Approach Navigation

Visual Approach Procedures
- Visual Approach
  - visibility > 3nm

Contact Approach
- visibility > 1nm

Instrument Approach Procedures (IAP)
- Terminal Instrument Approach Procedures (TERPS)
- Flight Checks
- Instrument Approach Procedure Charts/Approach Plates

Initial

Intermediate

Final
- Precision
- Non-precision

Missed Approach

Lighting

Runway
- ALSF-1
- ALSF-2
- RAILS
- SSALS
- SSALR

Approach
- MALSR
- ODALS
- LDIN
- REIL

Electronic Navigation

Terminal

ILS

Marker Beacon
- Outer
- Middle
- Inner

ILS/DME

GPS
- WAAS
- LAAS

2
Visual Approach Procedures

• Pilot accepts responsibility for navigation to the airport
  – Pilots under VFR
    • Pilots use “see-and-avoid”

• Two types of Visual Approach Procedures
  – Visual Approach
    • Initiated by pilot or ATCo
    • Visibility > 3nm
  – Contact Approach
    • Initiated by pilot
    • Visibility > 1nm
Instrument Approach Procedures

• Pilot follows a published Instrument Approach Procedures (IAP)
  – Provides guidance, obstacle clearance to airport

• IAP designed by FAA
  – Terminal Instrument Approach Procedures (TERPS)
  – Flight Checks
  – IAP Charts (also known as Approach Plates)
Segments of IAP

1. Initial Approach Segment
2. Intermediate Approach Segment
3. Final Approach Segment
   - Non-precision Approach
   - Precision Approach
4. Missed Approach
Initial Approach Segment

• Objective:
  – Ground-track to transition aircraft from en-route airway to intermediate approach segment

• Start/Termination
  – Starts at Initial Approach Fix (IAF)
    • Located on airway
  – Ends at Intermediate Approach Segment

• Defined by:
  – Defined by Heading or Radial from IAF
  – Minimum allowable altitude
Intermediate Approach Segment

- **Objective:**
  - Permit pilot to:
    - descend to intermediate altitude
    - Align aircraft to runway course
  - **Start/Termination**
    - Start at end of Initial Approach Segment
    - End at Final Approach Fix (FAF)
- **Defined by:**
  - Course to Final Approach Fix (FAF)
  - Part of Procedure Turn
Final Approach Segment

• **Objective:**
  – Navigate to runway using navigation aid (located at or nearby runway)

• **Start/Terminate:**
  – Start at FAF
  – End at Missed Approach Point (MAP)

• **Defined by:**
  – Runway center-line course
  – Descent on 3° to runway
Final Approach – Nonprecision

- Lateral guidance only
  - Navaids:
    - VOR (Terminal)
    - VOR/DME
    - NDB
- Aircraft descends from FAF to Minimum Descent Altitude (MDA)
- Pilot maintains MDA on runway center-line to Missed Approach Point (MAP)
- If runway in sight at MAP, then land
- If runway not in sight at MAP, then Missed Approach Segment
Final Approach - Precision

- Lateral AND Vertical Guidance
- Aircraft descends from FAF down Glideslope to Decision Height (DH)
  - Glideslope provides 3° descent
  - Decision Height lower than MDA
- If runway in sight at DH, then land
- If runway not in sight at DH, then Missed Approach Segment
Missed Approach Segment

• **Objective:**
  – To guide aircraft above obstacles away from traffic to safe location, prior to entering the queue for the approach again
    • **Navigation Aids:**
      – Instrument Landing System (ILS)

• **Start/Terminate:**
  – Start at MP or DH
  – Terminate at Exit Hold

• **Defined by:**
  – Climb to safe altitude
  – Hold at published location
Instrument Approach Procedure
Grand Forks – GPS RWY 26

– Initial Approach Segment:
  • EYWUS (IAF), 174° to URBAH. Cross URBAH at 2600’
  • JIXIR (IAF), 354° to URBAH, Cross URBAH at 2600’

– Intermediate Approach Segment:
  • Descend from URBAH, on 264° to OMEPE (FAF). Cross OMEPE at 2400’
  • URBAH to OMEPE is 6nm.

– Final Approach Segment:
  • FAF (OMEPE), 264° to MAP
  • OMEPE to MAP is 5nm (3+2)
  • Descend from OMEPE on 2.86° Flight Path Angle
  • Cross 3nm from Runway at 1800’

– Missed Approach Segment
  • Climb to 1700’, then left turn to 2600’, direct to HISER waypoint, Right Hold at Hiser on 354°
  • Return to IAF JIXIR on course 093° at 2600’
Terminal VOR

- Provides lateral guidance (course) to runway for airport needing instrument approach
- Low-powered VOR upto 25nm
Instrument Landing System

• ILS provides pilot with lateral and vertical approach path to runway centerline
• ILS is equipped with three types of transmitters:
  – Localizer
  – Glideslope
  – Marker Beacons (2 or 3)
Localizer - Components

• 3 components:
  – Transmitter building
    • 300’ to side of localizer antenna
  – Localizer antenna
    • 1000’ beyond the opposite end of the arrival runway
  – Monitoring equipment
    • Part of antenna system
Localizer - Signals

• VHF Band – 108.1 to 111.9 MHz
• Antennae radiates signal aligned with runway center-line
  – Modulated with 2 tones
    • 90 Hz (left of runway) and 150 Hz (right of runway)
Localizer – Signal Geometry

• Localizer signal is transmitted;
  – along a narrow path extending 35° to the left and right of the centerline
  – Approx 7° high
• Transmitted to a distance of 10nm
  – Between 10nm and 25nm from runway accurate only within 10° of center-line
• Localizer Directional Aid (LDA)
  – Scalloping, degraded navaid
Localizer – On Aircraft

• Full-scale deflection 3° “off course”
• On-course narrows as approach antennae
  – Ten miles from runway, full-scale deflection, aircraft ½ mile off course
  – Approach end of runway, full scale deflection, aircraft is 300 ft off course
Localizer - Review

VHF LOCALIZER

Provides Horizontal Guidance
108.1 to 111.95 MHz. Radiates about 100 watts. Horizontal polarization.
Modulation frequencies 90 and 150 Hz. Modulation depth on course 20% for each frequency. Glide angle identification (100 Hz, 5%) and voice communication (modulated 50%) provided on same channel.

UHF GLIDE SLOPE TRANSMITTER

Provides Vertical Guidance
328.3 to 330.0 MHz. Radiates about 5 watts. Horizontal polarization, modulation on path 49% for 90 Hz and 150 Hz. The glide slope is established nominally at an angle of 2.5 degrees, or higher, depending on local terrain.

INDEX

1. VHF LOCALIZER
2. UHF GLIDE SLOPE TRANSMITTER
3. RATE OF DESCENT CHART
4. NOTE

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Glideslope - Components

- Glideslope components
  - Antenna (30 ft)
    - 500 ft from runway center-line
    - 1000 ft from approach end of runway
  - Transmitter building
    - 500 ft from runway center-line
    - 1000 ft from approach end of runway
  - Monitoring antenna
  - Clear zone
    - Glideslope reflecting area
Glideslope - Signals

- UHF band 329mHz to 335mHz
- GS transmits
  - 90Hz above glideslope (+3°)
  - 150Hz below glideslope (-3°)
Marker Beacons

- Located at known distance along final approach course
  - Outer Marker
    - 5nm from approach end of runway
    - Blue light, 400Hz beeps
  - Middle Marker
    - 3000 ft (1/2 mile) from approach end of runway
    - Amber light, 1300Hz beeps
    - Aircraft 200 ft AGL = Decision Height
  - Inner Marker
    - 1000ft from approach end of runway
    - White light, 3000Hz beeps
    - Aircraft 100 ft AGL
- Transmit cone shaped signal upwards
Compass Locators/Non-Directional Beacons

• Non-directional Beacons
  – Known as Compass Locators
  – Co-located at Outer or Middle Marker
• Locator Outer Marker (LOM)
  – NDB at OM
  – Available where no radar coverage
• Locator Middle Marker (LMM)
  – NDB at MM
  – Very few left, being decommissioned
Non-Directional Beacons

- NDB transmits radio signal
  - Omni-directional signal
  - Low-medium frequency (190 – 540 kHz)
- Automatic Direction Finder (ADF) on aircraft
  - Displays (relative) bearing to the NDB
    - 0° NDB is straightahead, 90° NDB to the right, …
- Nowdays, located at smaller airports as instrument approach aids
ILS/DME

- DME co-located with Localizer
- Used when terrain prevents installation of Outer Marker and/or Middle Markers
- DME is tuned on same frequency as ILS
ILS Categories

- 3 Categories
  - Determined by:
    - Decision Height
    - Runway Visual Range (i.e. Visibility)
  - **Cat I**
    - DH - 200’ RVR - ½ mile or 2400’
  - **Cat II**
    - DH - 100’ RVR – 1,200 (Runway RVR equipped)
  - **Cat III**
    - DH – 0’
    - RVR – 700’ Cat III-a (Runway RVR equipped)
    - RVR – 150’ Cat III-b (Runway RVR equipped)
    - RVR – 0’ Cat III-c (aircraft equipped with Automatic Landing System)
Runway Visual Range Equipment

- Measures visibility along runway
  - Rain, smoke, haze, fog
- Used for Instrument Approaches
- Components
  - Projector
    - Located to side of runway
    - Upto 3 locations on touchdown, midpoint, rollout
    - 500' from Detector
  - Detector
  - Data Convertor
    - Takes into account time of day, location of sun
  - Remote Digital Display
ORD – ILS RWY 14L

- Initial Approach Segment:
  - FARMM Intercept (IAF), located on radial 293° from NORTHBROOK (OBK) VOR
  - Cross FARMM at 4000’, descend on Glideslope of 3° PLUNC Intercept
    - PLUNC Intercept is located on 293° from NORTHBROOK (OBK) VOR
    - 4.8 nm to 2500’ at Locator Outer Marker (LOM)

- Intermediate Approach Segment:
  - Descend from LOM, on 142° to BESSE (FAF).

- Final Approach Segment:
  - FAF 142° to DH
  - Descend on Glideslope

  - TDZE (Touchdown Zone Elevation) – 652’
  - Airport Elevation – 668’

- Missed Approach Segment
  - Climb to 1200’
  - then climbing left turn to 4000’ via ORD R-089 (radial) to LAIRD Intercept
  - LAIRD Intercept is ORD R-089 and CGT R356
  - Hold

- Misc.
  - Simultaneous approach authorized on RWY 14R

Nolan, Chap 2, pg 113
Homework

• Prepare for quiz
  – Name components of Localizer, Glideslope, Runway Visual Range Equip?
  – What are the 3 categories of ILS approaches?
  – Where are Non-directional beacons located?
  – What signal do Marker Beacons provide pilot?
  – Where is localizer equipment located (relative to runway)?
  – What is range of Terminal VOR?
  – What are segments of approach?
  – What is difference between Precision, non-Precision Approach?
  – Describe 2 types of visual approach?