Putnam, hold northwest on the 330 radial, expect further clearance at 1452 Zulu”*



## Building a Holding Pattern

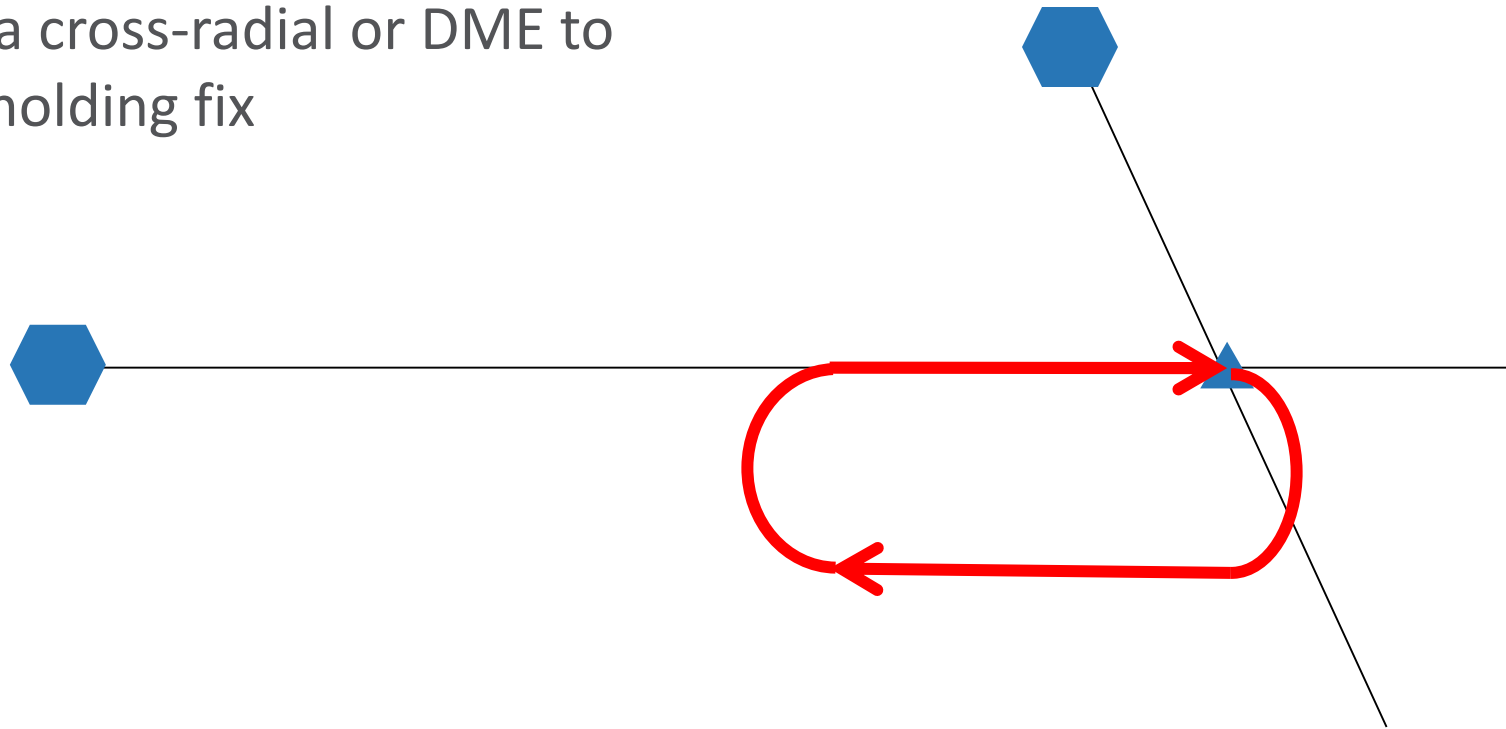
*“Cessna 5GR, cleared to Putnam, hold northwest on the 330 radial, expect further clearance at 1452 Zulu”*

- The holding fix is the PUT VOR
- The cardinal direction (northwest) defines where the hold is located in relation to the fix
- The specified radial defines the course to track on the inbound leg (i.e., 150)
- The absence of turn directions indicates that turns should be standard (right)



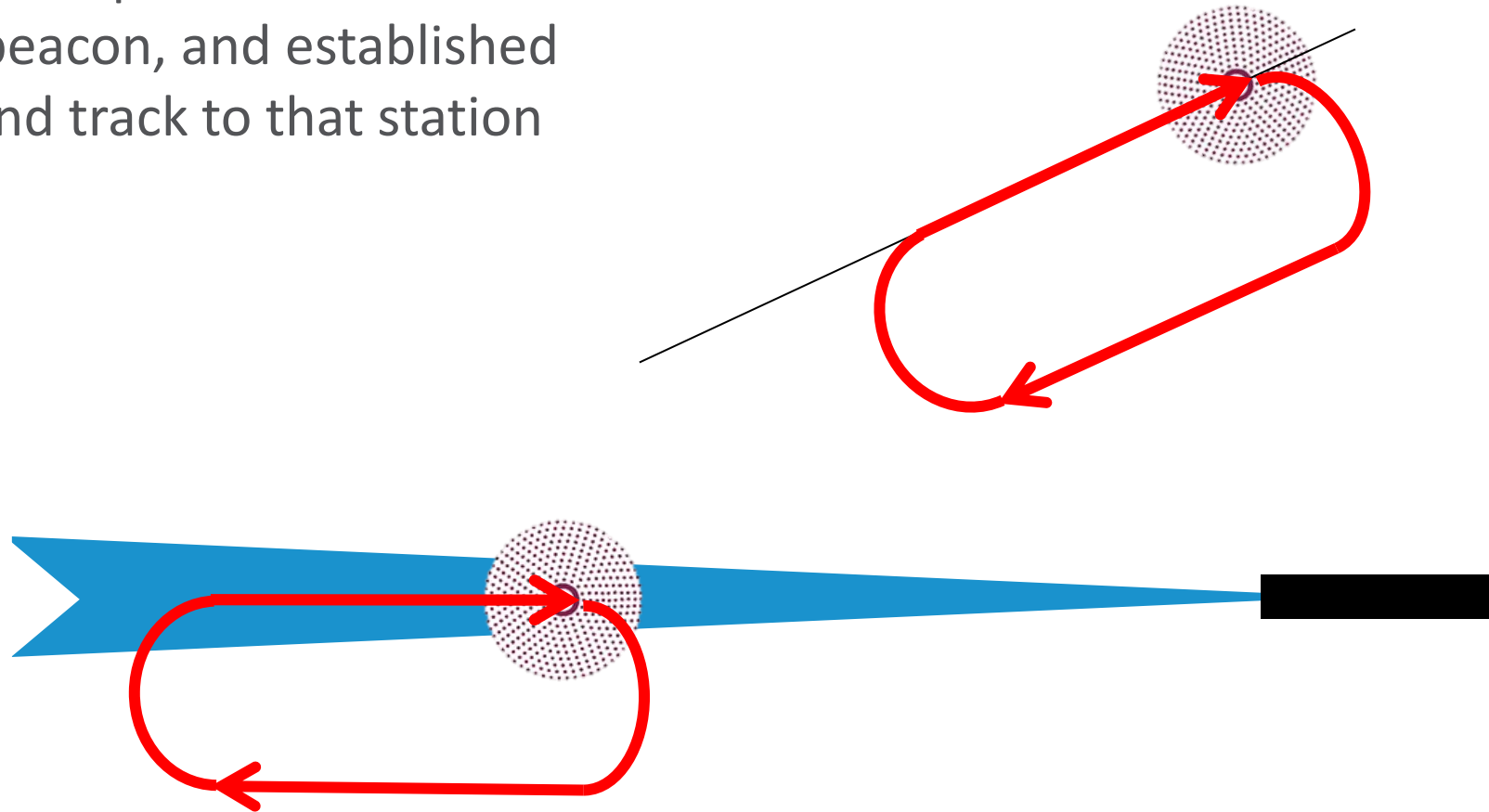
## Intersection or DME Hold

- Holding is accomplished along a VOR radial, using either a cross-radial or DME to identify the holding fix



## NDB Holds

- Holding is accomplished at a non-directional beacon, and established on an inbound track to that station



## Flying a Hold

- Perform the appropriate entry. All entries end with the aircraft crossing the fix on the inbound leg
- Turn outbound in the appropriate direction
- Begin timing the outbound leg abeam the fix
  - VOR Hold
    - You are abeam when the TO/FROM flag reverses indication
  - NDB Hold
    - You are abeam when the ADF needle points to a 90 or 270 relative bearing
  - DME Hold
    - You are abeam when the DME indicates the same DME as the holding fix
- Reaching the predetermined outbound time, turn towards the inbound course. Start the inbound timer upon completion of the turn
- Track the inbound course to the fix and note time crossing the fix. Turn outbound and repeat
- Always make standard rate turns



# A Standard Rate Turn



Holds



## Wind Correction

- Wind can have two effects on your holding pattern
  - A headwind or tailwind will cause your inbound leg timing to be incorrect
  - A crosswind will cause you to undershoot or overshoot the inbound course on your inbound turn
- When flying a holding pattern, there are two primary corrections you need to make to correct for wind
  - Adjust outbound heading to roll out of the inbound turn on the inbound course
  - Adjust outbound time to create a 1 minute inbound leg





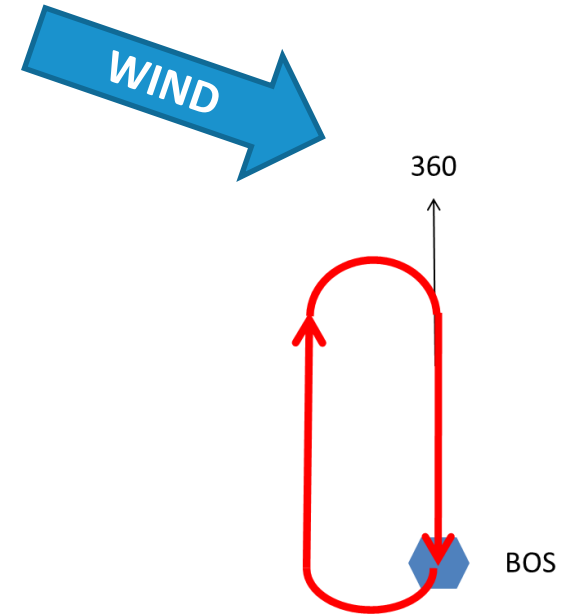
## Wind Correction

- Adjust heading by doubling the crab angle/correction maintained on the inbound leg
  - Example: a crab of  $7^\circ$  right on the inbound would imply a  $14^\circ$  left crab on the outbound leg
- Adjust timing by lengthening or shortening the outbound leg by  $2/3$ 's to achieve a timing of 1 minute on the inbound leg by taking  $2/3$  of the difference in timing\*
  - Example: if the inbound leg takes 40 seconds, 20 additional seconds are needed
  - $2/3$  of 20 is 13 seconds, so the outbound should be flown for 73 seconds
- NOTE: Corrections are less effective when there is a tailwind on the inbound leg. In those cases, apply additional correction as determined through trial and error
  - 1 second of correction per knot of head/tailwind component is a good baseline



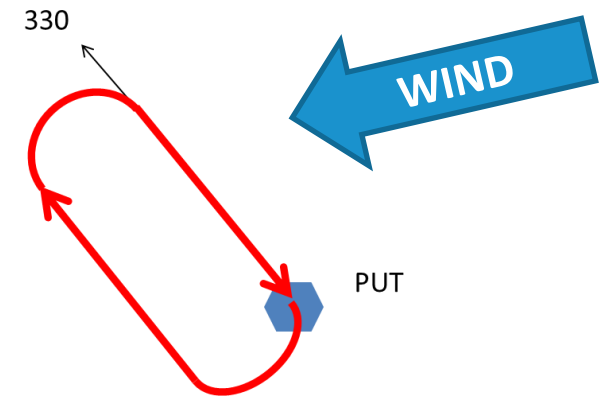
## Example

- Holding clearance:
  - Cleared to Boston, hold north on the 360 radial, expect further clearance 1600 Zulu
- What is the uncorrected outbound heading?
  - 360
- What is the uncorrected inbound heading?
  - 180
- What outbound heading should the aircraft fly if heading 185 is required to maintain the inbound track?
  - 350
- What timing should be maintained on the outbound leg if the inbound leg takes 51 seconds instead of the desired 60 seconds?
  - 66 seconds



## Example

- Holding clearance:
  - Cleared to Putnam, hold northwest on the 330 radial, expect further clearance 1452 Zulu
- What is the uncorrected outbound heading?
  - 330
- What is the uncorrected inbound heading?
  - 150
- What outbound heading should the aircraft fly if heading 140 is required to maintain the inbound track?
  - 350
- What timing should be maintained on the outbound leg if the inbound leg takes 90 seconds instead of the desired 60 seconds?
  - 40 seconds
- What direction is the wind blowing from?
  - Northeast



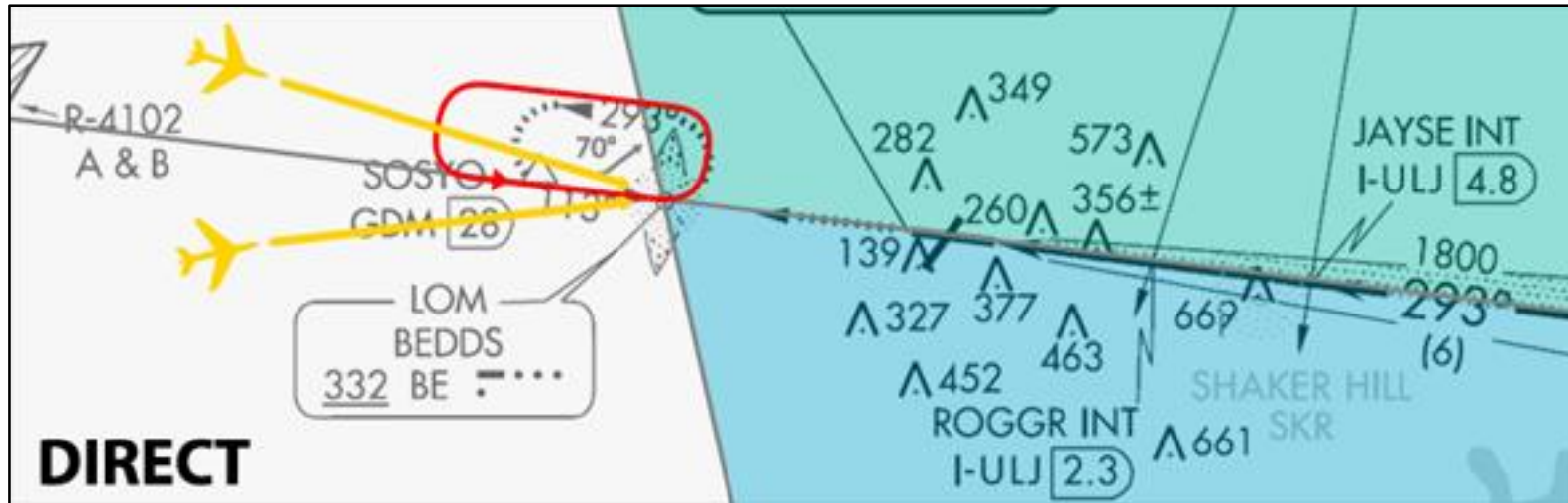
## Hold Entry

- Now that we've covered flying the hold, let's discuss the hold entry
  - Hold entries are relevant not just to holding procedures but also instrument approach procedures
- There are three hold entries:
  - Direct
  - Parallel
  - Teardrop (or offset)
- Unless otherwise instructed, report:
  - The time and altitude the first time you cross the holding fix as part of the entry
  - When leaving any assigned holding fix or point
- No other reports are required unless ATC specifically asks you to



# Direct Entry

- For a direct entry, cross the fix and begin the normal outbound turn



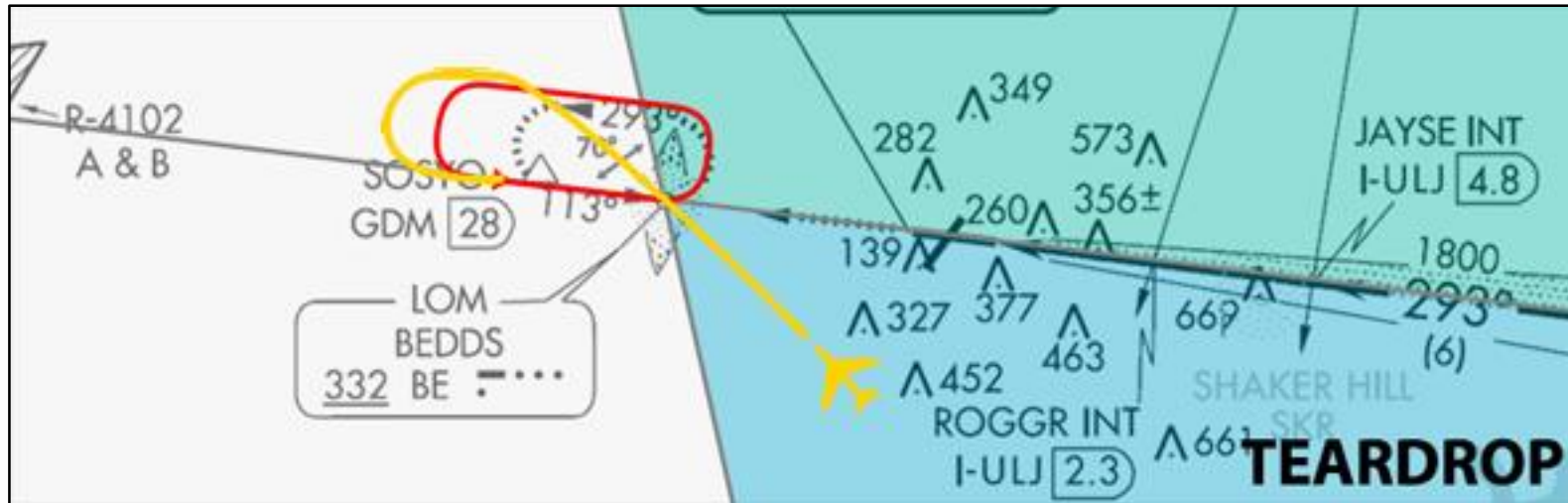
# Parallel Entry

- For a parallel entry, cross the fix and turn outbound to parallel to the inbound course
- After 1 minute, turn 225-240 degrees towards the hold and intercept the inbound course



# Teardrop Entry

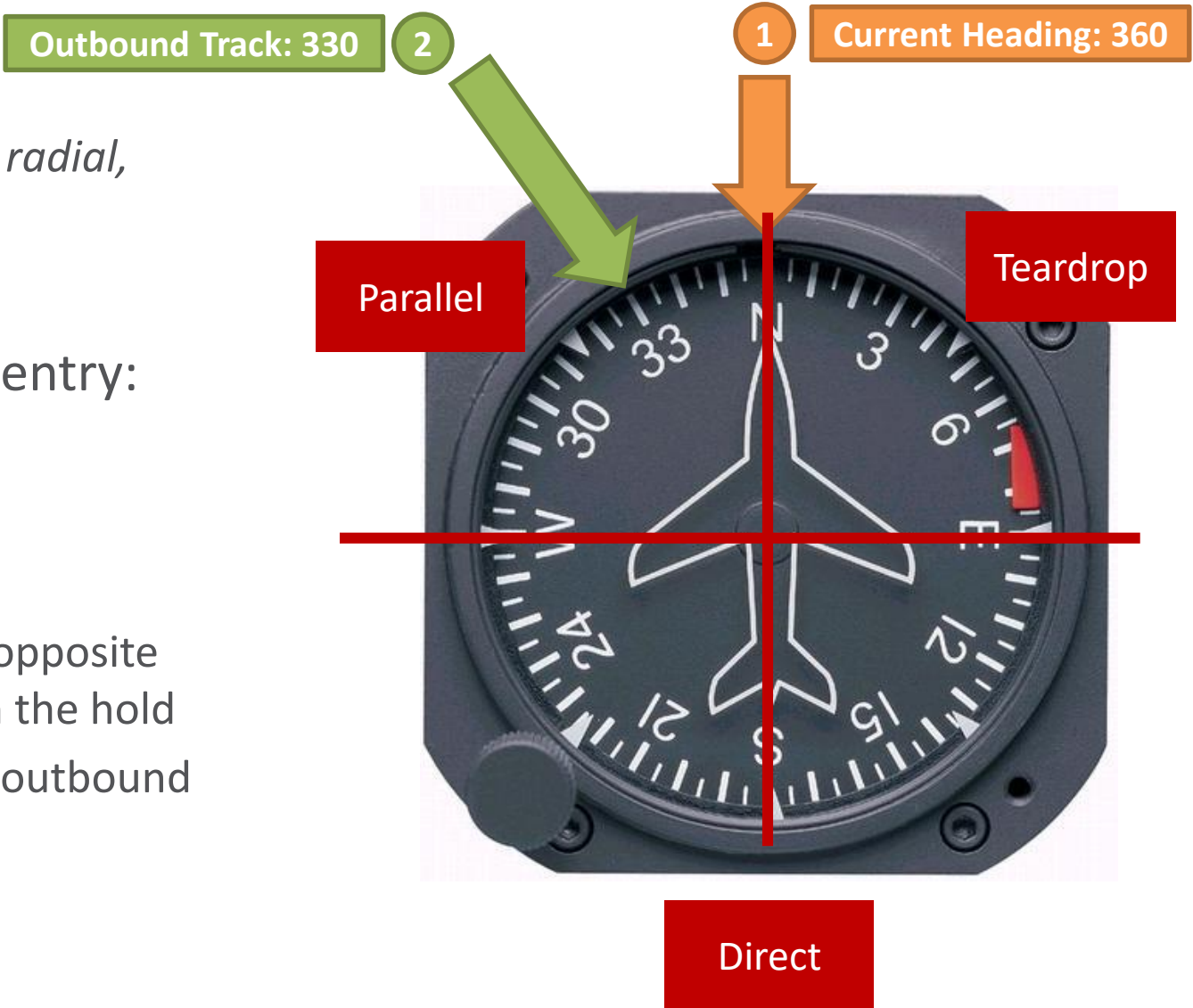
- For a teardrop entry, cross the fix, and turn to a heading 30 degrees from the outbound course on the holding side
- After 1 minute, turn towards the inbound course to intercept



# Hold Entry

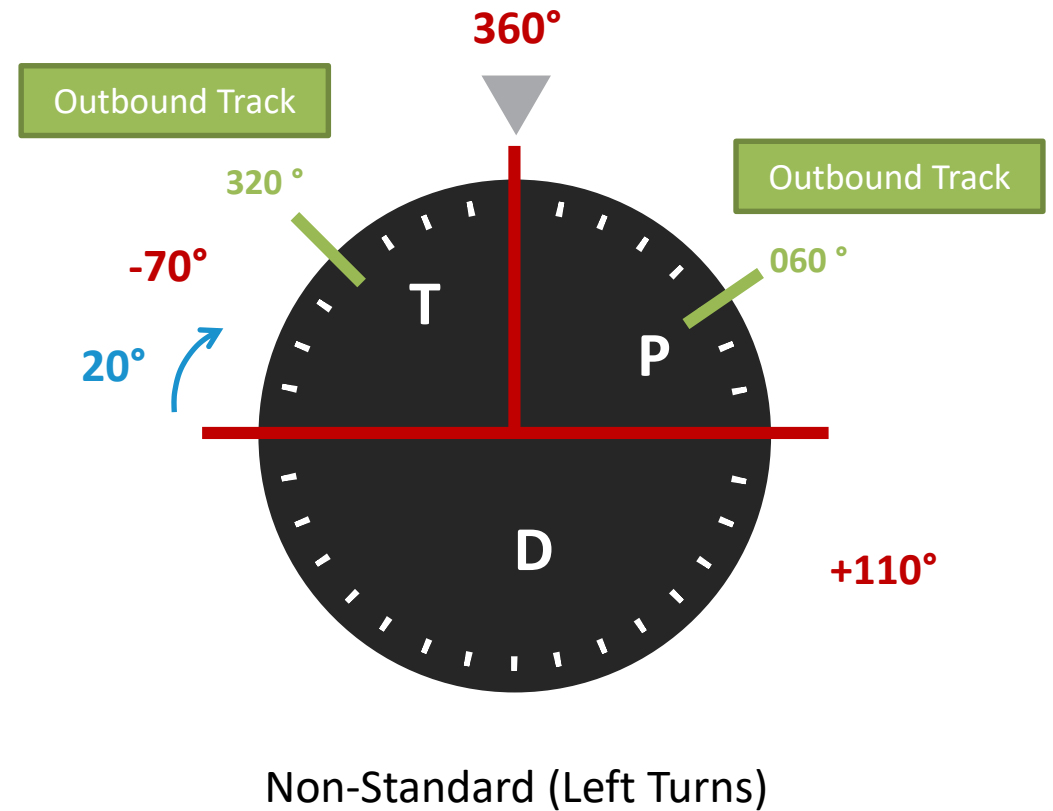
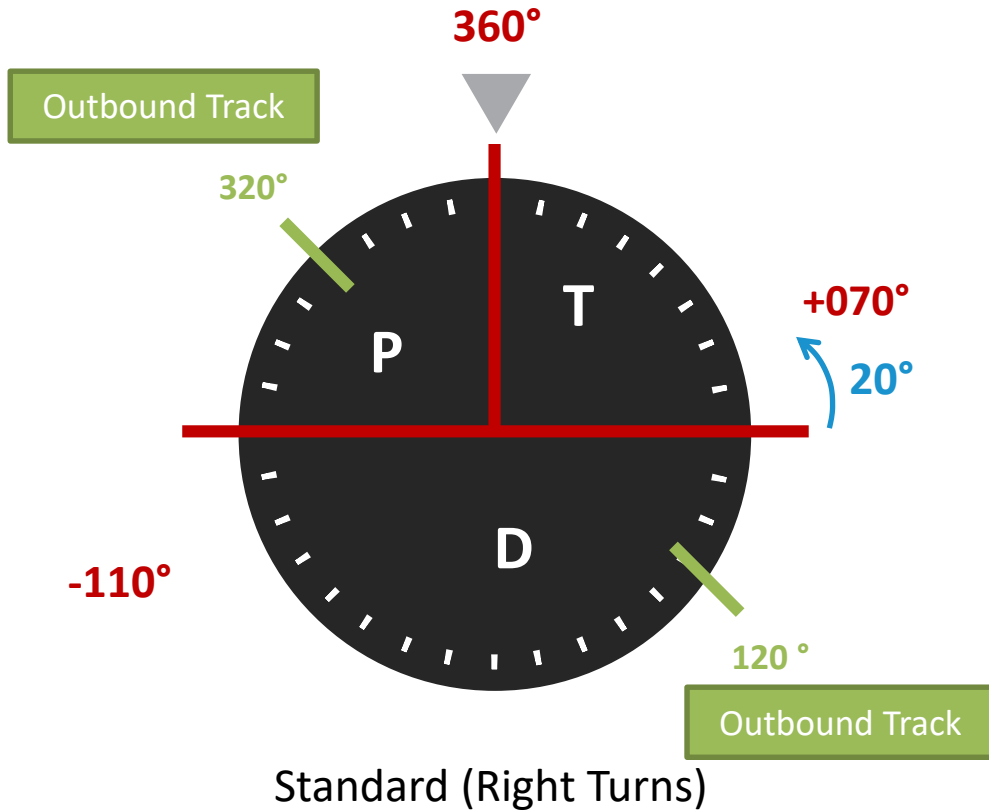
*“Cleared to Putnam, hold northwest on the 330 radial, right turns, expect further clearance 1452 Zulu”*

- To determine the recommended hold entry:
  1. Start with your current heading
  2. Identify the outbound track to fly
  3. “Segment” your heading indicator
  4. Turn the horizontal segment 20° in the opposite direction of the direction of the turns in the hold
  5. Determine which of the segments your outbound track fits into



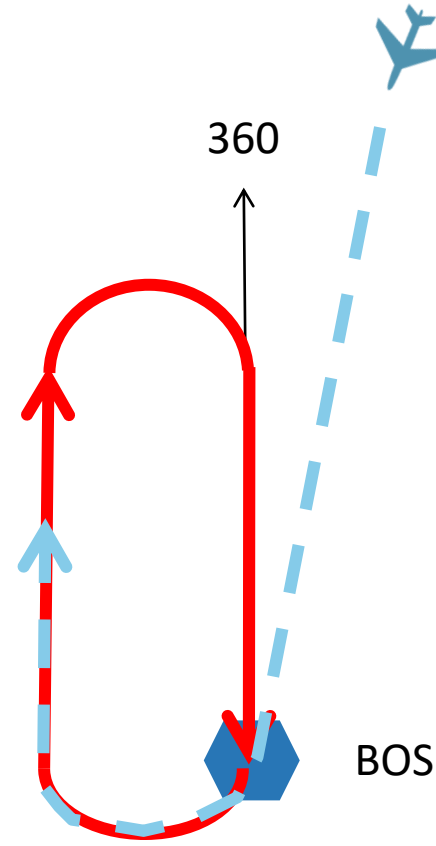
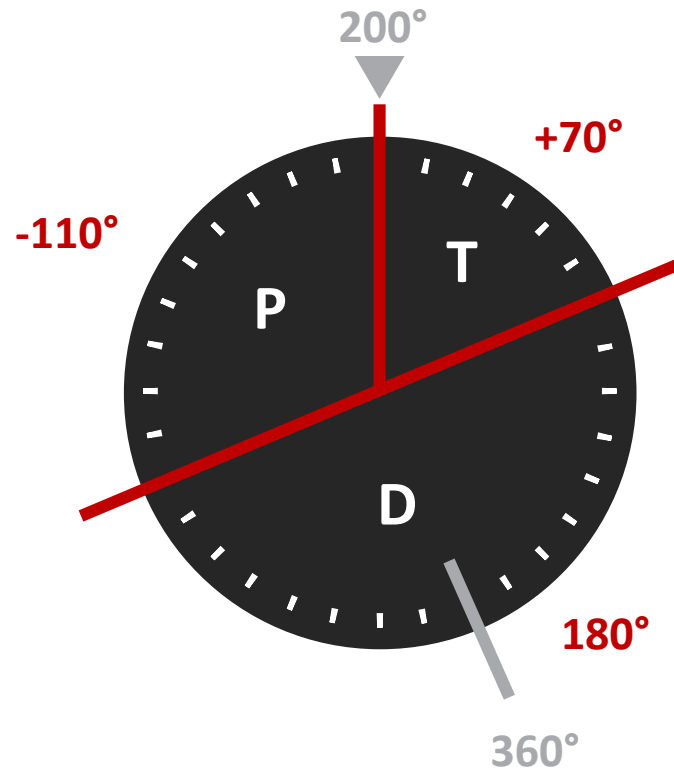


# Segmenting the Heading Indicator



# Determine the Entry

- Aircraft heading: 200
- Holding radial: BOS R-360
- Right turns (standard)



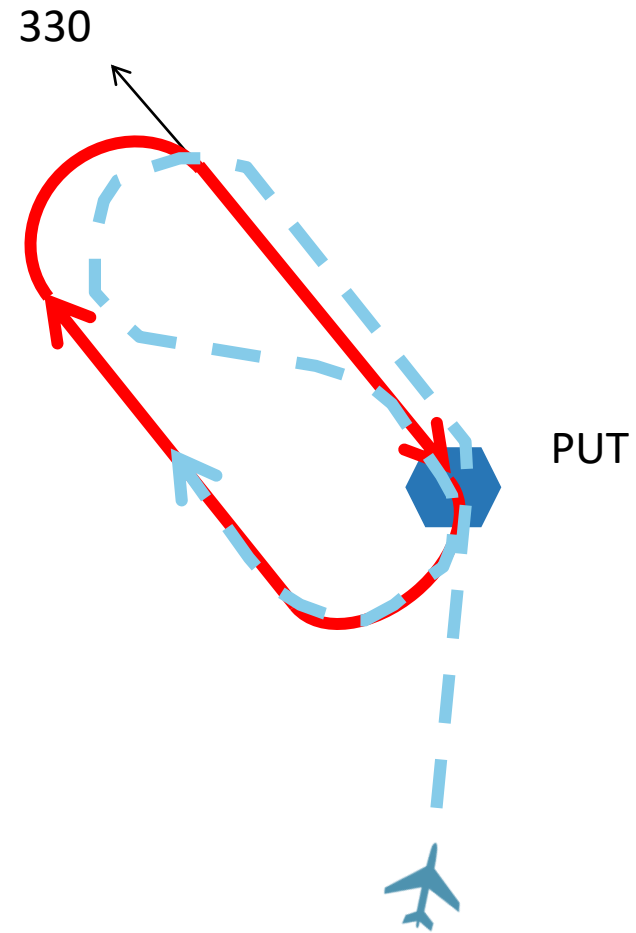
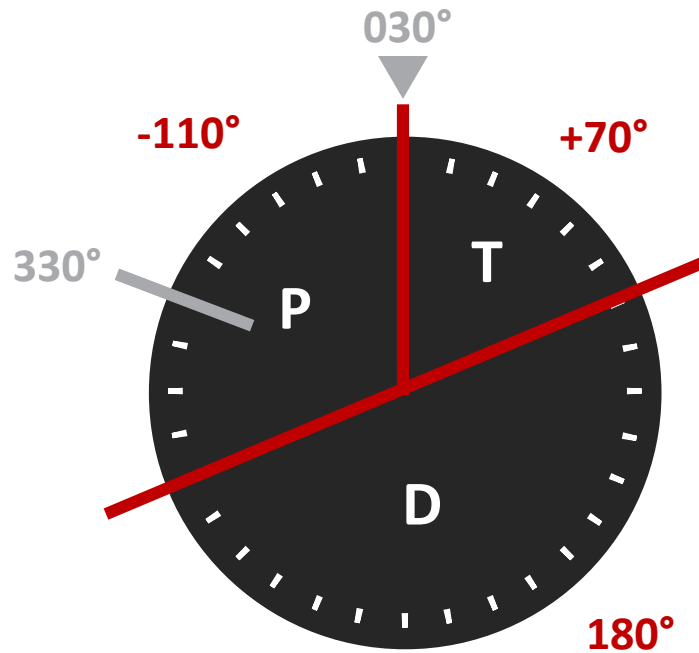
Direct Entry

Holds



# Determine the Entry

- Aircraft heading: 030
- Holding radial: PUT R-330
- Right turns (standard)

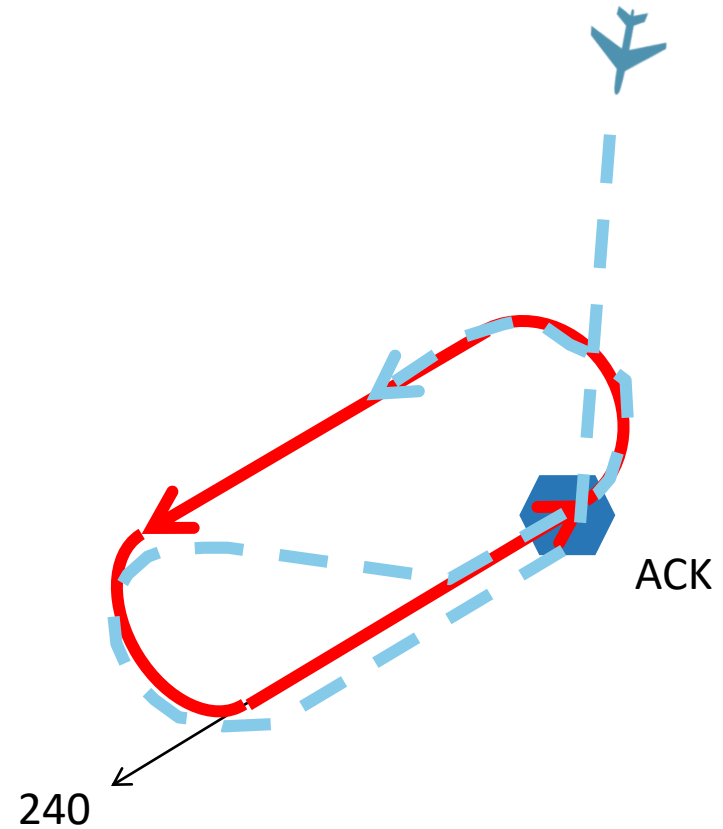
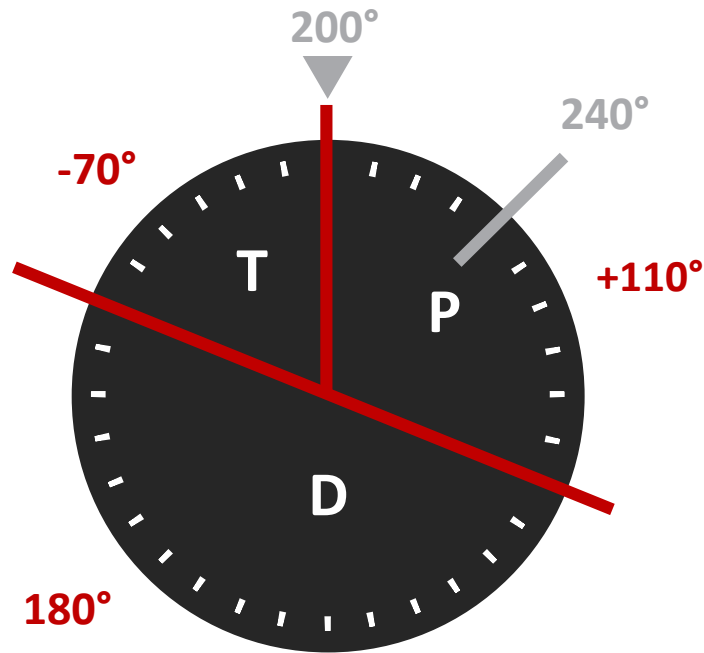


Parallel Entry



# Determine the Entry

- Aircraft heading: 200
- Holding radial: ACK R-240
- Left turns (non-standard)



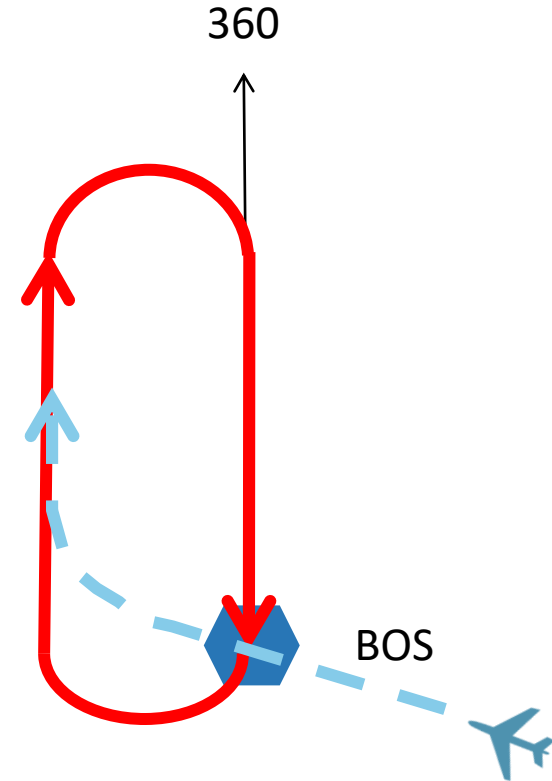
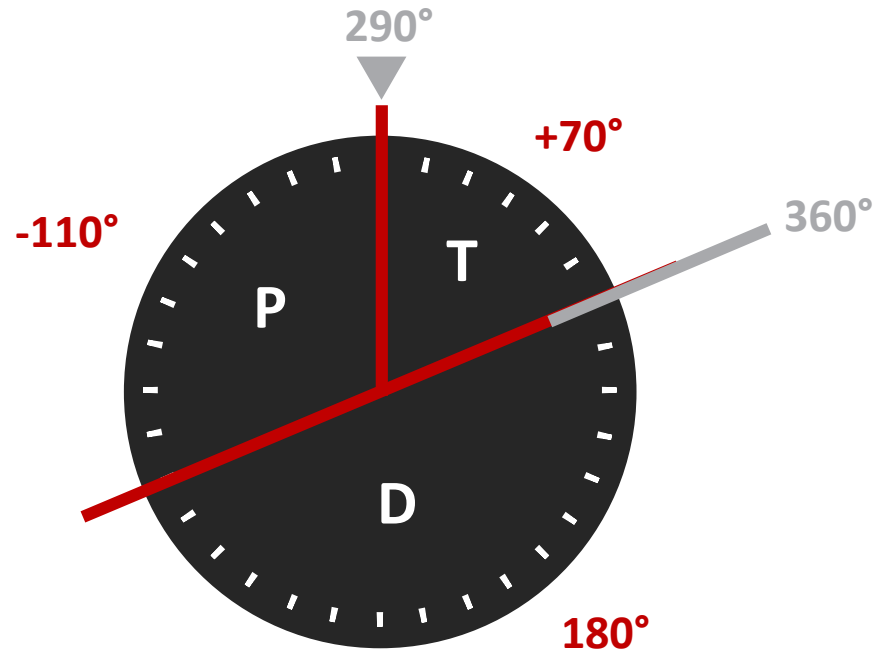
Parallel Entry



# Determine the Entry

- Aircraft heading: 290
- Holding radial: BOS R-360
- Right turns (standard)

Because the heading is within 5° of the boundary, either a Teardrop or Direct Entry is recommended.

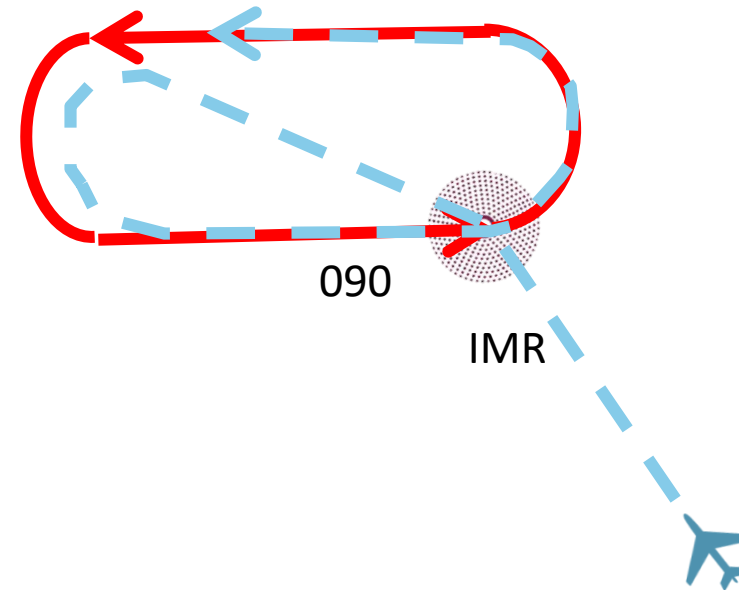
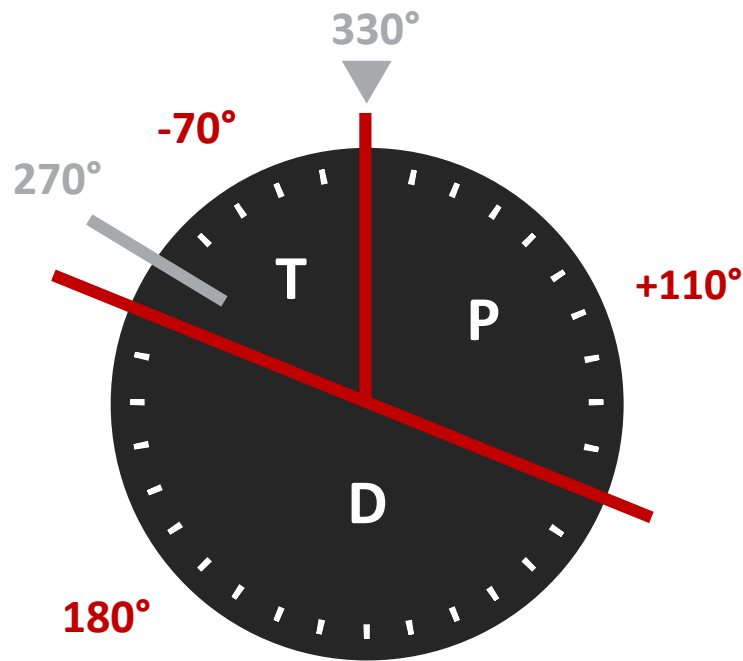


Direct Entry



# Determine the Entry

- Aircraft heading: 330
- NDB hold along the 090 *inbound track*
- Right turns (standard)

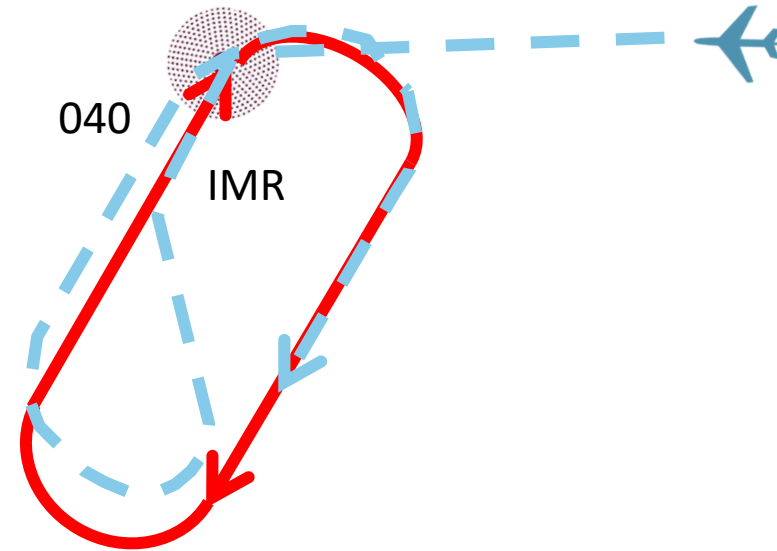
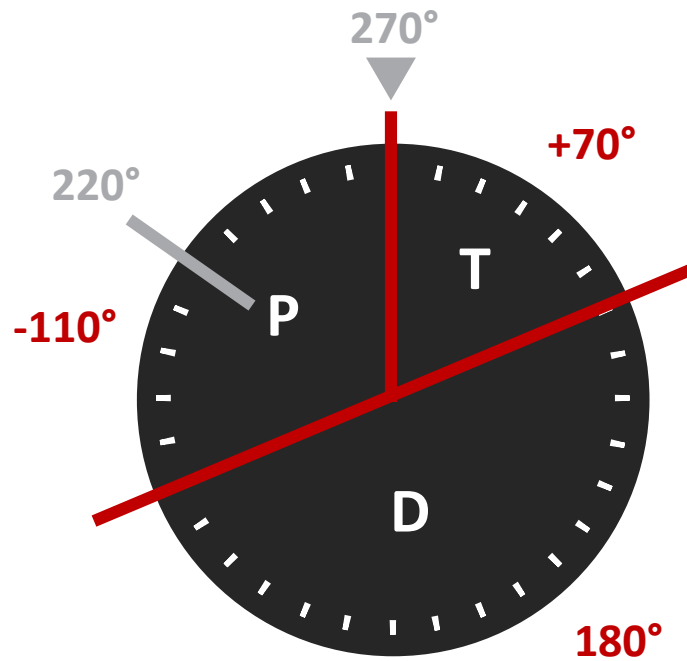


Teardrop Entry



# Determine the Entry

- Aircraft heading: 270
- NDB hold along the 040 *inbound track*
- Right turns (standard)

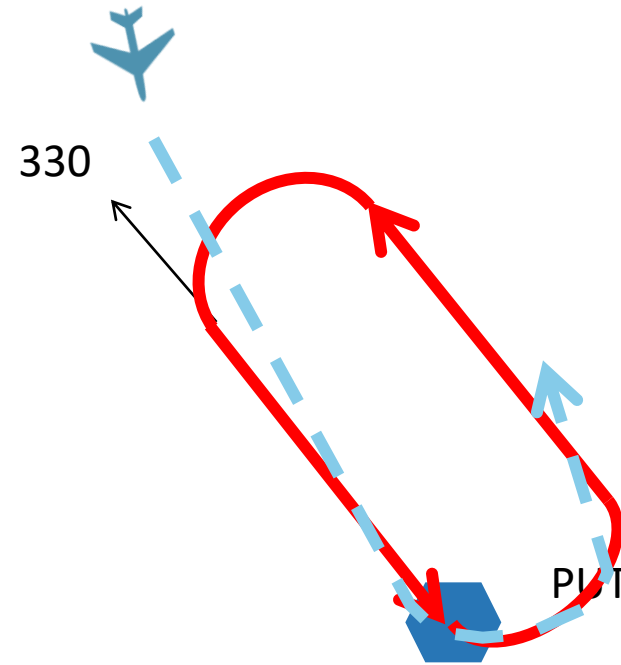
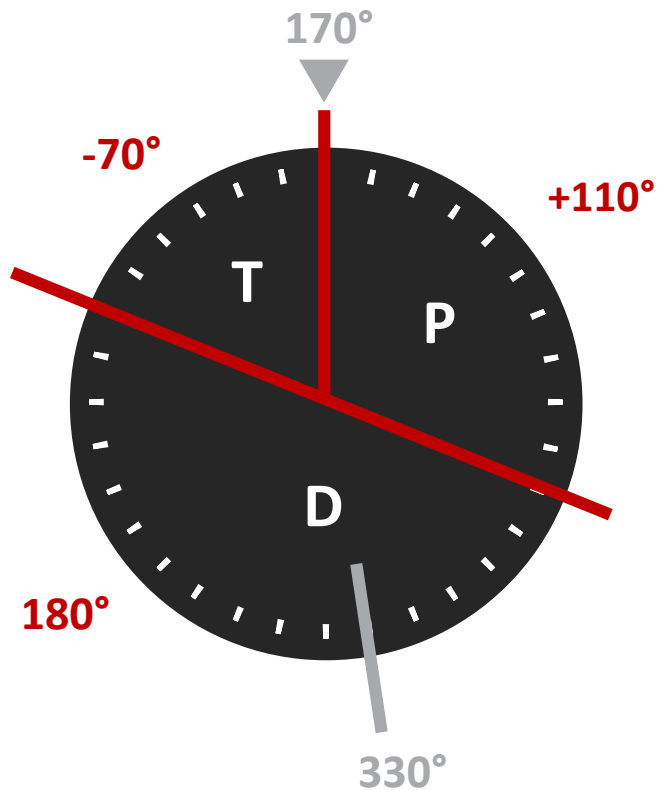


Parallel Entry



# Determine the Entry

- Aircraft heading: 170
- Holding radial: PUT R-330
- Left turns (non-standard)



Direct Entry

Holds





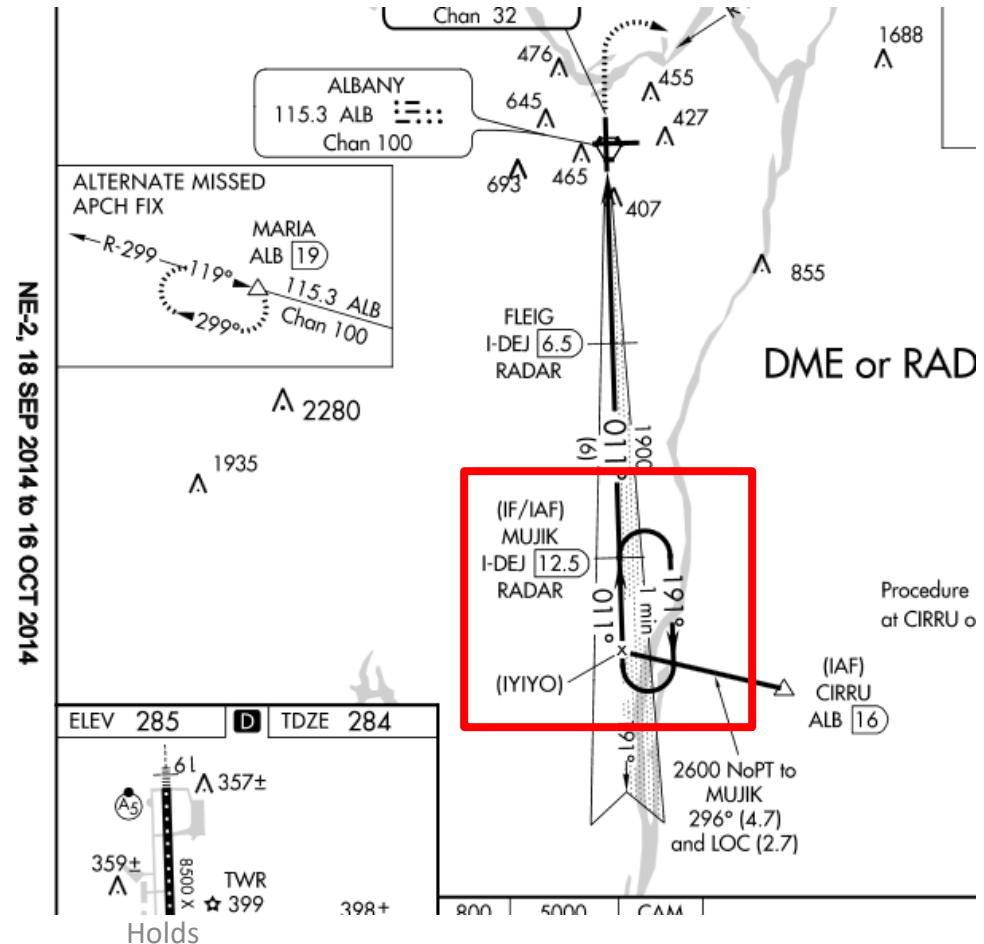
## Fuel Usage

- Most holds are short-term (<15 minutes), and fuel is not normally an issue
- If you are holding for an extended period of time, consider reducing power to conserve fuel. The most efficient configuration for holding is your aircraft's maximum endurance airspeed. If not published, you can estimate max endurance:
  - Propeller Aircraft: 75% of best glide speed
  - Turbojet Aircraft: Best glide speed



# Practicing Holds

- Want to practice holds and entries?
  - Fly “full procedure” instrument approaches that require hold entries in lieu of procedure turns
  - Request to fly full missed approach procedures and hold as published
  - Request a hold from ATC
  - Participate in the Pilot Ratings Program



# Thank You!

Boston Virtual ARTCC Ground School takes place in our Member TeamSpeak.  
The program is designed to help pilots of all skill levels share their knowledge and experience with members.

## Ground School Curriculum

Radio Communications ✓

Weather ✓

VFR Departure and Arrival Procedures ✓

IFR Clearances ✓

Oceanic Procedures ✓

Holds ✓

Approach Plates – Part 1 (March 11, 7pm ET)

Approach Plates – Part 2 (March 18, 7pm ET)

RNAV (Area Navigation): Departures, Arrivals, and Approaches

