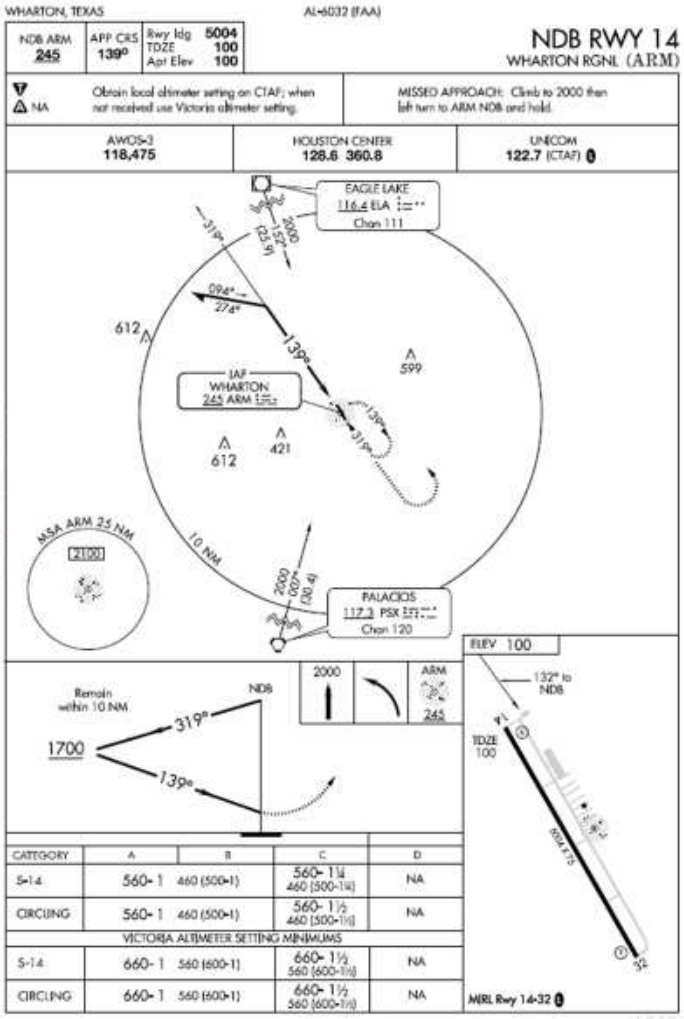
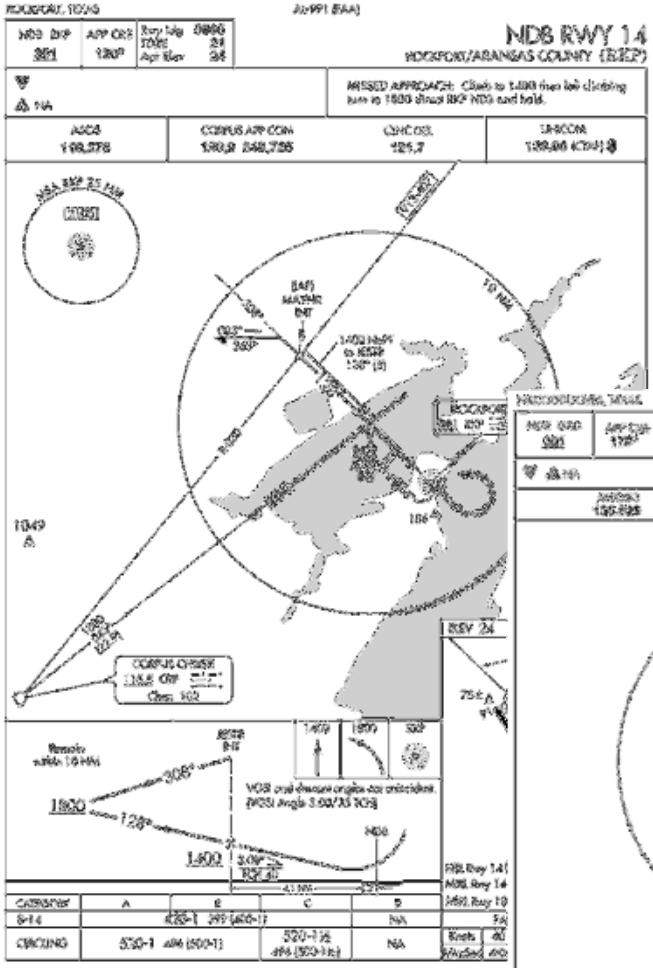
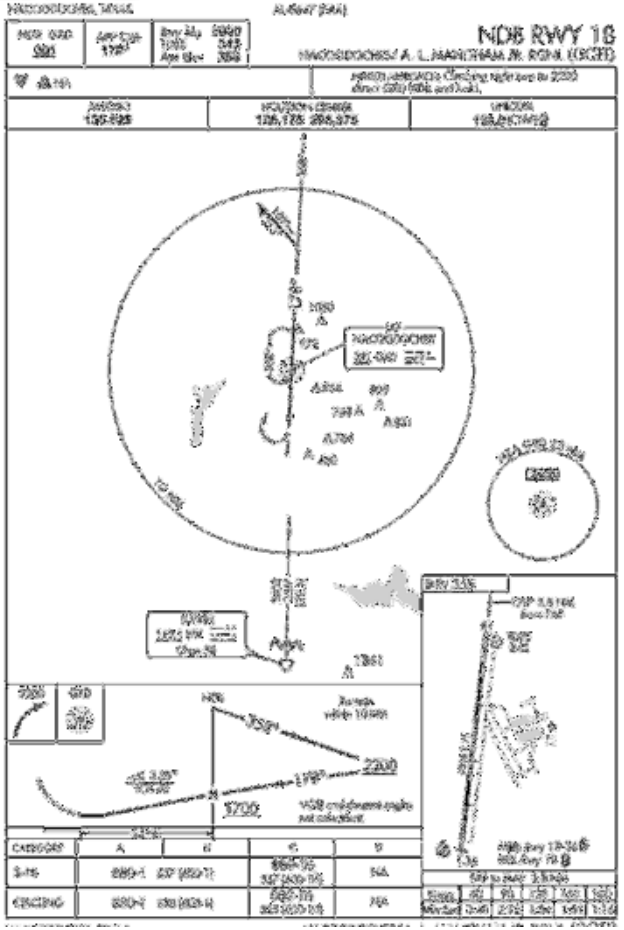
NDB Approaches







NDB Approach Background

- One of the oldest and most disliked approaches
- Can use NDBs both on and off of the destination airport
- NDB approaches can be on the TO or FROM side of an NDB; some use both the TO and FROM sides – Navigation is based upon a specific bearing
- NDB approach may or may not have a final approach fix –
  - off airport NDB usually the final approach fix
  - On airport NDB – usually has no depicted FAF
- NDB is normally the IAF – but can have others or none with radar
- It is a non-precision approach as there is no vertical guidance
- Requires situational awareness and subtle use of geometry
  - MH + RB = MB

NDB Equipment

- ADF receiver and ADF radio bearing indicator (RBI) or radio magnetic indicator (RMI)
- Some approaches also require a VOR NAV receiver

NDB Receiver

Power / identification volume control

Frequency

Flight timer

Tuning knob

ADF function button

Beat frequency oscillator
(generates an audio tone to let you identify unmodulated NDBs that identify themselves using interrupted-carrier keying - seldom used in the United States)

Flight timer or elapsed timer and reset button

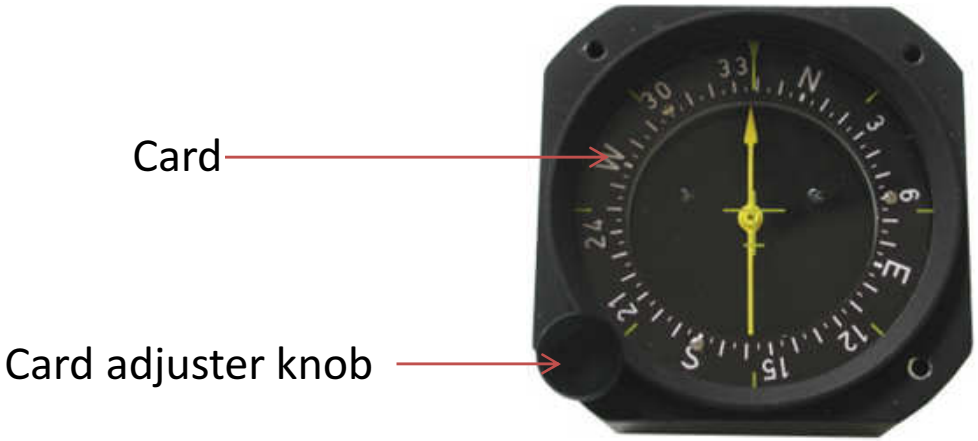
NDB Ground Station

Understanding the Signals

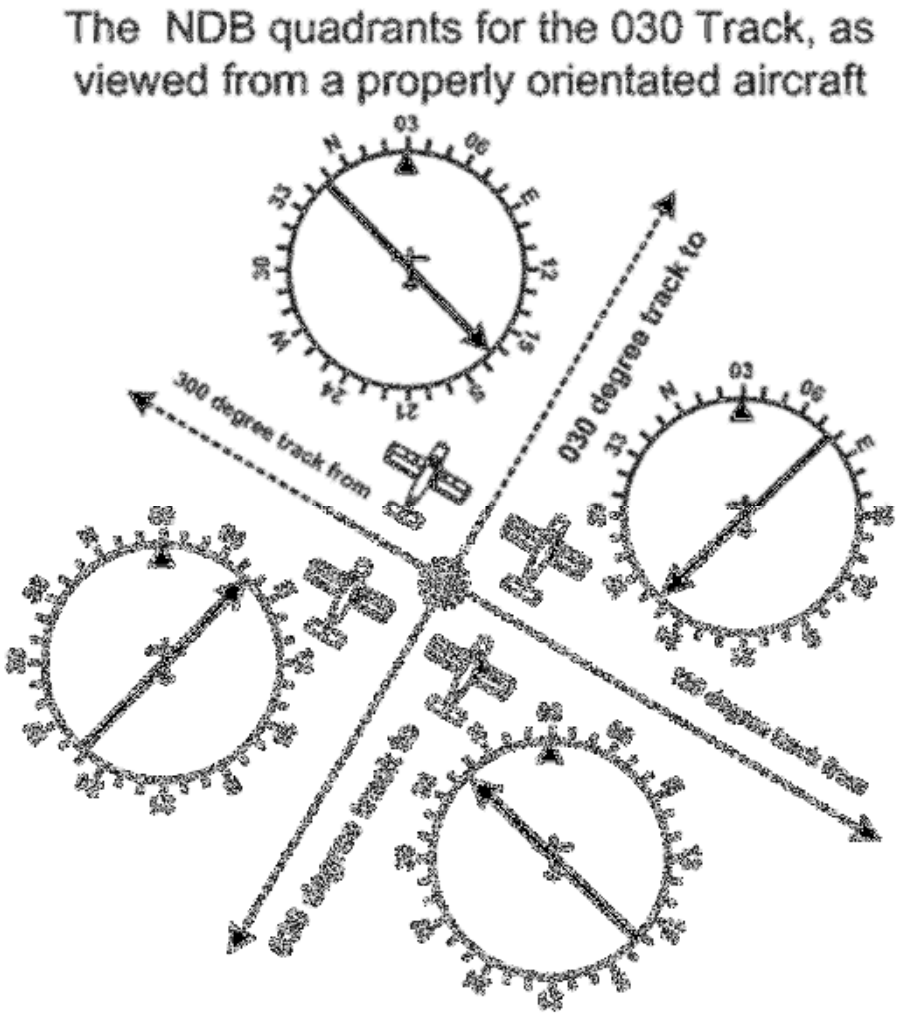
- Tune the NDB frequency
- Morse code identifier – identify and keep it on in the background – **No other definitive evidence of signal loss (**NDB – 3 letters; LOM – 2 letters**)**
- If equipped, press the test button to check equipment
- Indicator / Signal Errors
  - **Night effect**: radio waves reflected back by the ionosphere can cause signal strength fluctuations 30 to 60 nautical miles from the transmitter, especially just before sunrise and just after sunset (more common on frequencies above 350 kHz)
  - **Terrain / mountain effect**: high terrain like mountains and cliffs can reflect radio waves, giving erroneous readings; magnetic deposits can also cause erroneous readings
  - **Electrical effect**: electrical storms, and sometimes also electrical interference (from a ground-based source or from a source within the aircraft) can cause the ADF needle to deflect towards the electrical source
  - **Shoreline effect**: low-frequency radio waves will refract or bend near a shoreline, especially if they are close to parallel to it
  - **Bank effect**: when the aircraft is banked, the needle reading will be offset
  - **Quadrantal Error** - Signal is bent by aircraft metal; quadrantal effect is minimal at the cardinal points (nose, tail and wing tips), and greater in the intermediate bearings;
  - **Needle Oscillation** - Needle oscillates in conditions of static (rainfall and thunderstorms) and weak transmissions;
  - **Ore Deposits** - Can cause needle deflections

Using the Radio Bearing Indicator (RBI)

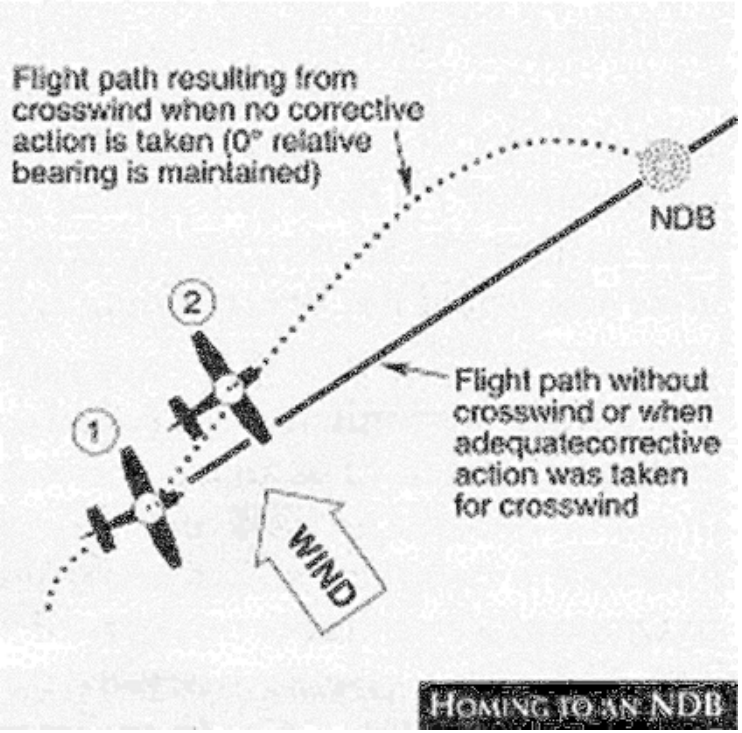
- ADF indicator is a performance instrument – Keep it in the scan
- Set the card to the course, if the RBI has a movable card
- Look at indicator for needle location and trend; BUT FLY THE ATTITUDE INDICATOR / DG – don't chase the RBI
- Initially steer desired radial +/- wind correction
- Make corrections with gentle coordinated turns to reference headings on the DG using bracketing
- Make corrections early and often to avoid the need for large corrections

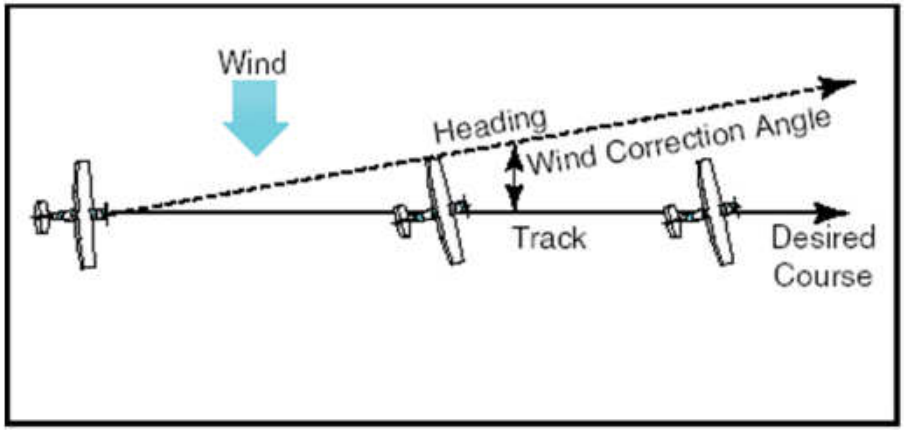


RBI Indications



Homing vs Flying a Course

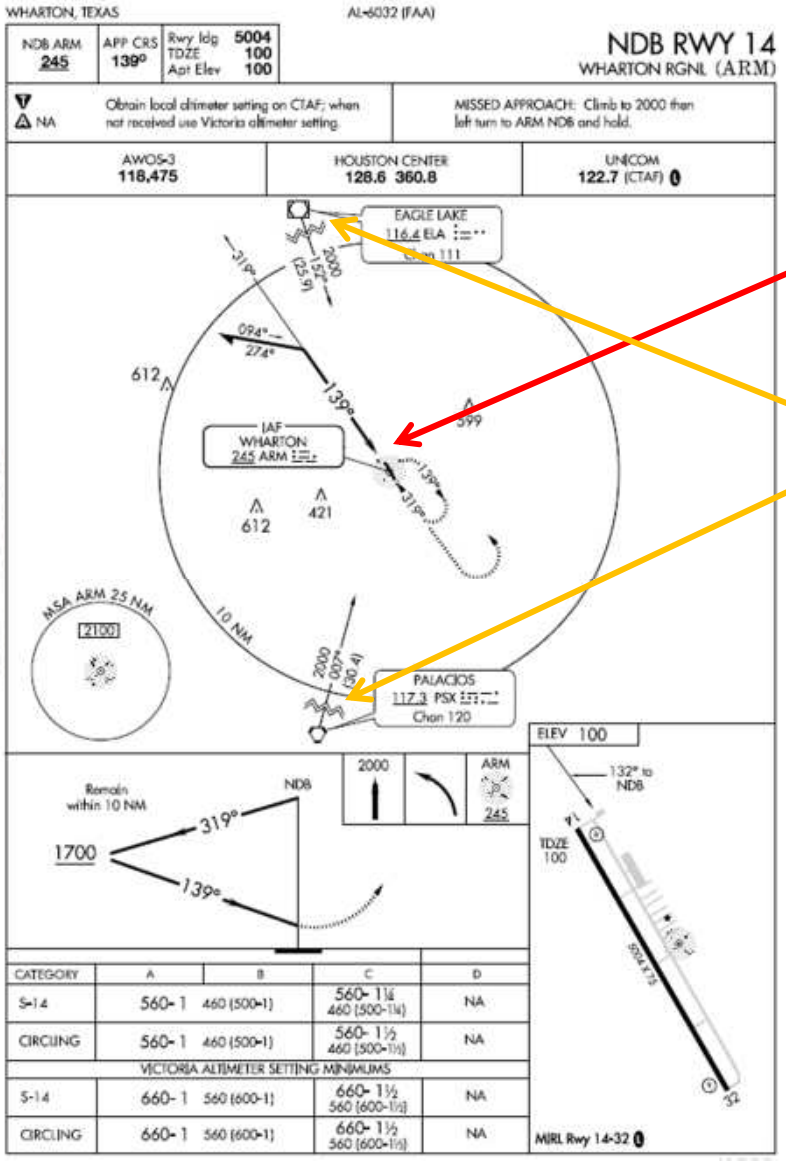




Homing vs Flying a Course

- **To "home" to a station using ADF**:
  - note the relative bearing to the NDB and turn the aircraft so that the relative bearing is on the aircraft's nose (i.e., the magnetic heading of the aircraft equals the magnetic bearing to the NDB);
  - maintain a relative bearing of 360° (on the nose).
- **To intercept a pre-determined track using ADF**:
  - orient the aircraft so that the aircraft's heading is the same as the desired track to or from the NDB (paralleling the track);
  - note whether the indicator needle is indicating right or left of the longitudinal axis of the aircraft;
    - if the bearing indicator points to the right of the aircraft's nose, add the desired intercept angle to the current orientated heading and fly the intercept; if the bearing indicator points to the left of longitudinal axis, subtract the desired intercept angle;
  - if you are **intercepting a track from the NDB**, you slowly "pull the **tail**" of the RBI needle to match the intercept angle (turn toward where you want the TAIL of the needle to be) —when the tail "opens" to match your intercept angle, you are "on track";
  - if you are **intercepting a track to the NDB**, you slowly "push the **head**" of the bearing indictor to match the intercept angle (turn toward where you want the HEAD of the needle to be) — when the head matches the intercept angle, you are "on track." Now turn on course.

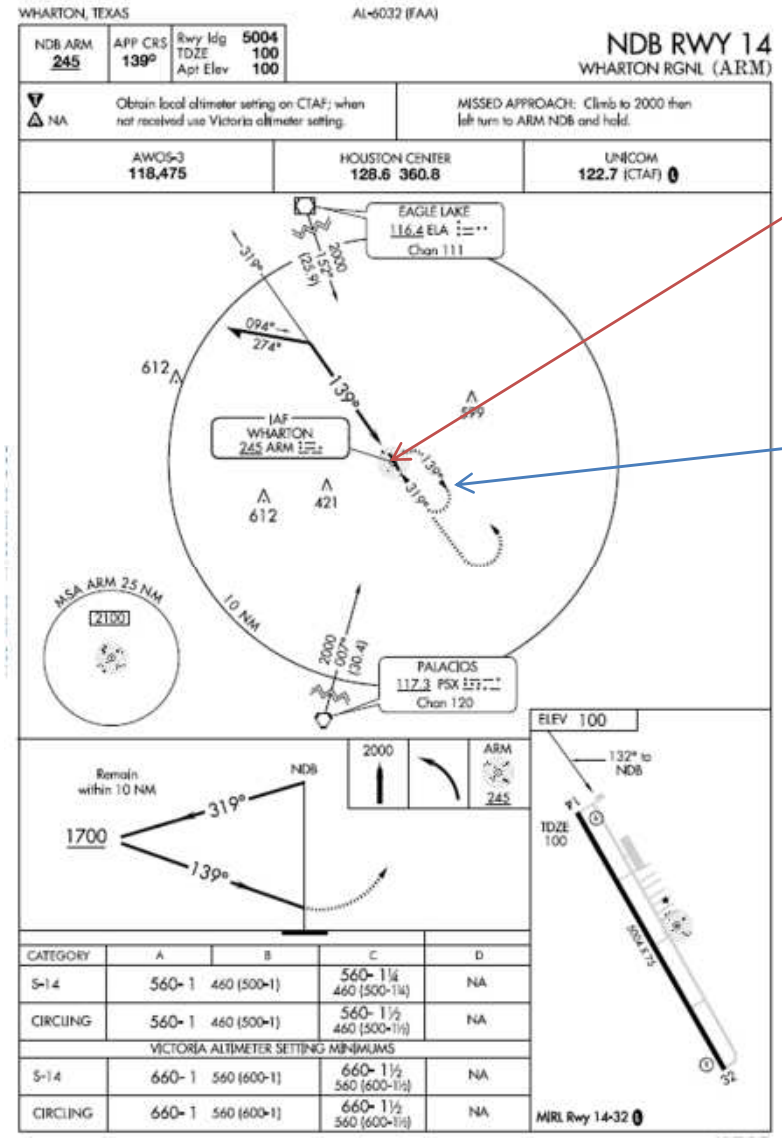
Let's Fly - IAF



Starting the Approach

- Approach starts at the initial approach fix (IAF) – There can be several IAF's – IAFS join at one or more common intermediate segments
- You will reach the IAF from a "feeder route" which can be a radar vector
- Must fly the entire procedure unless otherwise advised by ATC

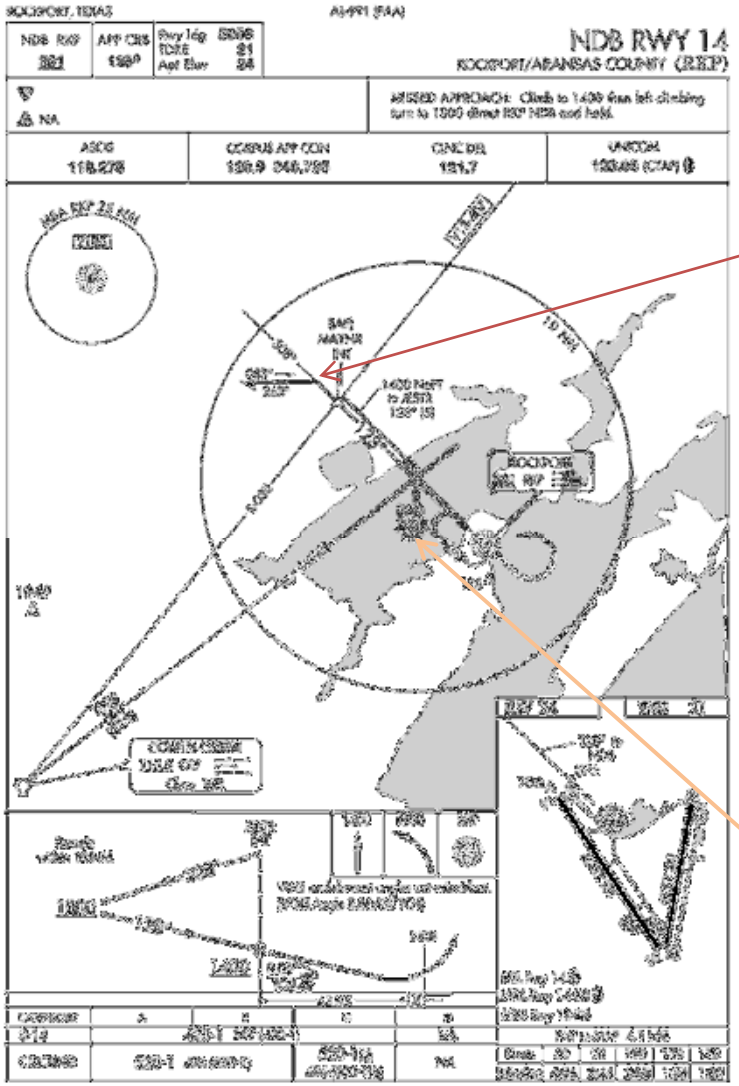
Let's Fly - IAF



Starting the Approach

- IAF is where the initial approach segment begins.
  - Purpose is to align the aircraft with the intermediate or final approach segment
  - Accomplished by using a course reversal, such as a procedure turn or holding pattern, or straight in route
  - IAF is usually a designated intersection, VOR, NDB, or DME fix
- IAF may be collocated with the intermediate fix of the instrument approach. In that case there is no initial approach segment
- Segment usually ends at the intermediate approach segment or at an Intermediate Fix (IF)

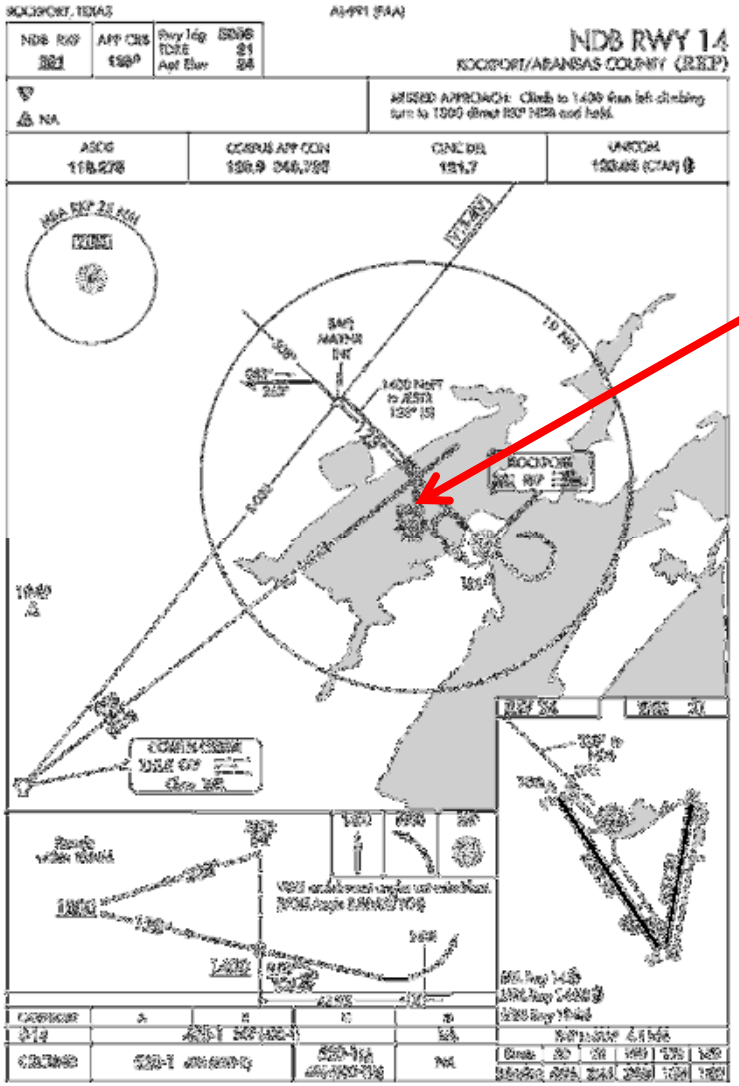
Let's Fly – Intermediate Segment



Starting the Approach

- Intermediate segment positions the aircraft for the final descent to the airport
- Normally aligned within 30° of the final approach course
- Segment begins when
  - you are proceeding inbound to the FAF,
  - are properly aligned with the final approach course, and
  - are located within the prescribed distance before the FAF
- May not be charted –
  - Approach with a procedure turn is the most common example of an uncharted IF
    - intermediate segment begins when you intercept the inbound course after completing the procedure turn
- Ends at beginning of Final approach

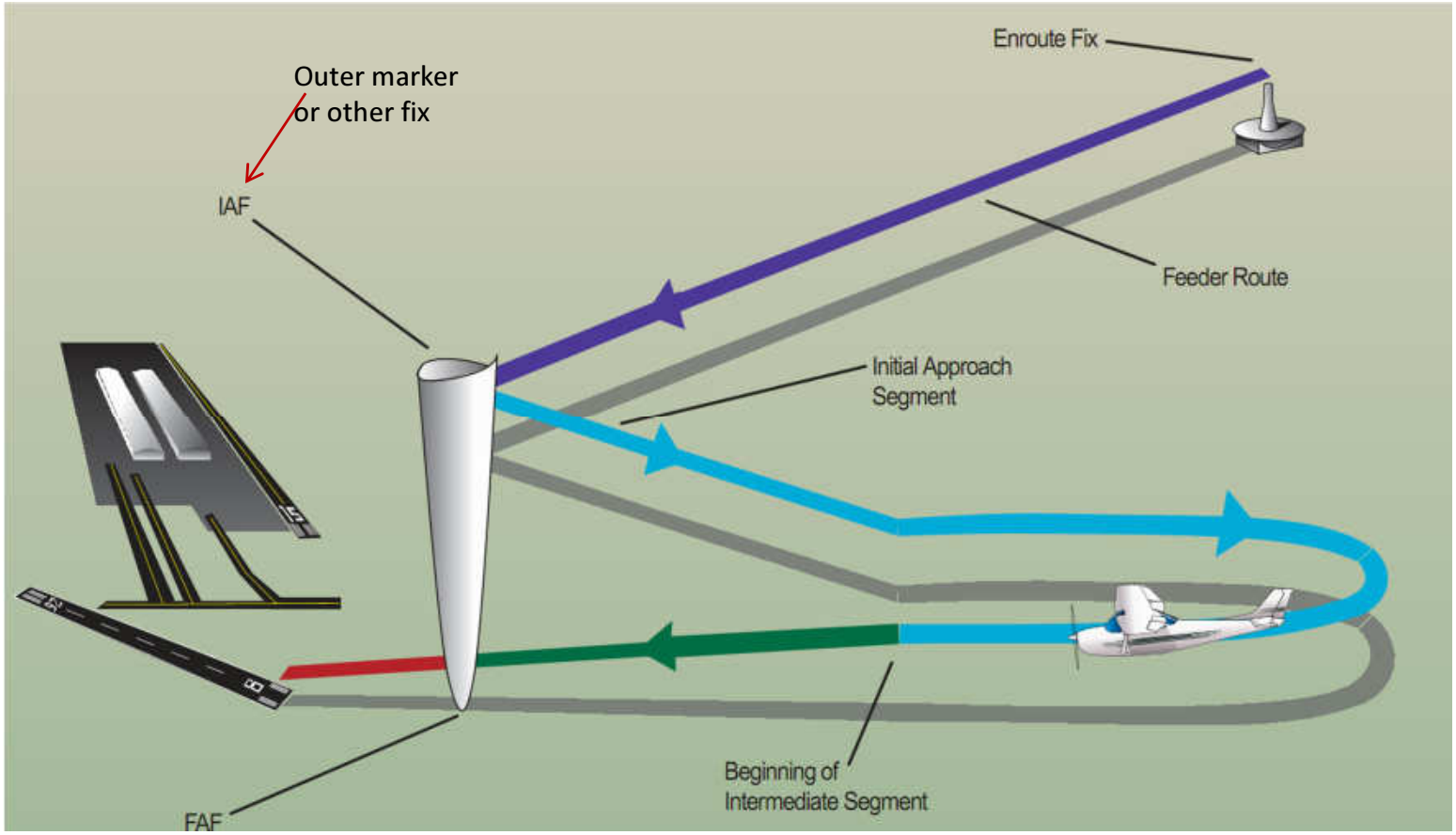
Let's Fly – Final Segment



Starting the Approach

- Final approach segment begins at a designated FAF, depicted as a Maltese cross (X) on the profile view, or at the point where the aircraft is established inbound on the final approach course
- Mandatory ATC report
  - When leaving the FAF
  - When you go missed in non-radar environment

Let’s Fly Approach Segments



Before the Initial Segment

- Preflight – Plan the approach – Must be familiar with “all available information concerning a flight” prior to departure and FDC Notams
- Enroute – Get weather (ATIS, FSS information, etc.) to help determine likely approaches and review
- Calculate / review performance data, approach speeds, and power settings – confirm aircraft and weather are appropriate for the ILS procedure for aircraft’s certified category or, if higher, the actual speed to be flown
- Set navigation / communication and automation - The navigation equipment required for an approach is generally indicated by the title of the procedure and chart notes

Before the Initial Segment

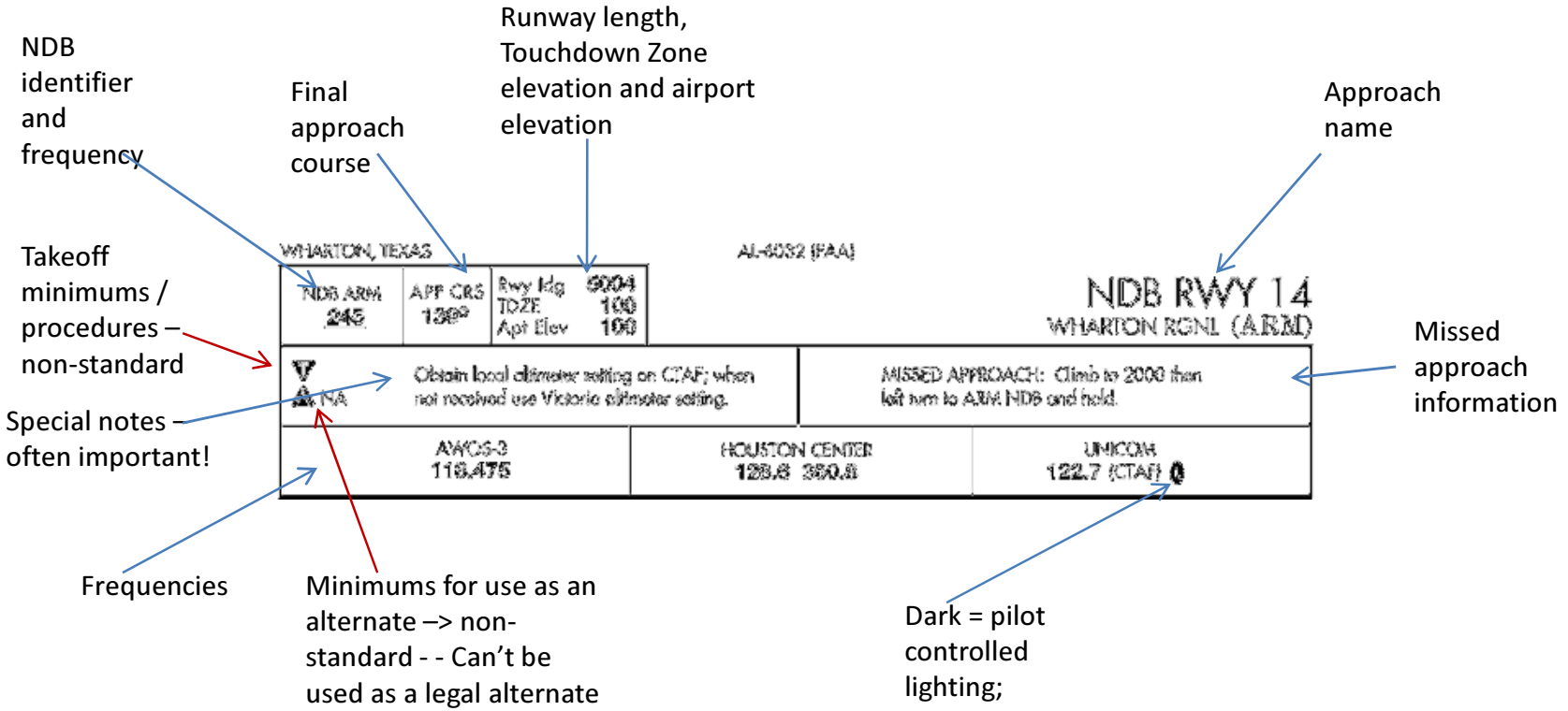
- Review and brief the approach – Don't forget to brief the missed approach
  - Commit to memory
    - Altitude step downs
    - MDA
    - Time from FAF to MAP or DME
      Visibility minimums
    - Missed approach procedure (at least initial steps)
- Begin reducing speed
- Obtain ASOS/ATIS/AWOS on comm 2 – listen in the background
- Note the time you cross the IAF

Initial Segment

- Complete briefing the approach
- Begin landing checklist – complete before final segment
- Reset comm and nav radios with required frequencies
- Comply with the clearance and approach
- Finish reducing power to approach settings (consider wind gusts, shear and turbulence)
- Configure aircraft for landing – Flaps
- Fuel related items set for landing (pumps, mixture, selectors)

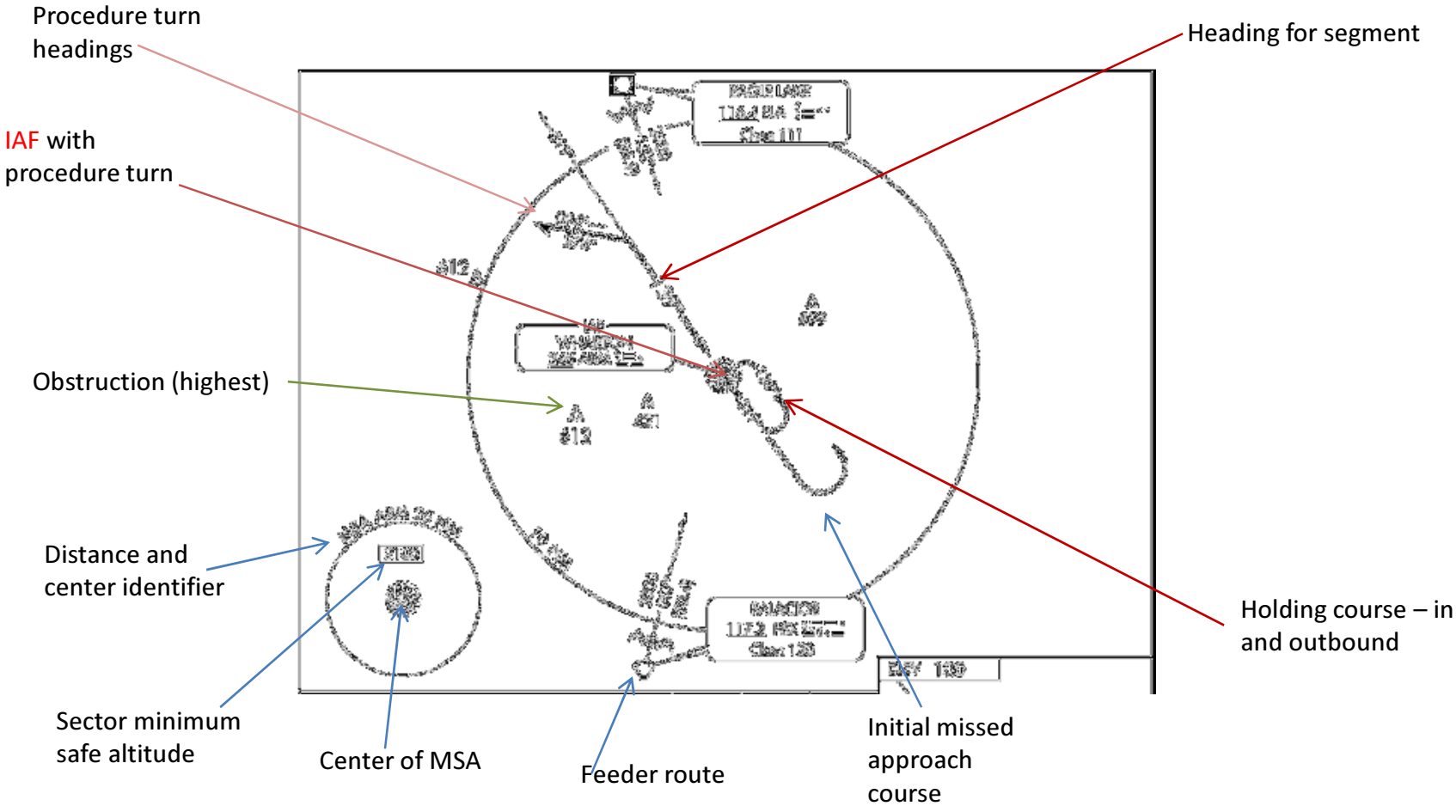
Initial Segment - Briefing

- Brief and review approach to assure you can execute it - Complete before end of segment



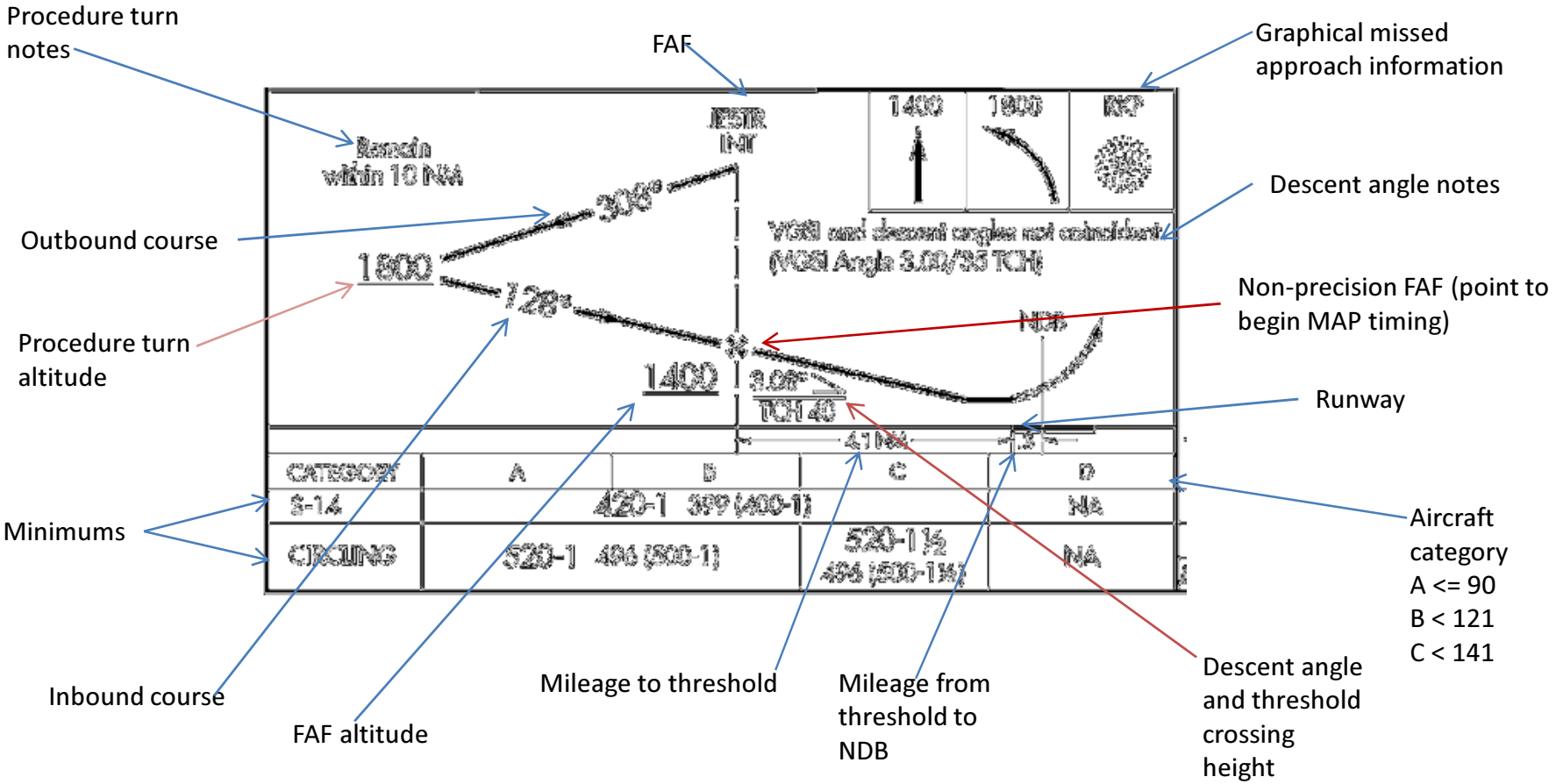
Initial Segment - Briefing

- Plan view – mentally run through the approach



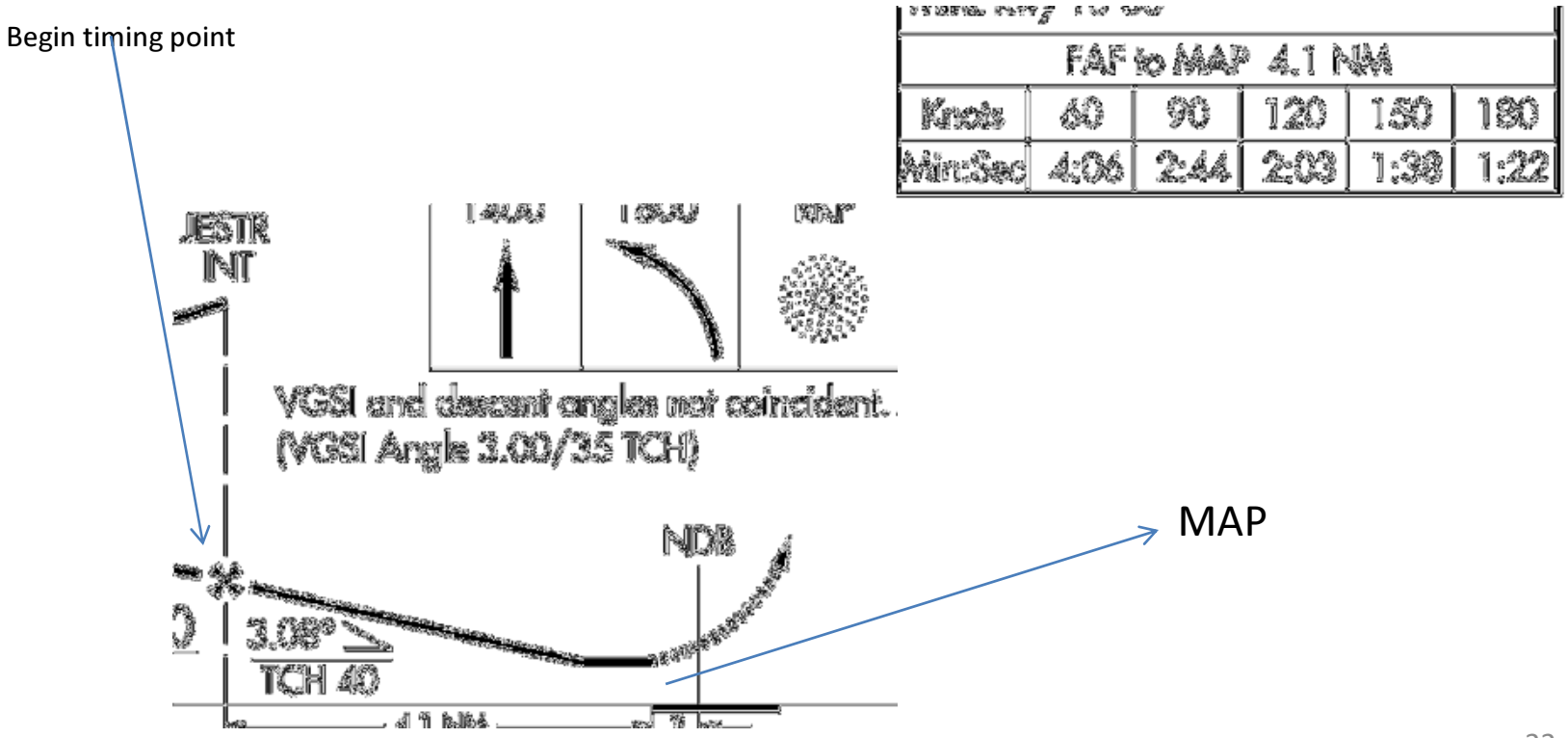
Initial Segment - Briefing

- Profile view – mentally run through the approach

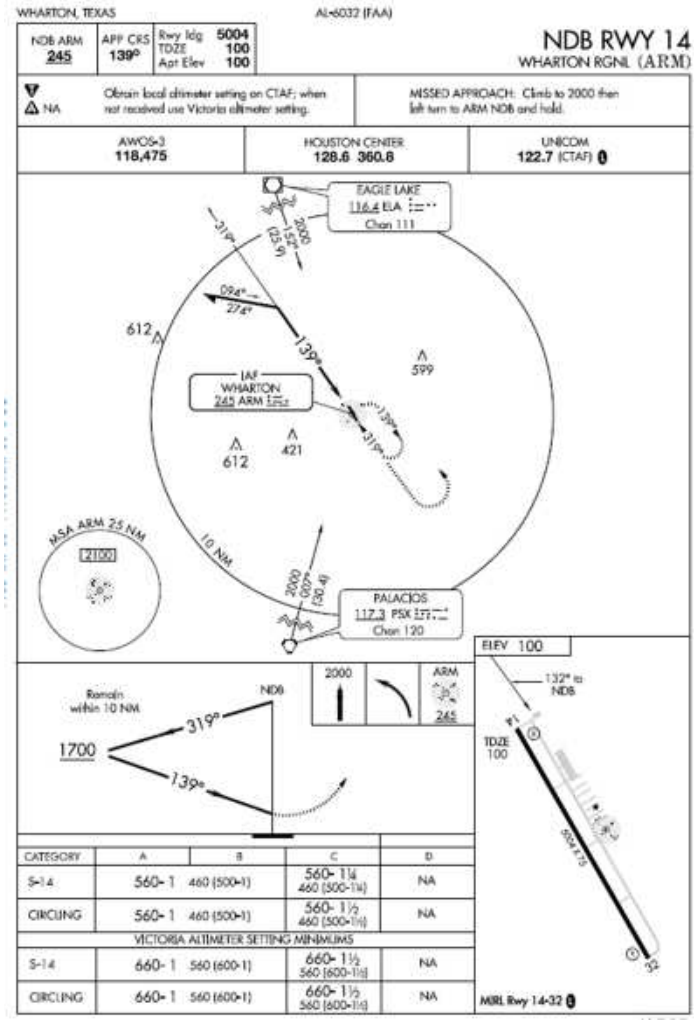


Segment - Briefing

- Missed Approach Timing Information (if ground speed information is unavailable – estimate from airspeed)
  - Add tailwind to airspeed (1/2 wind speed for quartering winds)
  - Subtract headwind from airspeed (1/2 wind speed for quartering winds)

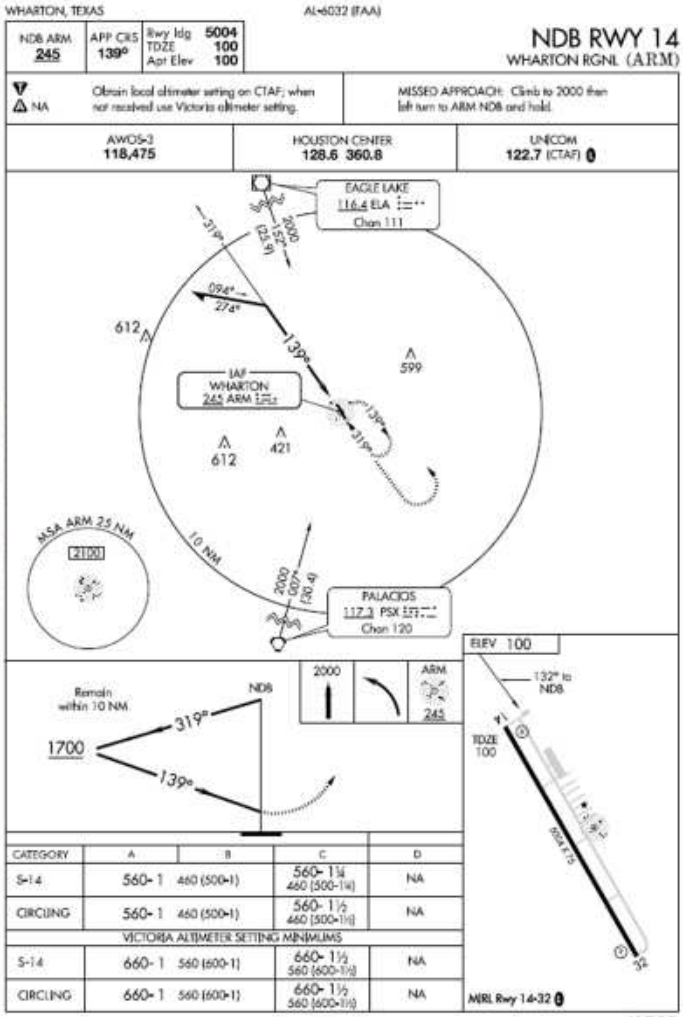


Let's Fly – The Initial Segment



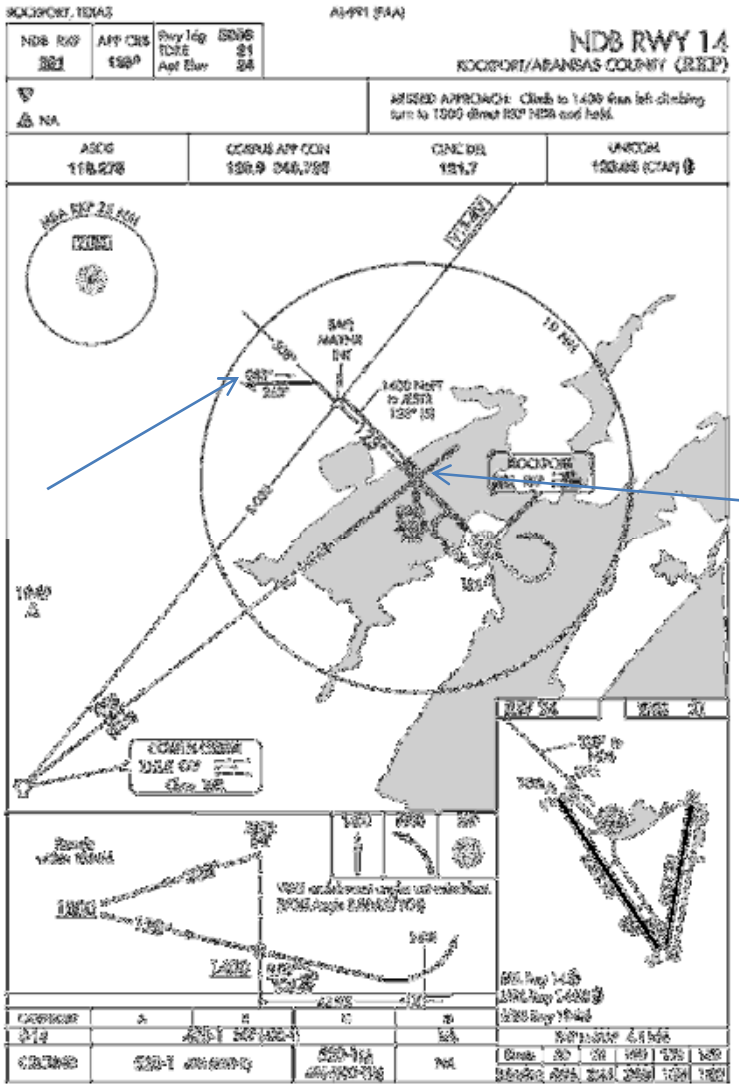
- Radios tuned to NDB to 245
- Confirm Morse code and leave on in the background
- Reduce power to approach setting
- Proceed on feeder at 2,000 feet
- Proceed outbound from the NDB to the procedure turn (1 – 4 minutes depending upon speed and NDB location)
- One minute outbound on procedure turn; Then turn inbound
- As the NDB needle begins to move towards 45 degree intercept angle (note the rate of movement) turn inbound on course (139°) – determine heading to hold with the wind correction angle

NDB Procedures
On-Airport NDB



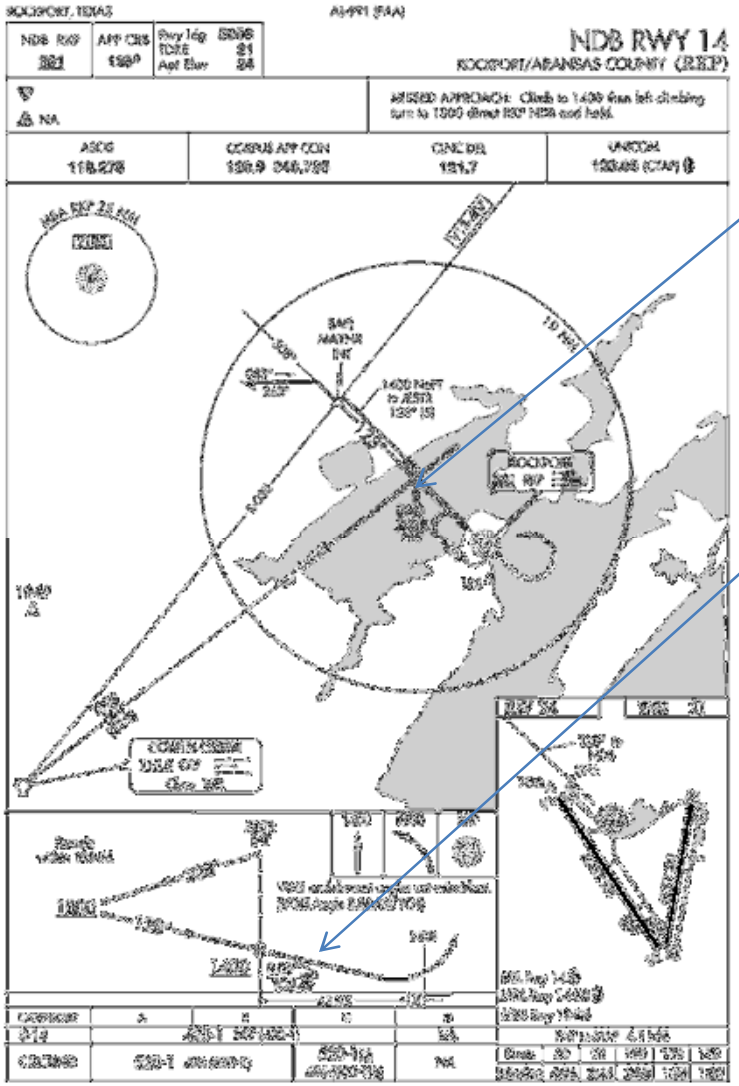
- You can tell NDB is on the airport from the approach chart profile view
- Generally an on airport NDB approach will have no depicted final approach fix. In which case, the final approach segment begins at the final approach point (FAP).
- The FAP is the point where you are established in-bound on the final approach course from the procedure turn/radar vector and can begin the final approach descent
- For a procedure turn fly out 3 to 4 minutes before the procedure turn to assure adequate distance to become established inbound
- The NDB is the MAP – when the needle swings 180° – no timing

Let's Fly – The Intermediate Segment



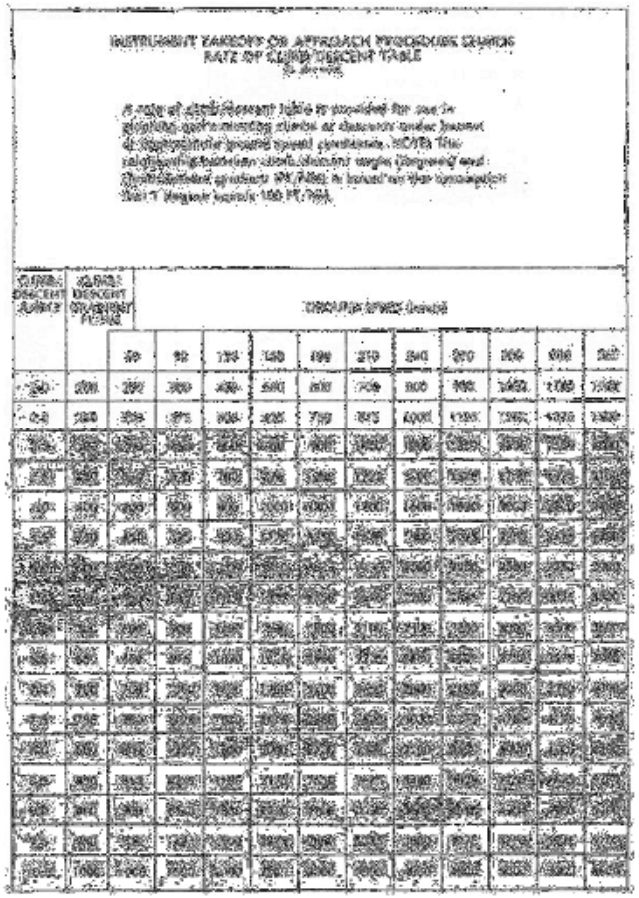
- Switch to local frequency WHEN INSTRUCTED
- Complete landing checklist as much as possible
- You are now at the final segment!

Let's Fly – The Final Segment



- At FAF (JESTR) start timing for missed approach (timing is based upon ground speed)
- Expeditious but safe descent (gen <700 ft min @ 90 kts) – However, if there is an angle of descent, you should calculate the corresponding rate of descent (inside back cover of TERPS)
- Maintain a constant speed – level and descending
- FAF inbound report to ATC required in non-radar environment
- Likely to be told to switch to local frequency – swap comm
- Confirm gear down
- Second notch flaps – Check in white arc

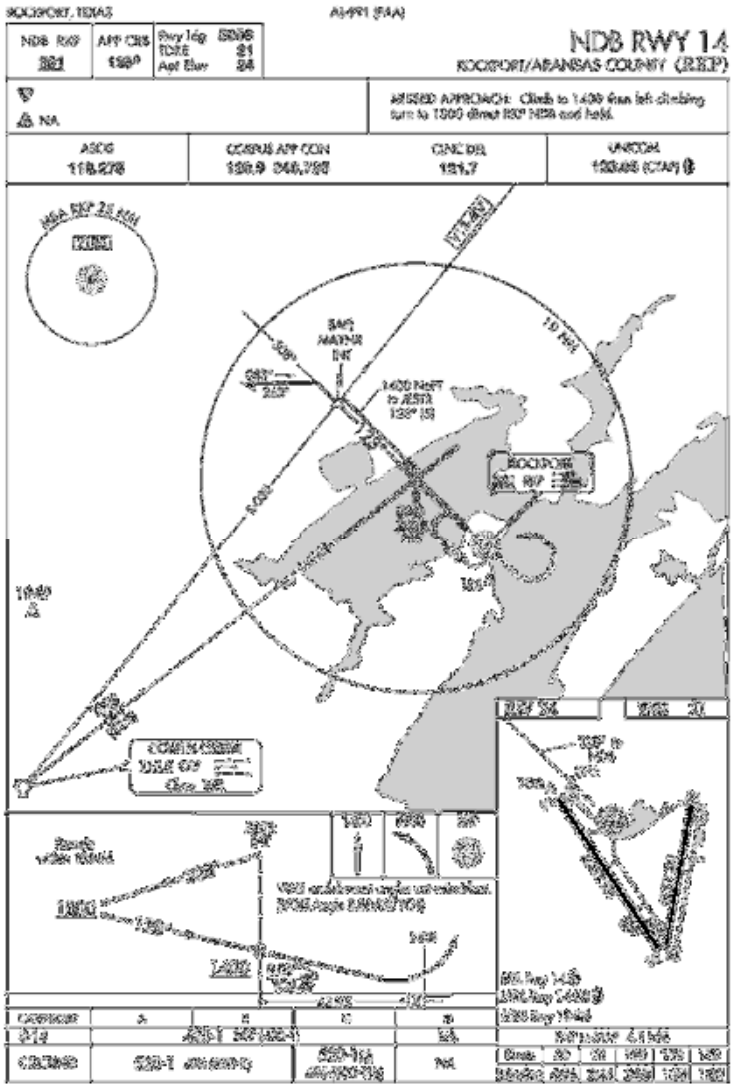
Rate of Descent Table



INSTRUMENT GLIDESLOPE OR APPROACH PROCEDURE GUIDED
RATE OF CLIMB/DESCENT TABLE

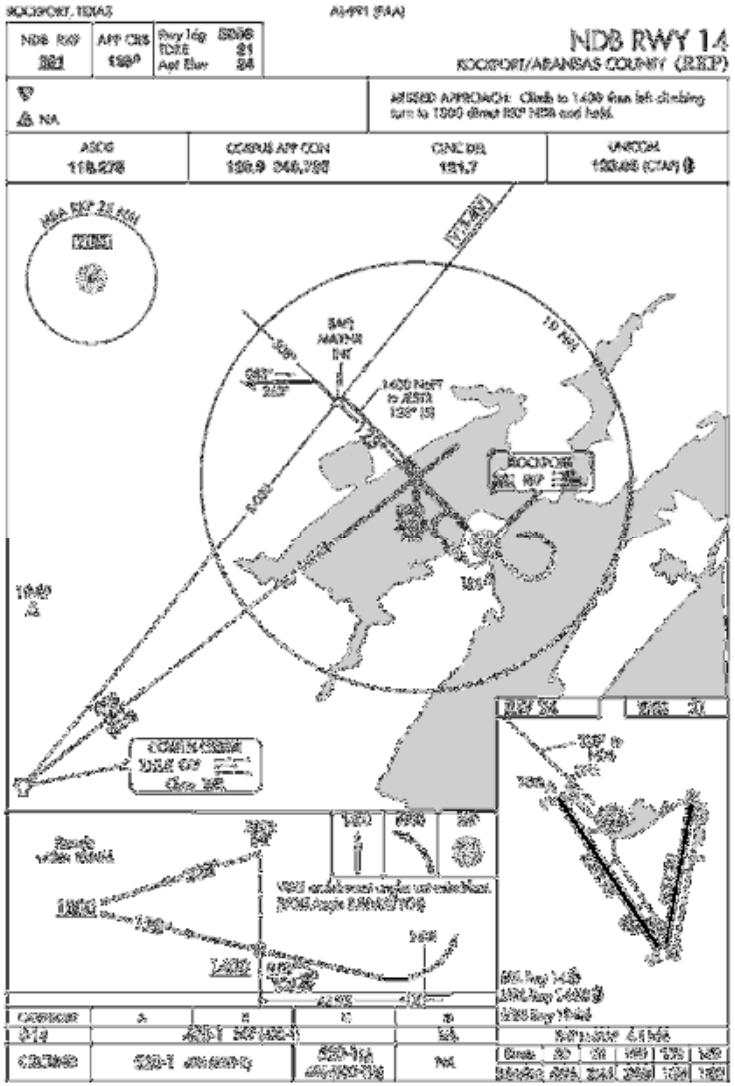
CLIMB/DESCENT ANGLE	CLIMB/DESCENT GUIDANCE FPM	GROUND SPEED (knots)										
		60	90	120	150	180	210	240	270	300	330	360
2.50	200	300	450	600	750	900	1050	1200	1350	1500	1650	1800
2.75	220	330	495	660	825	990	1155	1320	1485	1650	1815	1980
3.00	240	360	540	720	900	1080	1260	1440	1620	1800	1980	2160
3.25	260	390	585	780	975	1170	1365	1560	1755	1950	2145	2340
3.50	280	420	630	840	1050	1260	1470	1680	1890	2100	2310	2520
3.75	300	450	675	900	1125	1350	1575	1800	2025	2250	2475	2700
4.00	320	480	720	960	1200	1440	1680	1920	2160	2400	2640	2880
4.25	340	510	765	1020	1275	1530	1785	2040	2295	2550	2805	3060
4.50	360	540	810	1080	1350	1620	1890	2160	2430	2700	2970	3240
4.75	380	570	855	1140	1425	1710	1995	2280	2565	2850	3135	3420
5.00	400	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600
5.25	420	630	945	1260	1575	1890	2205	2520	2835	3150	3465	3780
5.50	440	660	990	1320	1650	1980	2310	2640	2970	3300	3630	3960
5.75	460	690	1035	1380	1725	2070	2415	2760	3105	3450	3795	4140
6.00	480	720	1080	1440	1800	2160	2520	2880	3240	3600	3960	4320
6.25	500	750	1125	1500	1875	2250	2625	3000	3375	3750	4125	4500
6.50	520	780	1170	1560	1950	2340	2730	3120	3510	3900	4290	4680
6.75	540	810	1215	1620	2025	2430	2835	3240	3645	4050	4455	4860
7.00	560	840	1260	1680	2100	2520	2940	3360	3780	4200	4620	5040
7.25	580	870	1305	1740	2175	2610	3045	3480	3915	4350	4785	5220
7.50	600	900	1350	1800	2250	2700	3150	3600	4050	4500	4950	5400
7.75	620	930	1395	1860	2325	2790	3255	3720	4185	4650	5115	5580
8.00	640	960	1440	1920	2400	2880	3360	3840	4320	4800	5280	5760

Let's Fly – The Final Segment



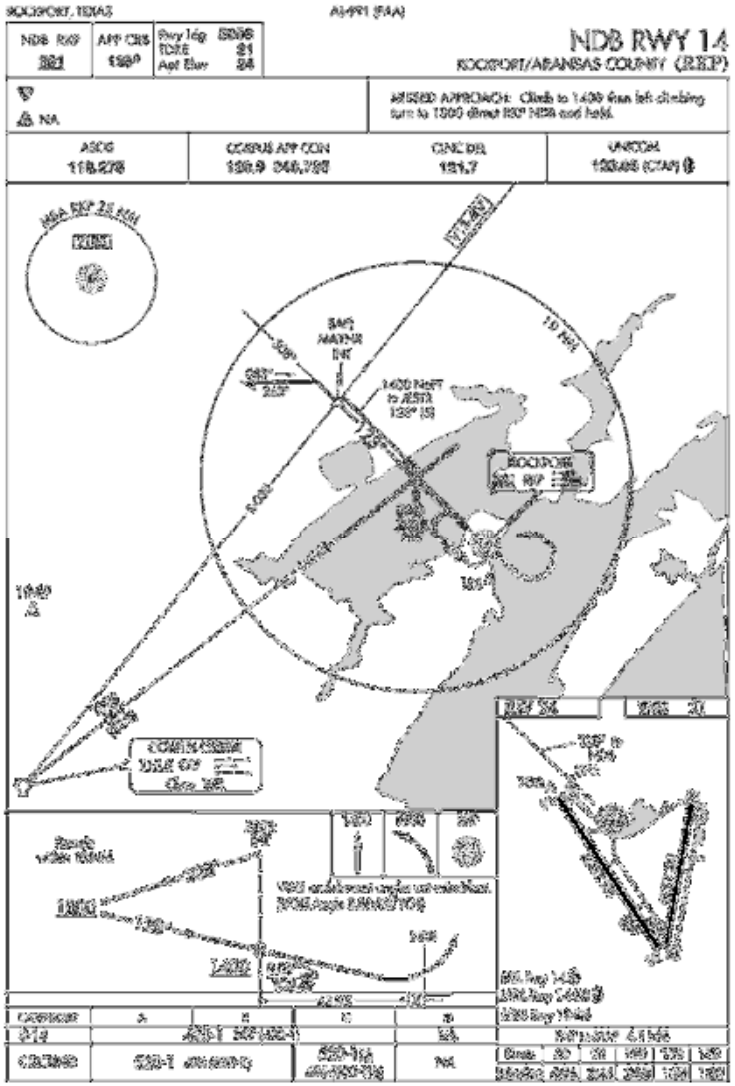
- Final speed reduction
- Glance out the window to look for the runway environment
- Begin level off about 100' before you reach the MDA 420'
- Airport Communications
  - Tower
  - Non-towered airport – Broadcast your intentions on the CTAF
    - Approach you are executing
    - Your position (every mile for last 5 miles)
    - Arrival over the FAF inbound
    - Missed approach

Let's Fly – The Final Segment



- If you now have an identifiable segment of the approach environment unmistakably visible and identifiable you may continue the approach if:
  - Visibility is above the minimums for approach category
  - You are in a position to make a normal descent to the intended runway using normal maneuvers
  - FAR 91.175
- If not, commence missed approach turn - do not turn out early
- MAP identified by
  - Needle swing 180°
  - Time from NDB
  - Other – e.g. cross radial

Let's Fly – The Final Segment

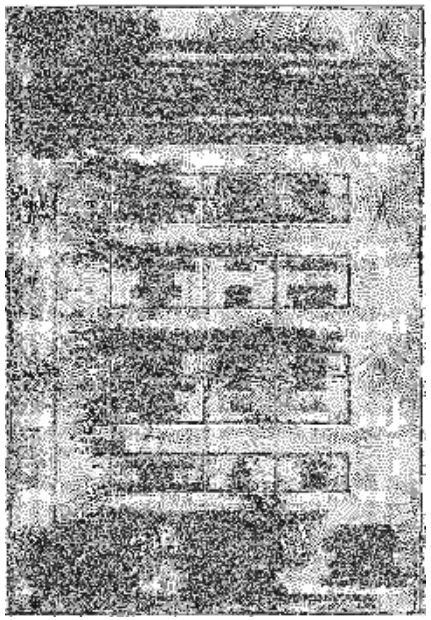


- Commence circle to land
- When aligned with final, drop full flaps and land
- At MAP:
  - Runway environment in sight
  - Visibility above minimums
  - Able to make a normal descent to intended runway

NDB Approach Problems

- Report any instrument or communication malfunctions to ATC
- If signal loss or interference at any time, go missed but follow the course - do not turn out early

- Inoperative components
  - No change in MDA
  - Increase visibility requirements – ¼ to ½ sm



Considerations

- If you are low generally do NOT climb – level off and re-intercept
- Make small adjustments – see what happens and readjust
- Remember sensitivity increases as you get near the NDB
- DO NOT FLY NDB needle – bad things will happen! FLY the DG and AI
- With aircraft properly trimmed small changes in power will cause a pitch change and allow you to maintain airspeed
- Must execute missed after the MAP if you lose sighting of the runway environment

- Runway environment
  - Approach lighting system – not below 100’ AGL until you see red side lights or red terminating bar
  - Runway or runway markings or lights
  - Threshold, threshold markings or lighting
  - REILS
  - VASI
  - Touchdown zone or markings or lighting
- Know for the approach
  - IAF and how to arrive at the FAF
  - Minimum altitudes for each segment and MDA
  - Missed approach procedure

Common Errors

- Failure to have essential approach information in memory
  - IAF
  - FAF
  - Altitudes, including MDA
  - MAP
- Poor communications
- Failure to complete checklist items or use checklist
- Descent below altitudes (keep a cushion on checkride)

QUESTIONS