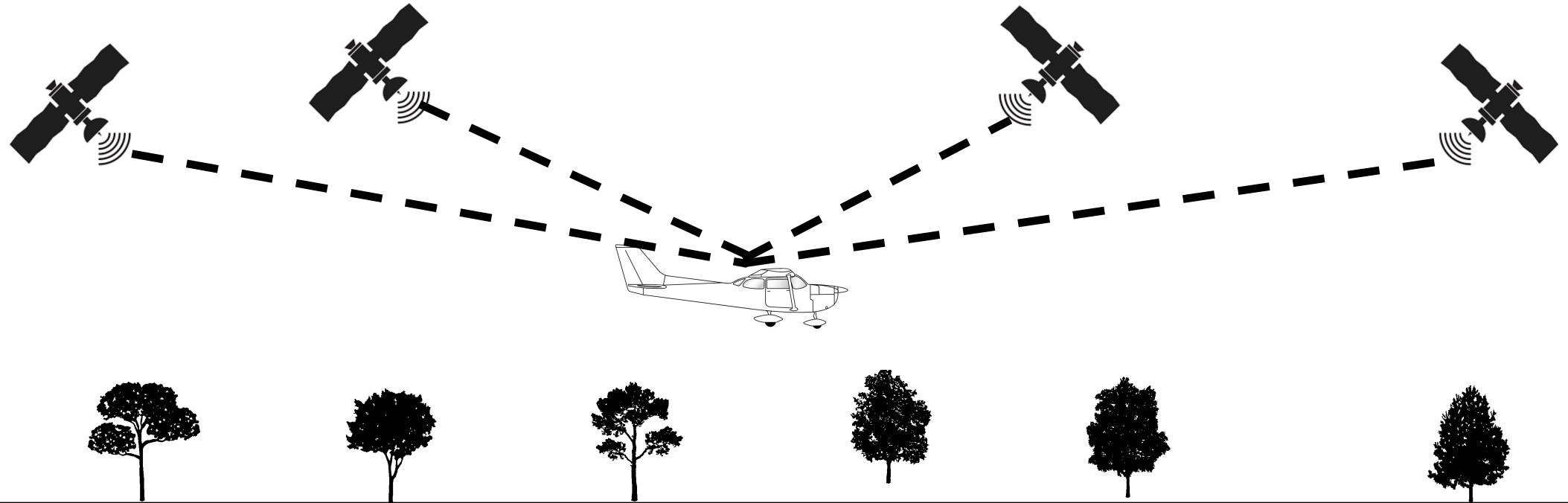
GPS Approaches

Instrument Rating

GPS Principles

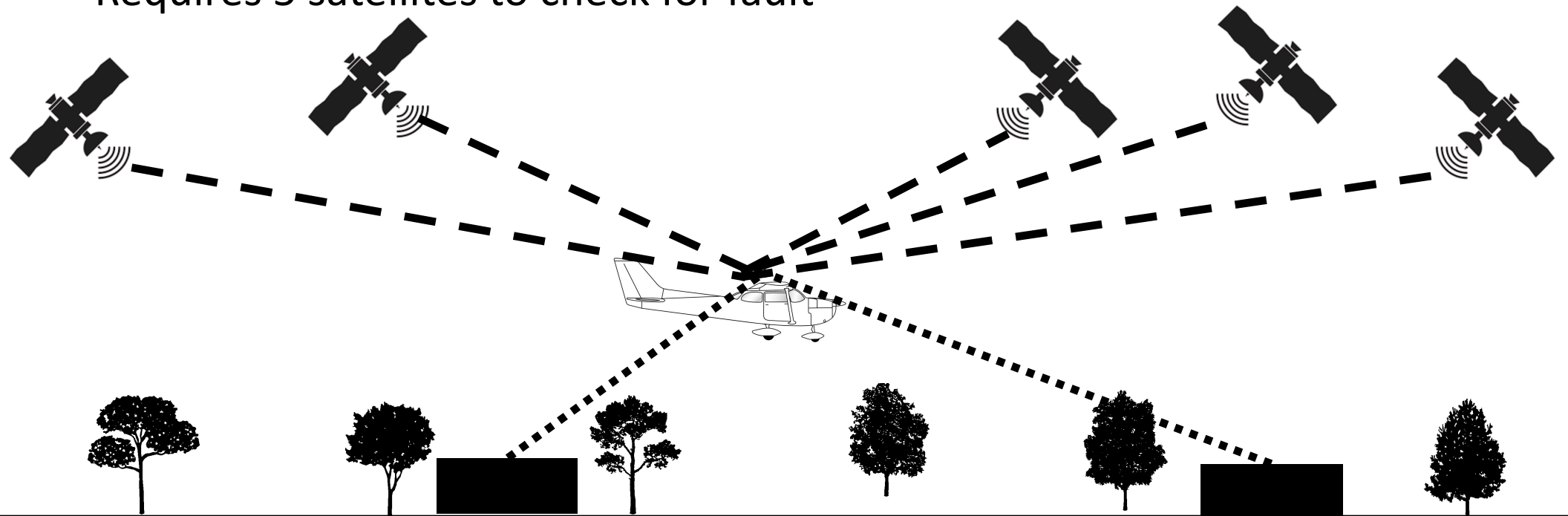
- The Global Positioning System (GPS) consists of 31 satellites that orbit the Earth at ~11,000 miles
- 3 satellites signals are required for 2D triangulation
- 4 satellites signals are required for 3D triangulation



EyeFlyMD.com

WAAS and RAIM

- WAAS – Wide Area Augmentation System
  - Uses a network of ground-based reference stations
- RAIM – Receiver Autonomous Integrity Monitoring
  - Assesses the integrity of GPS signals
  - Requires 5 satellites to check for fault



Terms

- Angular vs. Linear Guidance
  - Linear Guidance – course sensitivity is constant
  - Angular Guidance – course sensitivity increase closer to the runway (like an ILS)
- MDA – Minimum Descent Altitude
  - The lowest altitude (in MSL) to which a descent is authorized...in execution of a standard instrument approach procedure, *where no electronic glideslope is provided*.
  - Absolute minimum

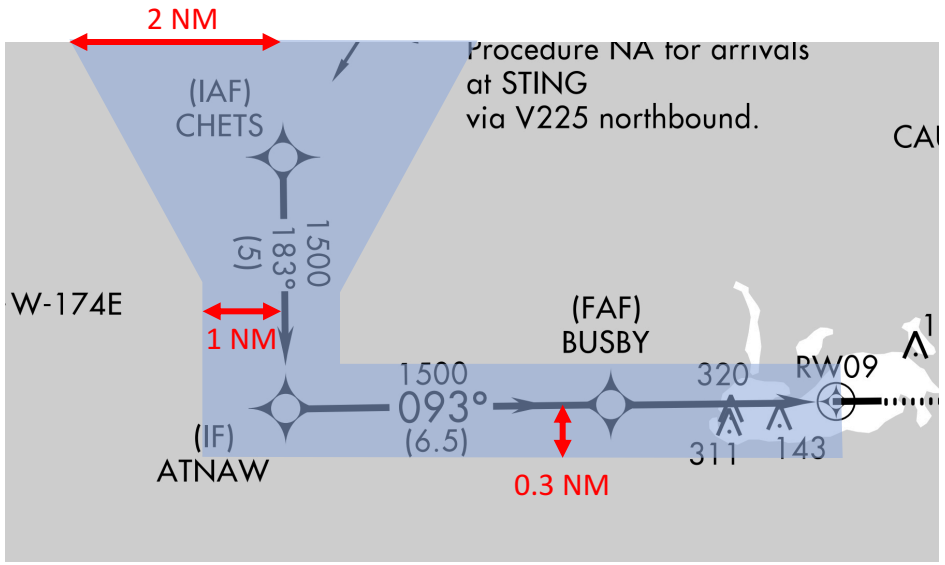
LNAV MDA

- DA – Decision Altitude
  - A specified altitude in the approach at which a missed approach must be initiated if the required visual reference *to continue* has not been established.
  - Only applies with vertical guidance
  - You make the "continue-to-land" or "go missed" decision at DA while on the glideslope

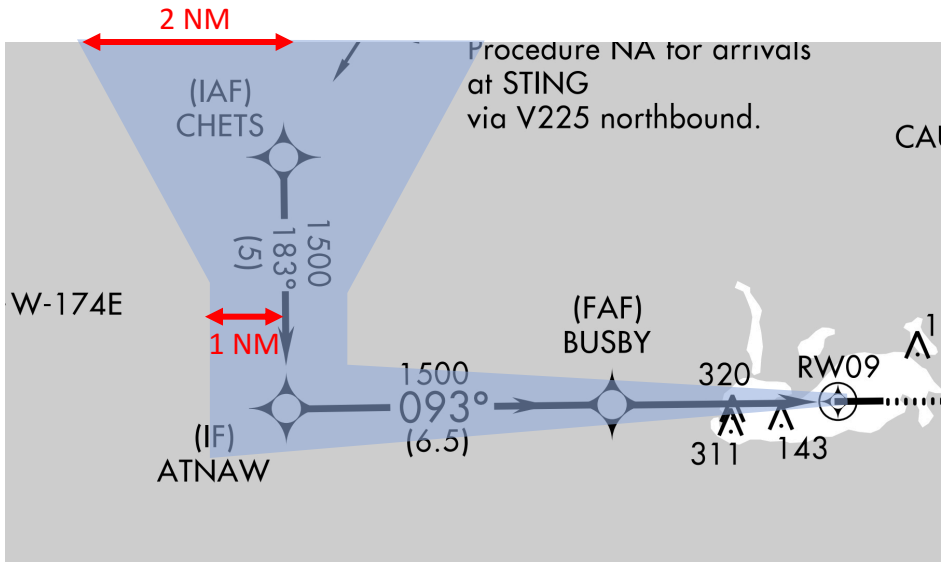
LPV DA

- VDP – Visual Descent Point
  - Defined point on the final approach course of a non-precision straight-in approach procedure from which *normal descent from the MDA* to the runway touchdown point may be commenced

Angular vs. Linear Guidance



Decreases to 0.3 NM sensitivity within 2 miles of the FAF until approach point.



Decreases to similar angular scaling within 2 miles of the FAF before becoming fixed scaling near the runway.

Flight Stage	Full Scale CDI Deflection
Enroute (>30 NM)	2 NM (5 NM for non-WAAS)
Terminal (2 NM from FAF)	1 NM
Approach (FAF)	0.3 NM

Types of GPS Approaches

Approach Type	Vertical Guidance?	WAAS	Course Guidance	Minimums	Explanation
LNAV	No	No	Linear	400 MDA	Simple lateral GPS navigation
LP	No	Yes	Angular	300 MDA	GPS navigation like a localizer
LNAV + V	Yes	Yes	Angular	400 MDA	Lateral navigation + a programed vertical glideslope
LNAV/VNAV	Yes	Yes	Angular	350 DA	Lateral navigation + Baro- or WAAS- aided vertical guidance
LPV	Yes	Yes	Angular	200 MDA	Lateral navigation + a precise WAAS glideslope

LNAV = Lateral Navigation
LP = Localizer Performance
LNAV + V = Lateral Navigation + Advisory Glideslope
LNAV/VNAV = Lateral Navigation + Vertical Navigation
LPV = Localizer Performance with Vertical Guidance

Types of GPS Approaches

Approach Type	Vertical Guidance?	WAAS	Course Guidance	Minimums	Explanation
LNAV	No	No	Linear	400 MDA	Simple lateral GPS navigation
LP	No	Yes	Angular	300 MDA	GPS navigation like a localizer
LNAV + V	Yes	Yes	Angular	400 MDA	Lateral navigation + a programed vertical glideslope
LNAV/VNAV	Yes	Yes	Angular	350 DA	Lateral navigation + Baro- or WAAS- aided vertical guidance
LPV	Yes	Yes	Angular	200 MDA	Lateral navigation + a precise WAAS glideslope

LNAV = Lateral Navigation
LP = Localizer Performance
LNAV + V = Lateral Navigation + Advisory Glideslope
LNAV/VNAV = Lateral Navigation + Vertical Navigation
LPV = Localizer Performance with Vertical Guidance

Types of GPS Approaches

For example, the KLN94 is Baro-Aided

The GTN650 is WAAS

RNAV

- Area Navigation
- “method of navigation that permits aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these” (AIM 1-2-1)
- RNAV (GPS) – Uses the US GPS satellite system
- RNAV (RNP) – Required Navigation Performance (RNP) requires on-board navigation performance monitoring and alerting capability to ensure that the aircraft stays within a specific area
- There are RNAV (GNSS) approaches that use international GPS systems but US registered aircraft aren’t allowed to fly these

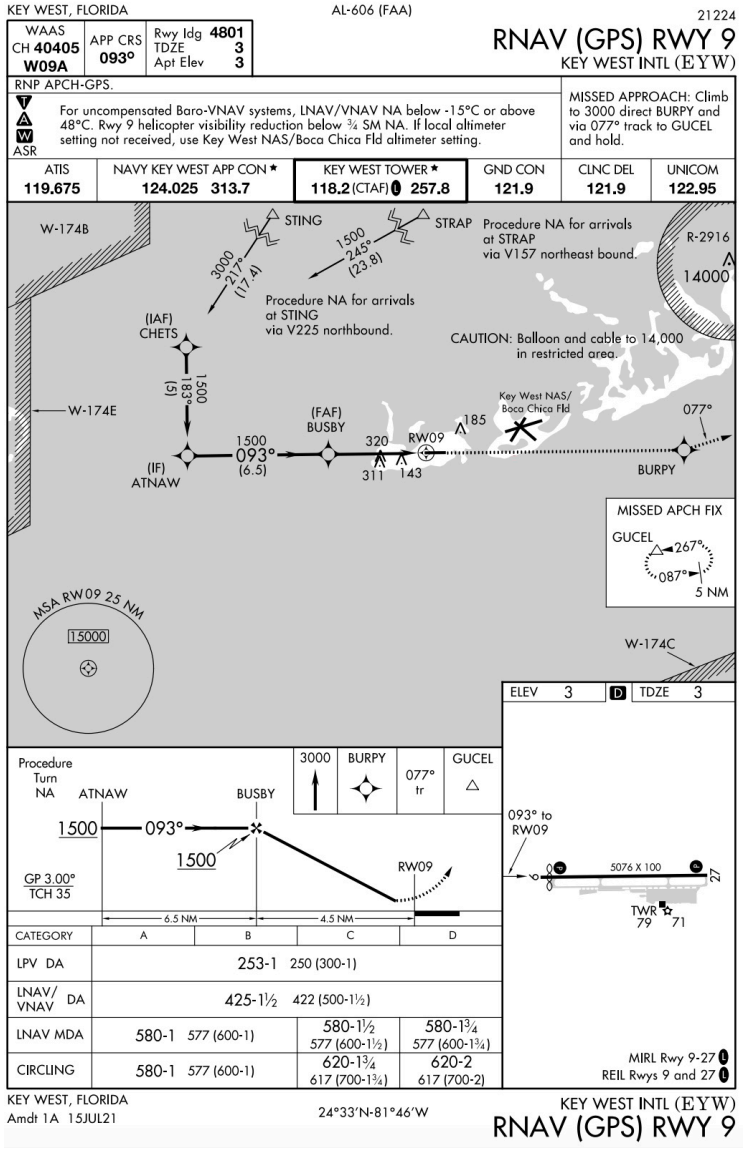
RNAV (GPS)

RNAV (RNP)

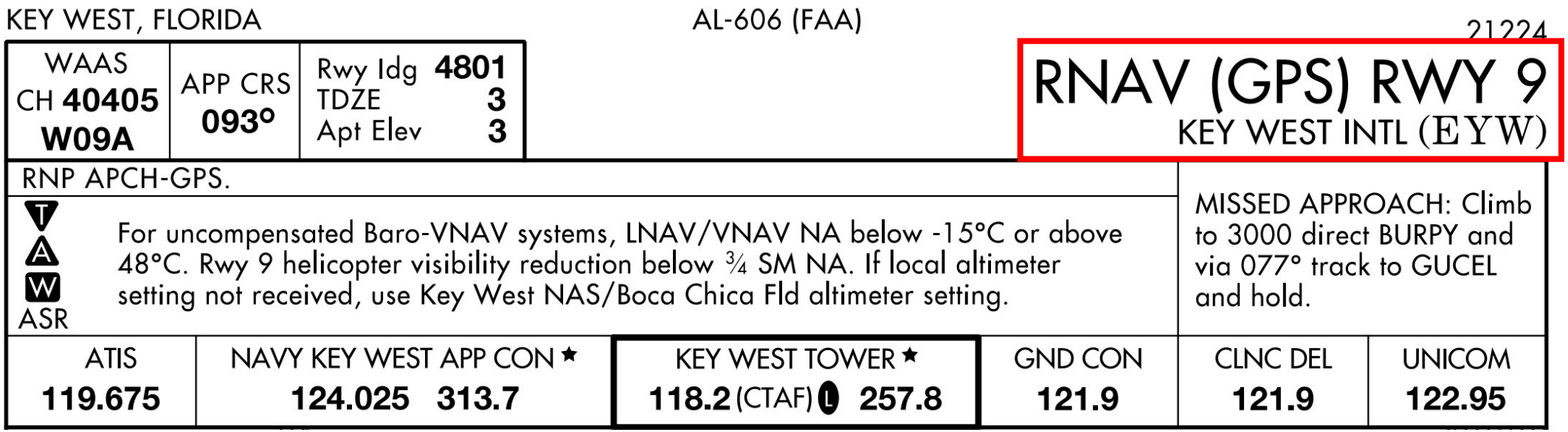
RNP 0.10 DA	
RNP 0.30 DA	

Approach Plate Example

Let's Brief It



Approach Plate Example



KEY WEST, FLORIDA

AL-606 (FAA)

21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

T A W ASR

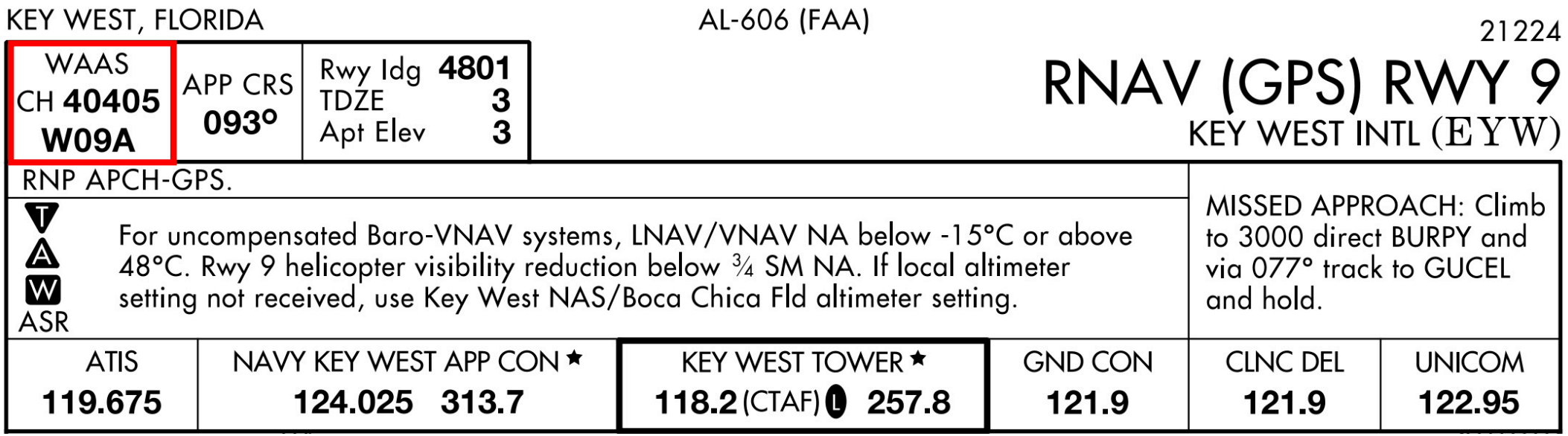
For uncompensated Baro-VNAV systems, LNAV/VNAV NA below -15°C or above 48°C. Rwy 9 helicopter visibility reduction below ¾ SM NA. If local altimeter setting not received, use Key West NAS/Boca Chica Fld altimeter setting.

MISSED APPROACH: Climb to 3000 direct BURPY and via 077° track to GUCEL and hold.

ATIS	NAVY KEY WEST APP CON ★	KEY WEST TOWER ★	GND CON	CLNC DEL	UNICOM
119.675	124.025 313.7	118.2 (CTAF) L 257.8	121.9	121.9	122.95

This is the RNAV Runway 9 into Key West

Approach Plate Example



KEY WEST, FLORIDA

AL-606 (FAA)

21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

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119.675	124.025 313.7	118.2 (CTAF) L 257.8	121.9	121.9	122.95

It is a WAAS approach

Approach Plate Example

KEY WEST, FLORIDA AL-606 (FAA) 21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

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For uncompensated Baro-VNAV systems, LNAV/VNAV NA below -15°C or above 48°C. Rwy 9 helicopter visibility reduction below ¾ SM NA. If local altimeter setting not received, use Key West NAS/Boca Chica Fld altimeter setting.

MISSED APPROACH: Climb to 3000 direct BURPY and via 077° track to GUCEL and hold.

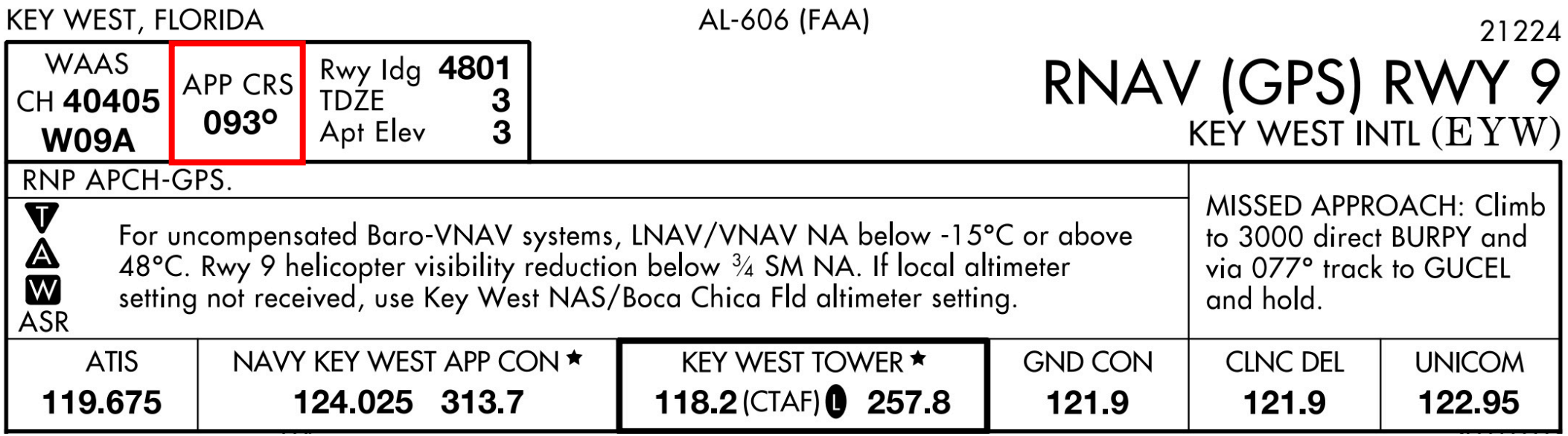
ATIS	NAVY KEY WEST APP CON ★	KEY WEST TOWER ★	GND CON	CLNC DEL	UNICOM
119.675	124.025 313.7	118.2 (CTAF) L 257.8	121.9	121.9	122.95

It is a WAAS approach

Not all of them are…

APP CRS	Rwy Idg 5002
153°	TDZE 488
	Apt Elev 488

Approach Plate Example



KEY WEST, FLORIDA

AL-606 (FAA)

21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg / TDZE / Apt Elev
CH **40405** **W09A**	**093°**	**4801** / **3** / **3**

RNP APCH-GPS.

T A W ASR

For uncompensated Baro-VNAV systems, LNAV/VNAV NA below -15°C or above 48°C. Rwy 9 helicopter visibility reduction below ¾ SM NA. If local altimeter setting not received, use Key West NAS/Boca Chica Fld altimeter setting.

MISSED APPROACH: Climb to 3000 direct BURPY and via 077° track to GUCEL and hold.

ATIS	NAVY KEY WEST APP CON ★	KEY WEST TOWER ★	GND CON	CLNC DEL	UNICOM
119.675	**124.025 313.7**	**118.2** (CTAF) (L) **257.8**	**121.9**	**121.9**	**122.95**

The final approach course is 093°

EyeFlyMD.com

Approach Plate Example

KEY WEST, FLORIDA AL-606 (FAA) 21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

TAW ASR

For uncompensated Baro-VNAV systems, LNAV/VNAV NA below -15°C or above 48°C. Rwy 9 helicopter visibility reduction below ¾ SM NA. If local altimeter setting not received, use Key West NAS/Boca Chica Fld altimeter setting.

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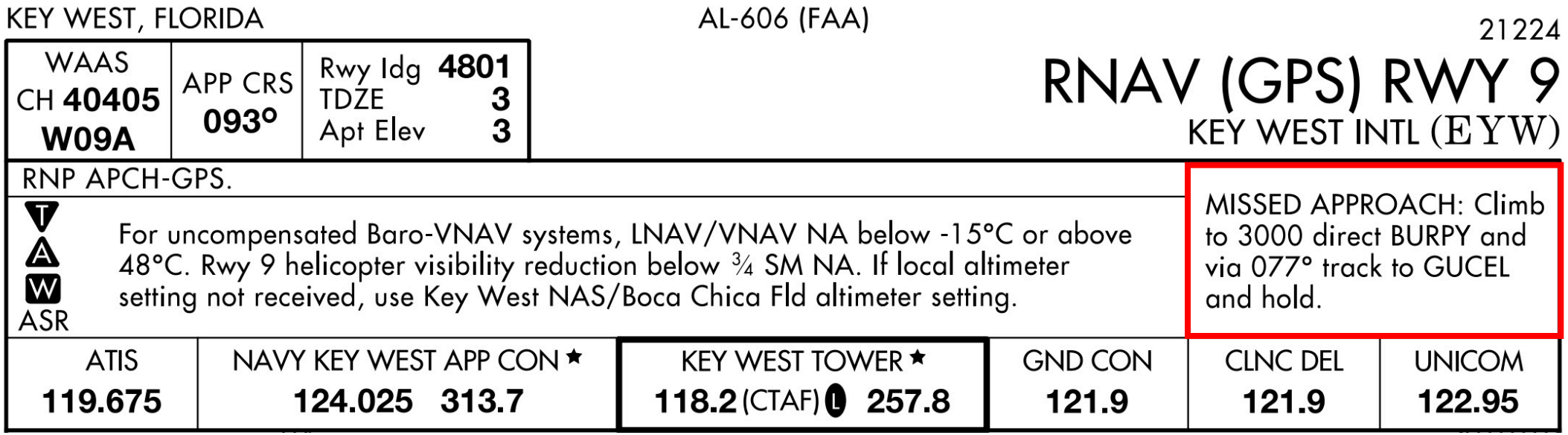
ATIS	NAVY KEY WEST APP CON ★	KEY WEST TOWER ★	GND CON	CLNC DEL	UNICOM
119.675	124.025 313.7	118.2 (CTAF) (L) 257.8	121.9	121.9	122.95

Runway length is 4,801’
Touchdown zone is 3’
Airport elevation is 3’

Approach Plate Example



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AL-606 (FAA)

21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

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CH 40405	093°	TDZE 3
W09A		Apt Elev 3

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ATIS	NAVY KEY WEST APP CON ★	KEY WEST TOWER ★	GND CON	CLNC DEL	UNICOM
119.675	124.025 313.7	118.2 (CTAF) (L) 257.8	121.9	121.9	122.95

For a missed approach we'll climb 3,000' direct to BURPY and then 077° to GUCEL and hold

Approach Plate Example

KEY WEST, FLORIDA

AL-606 (FAA)

21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

TAW ASR

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119.675	124.025 313.7	118.2 (CTAF) L 257.8	121.9	121.9	122.95

ATIS is 119.675

Approach Plate Example

KEY WEST, FLORIDA

AL-606 (FAA)

21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

TAW ASR

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MISSED APPROACH: Climb to 3000 direct BURPY and via 077° track to GUCEL and hold.

ATIS	NAVY KEY WEST APP CON ★	KEY WEST TOWER ★	GND CON	CLNC DEL	UNICOM
119.675	124.025 313.7	118.2 (CTAF) Ⓛ 257.8	121.9	121.9	122.95

Approach is 124.025

Approach Plate Example

KEY WEST, FLORIDA AL-606 (FAA) 21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

TAW ASR

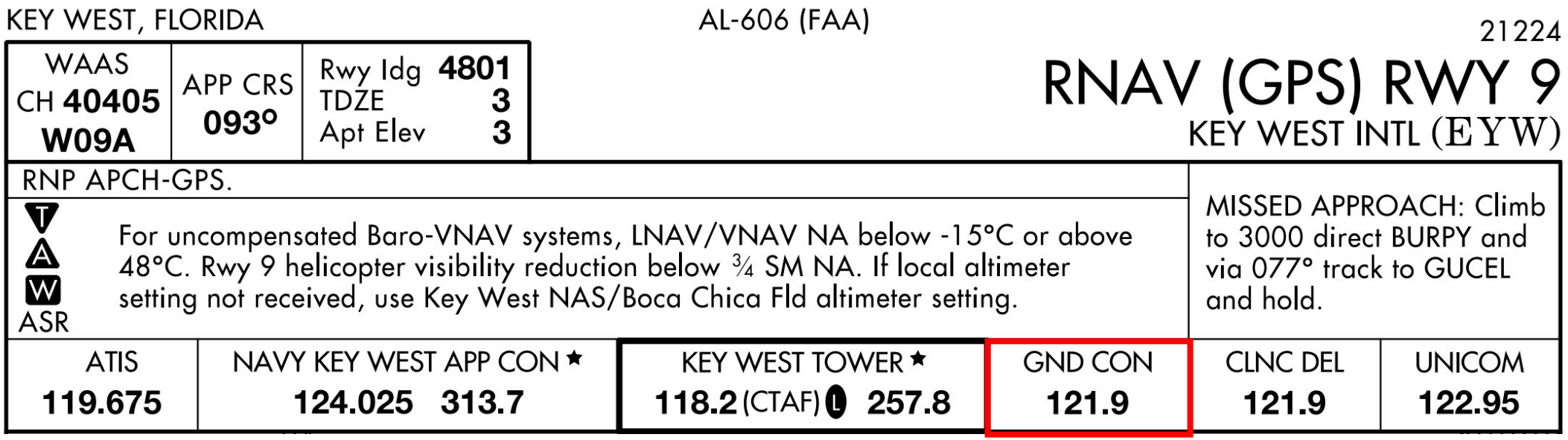
For uncompensated Baro-VNAV systems, LNAV/VNAV NA below -15°C or above 48°C. Rwy 9 helicopter visibility reduction below ¾ SM NA. If local altimeter setting not received, use Key West NAS/Boca Chica Fld altimeter setting.

MISSED APPROACH: Climb to 3000 direct BURPY and via 077° track to GUCEL and hold.

ATIS	NAVY KEY WEST APP CON ★	KEY WEST TOWER ★	GND CON	CLNC DEL	UNICOM
119.675	124.025 313.7	118.2 (CTAF) (L) 257.8	121.9	121.9	122.95

Tower is 118.2

Approach Plate Example



KEY WEST, FLORIDA

AL-606 (FAA)

21224

RNAV (GPS) RWY 9

KEY WEST INTL (EYW)

WAAS	APP CRS	Rwy Idg 4801
CH 40405	093°	TDZE 3
W09A		Apt Elev 3

RNP APCH-GPS.

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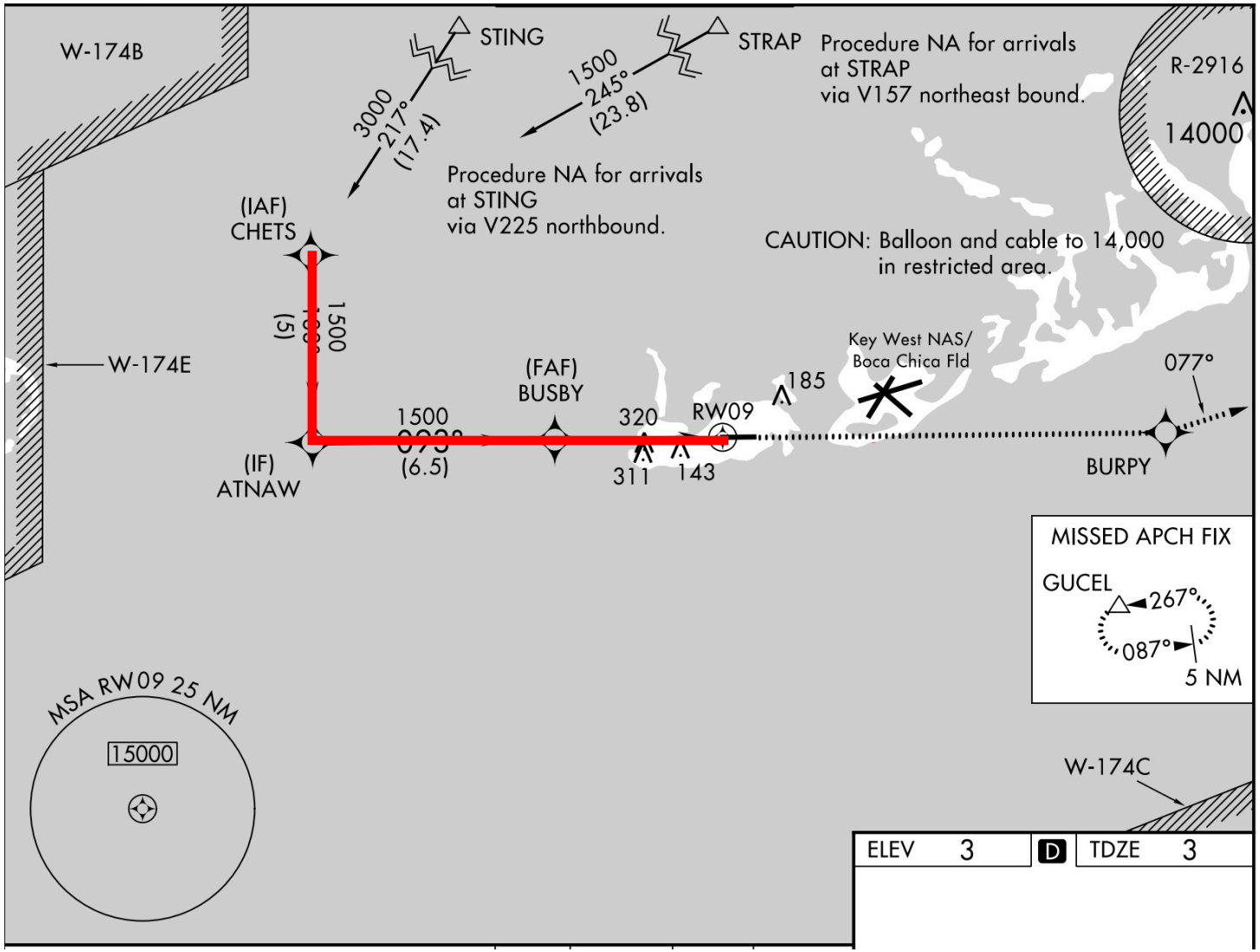
119.675	124.025 313.7	118.2 (CTAF) L 257.8	121.9	121.9	122.95

Ground is 121.9

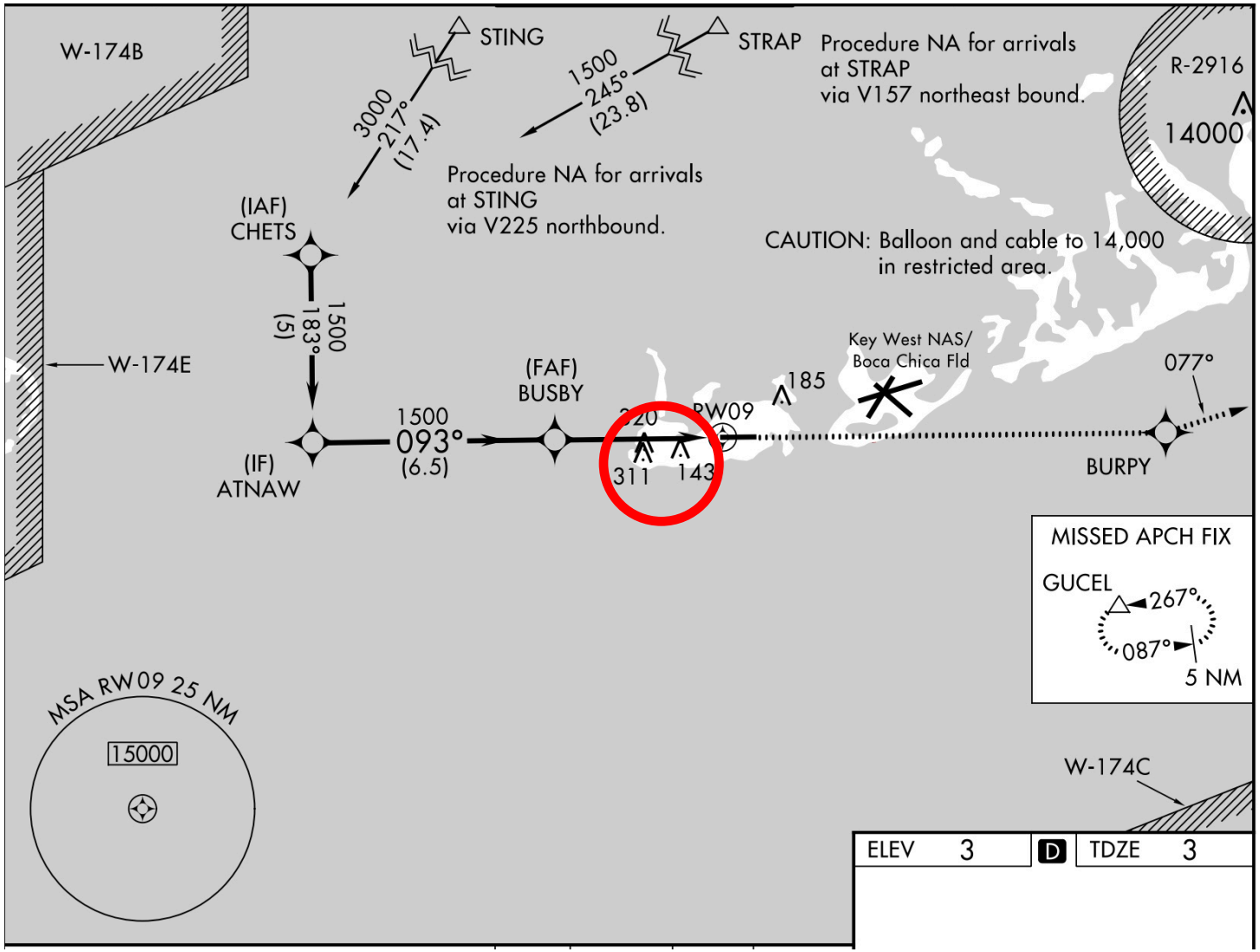
Approach Plate Example

From our IAF of CHETS we'll expect to fly heading 180° then at ATNAW 093° until the runway



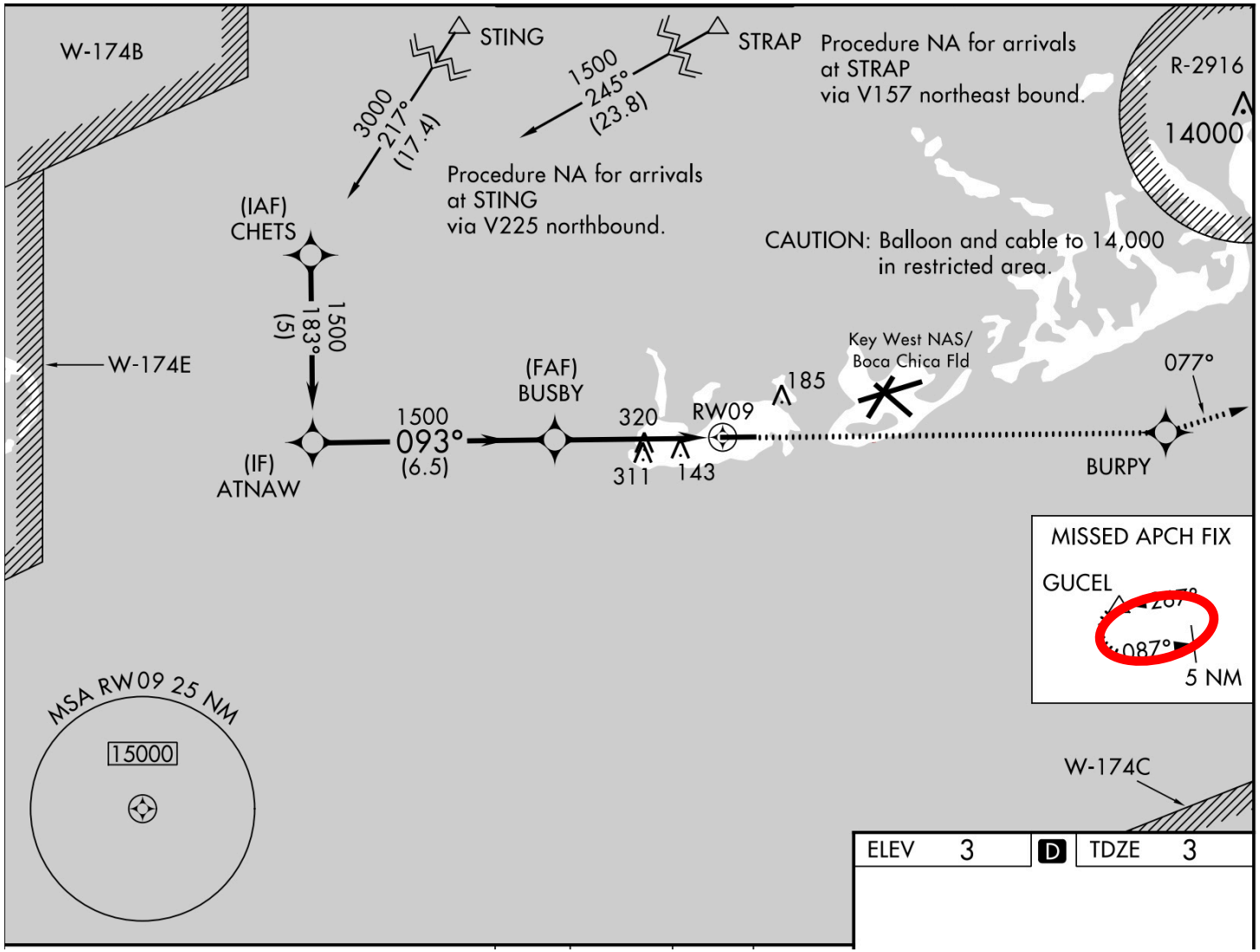
Approach Plate Example

We'll expect some obstacles to the right of the approach path



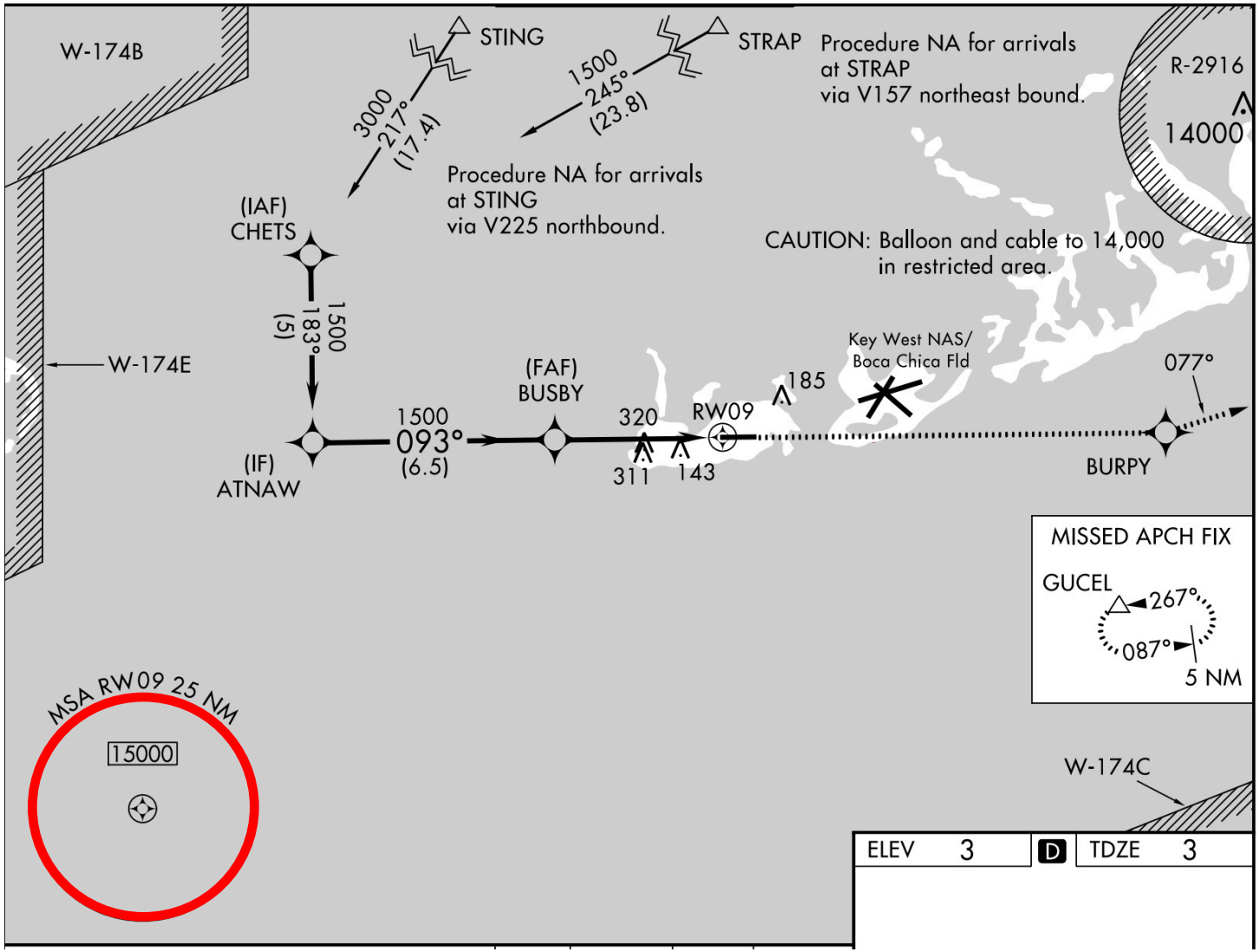
Approach Plate Example

We'll expect a parallel hold entry

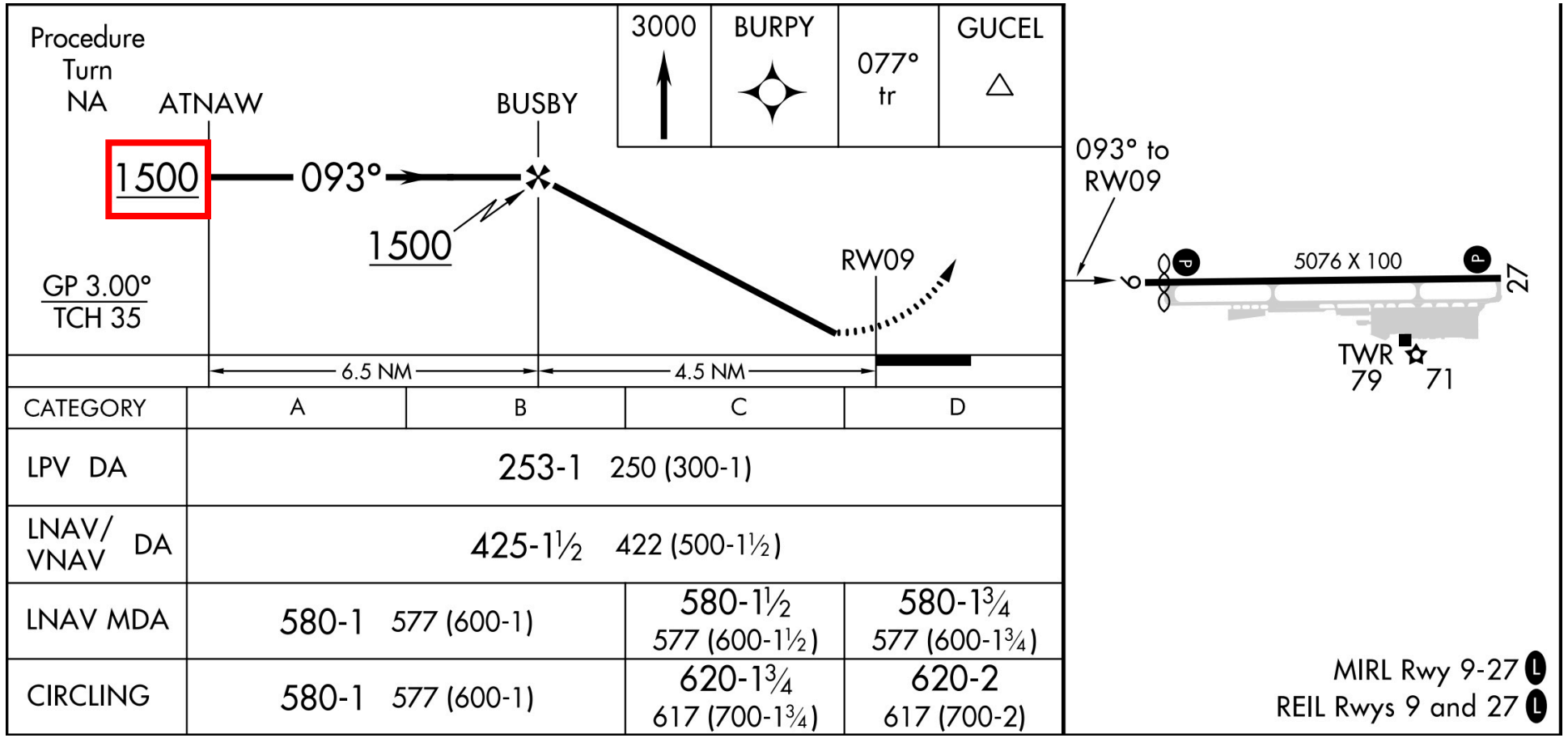


Approach Plate Example

And our MSA is going to be 15,000’



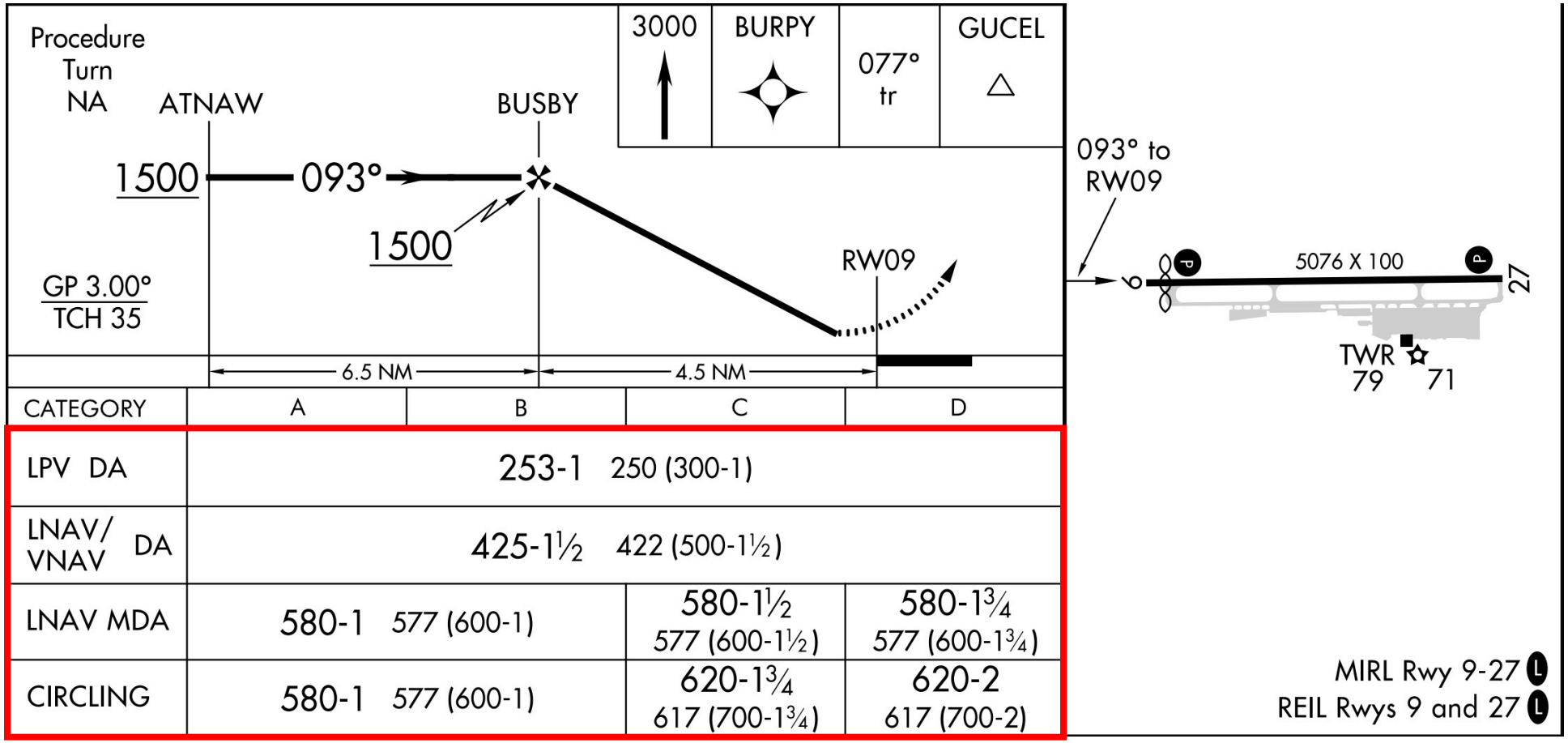
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

We'll expect to say 1,500' or greater until FAF BUSBY

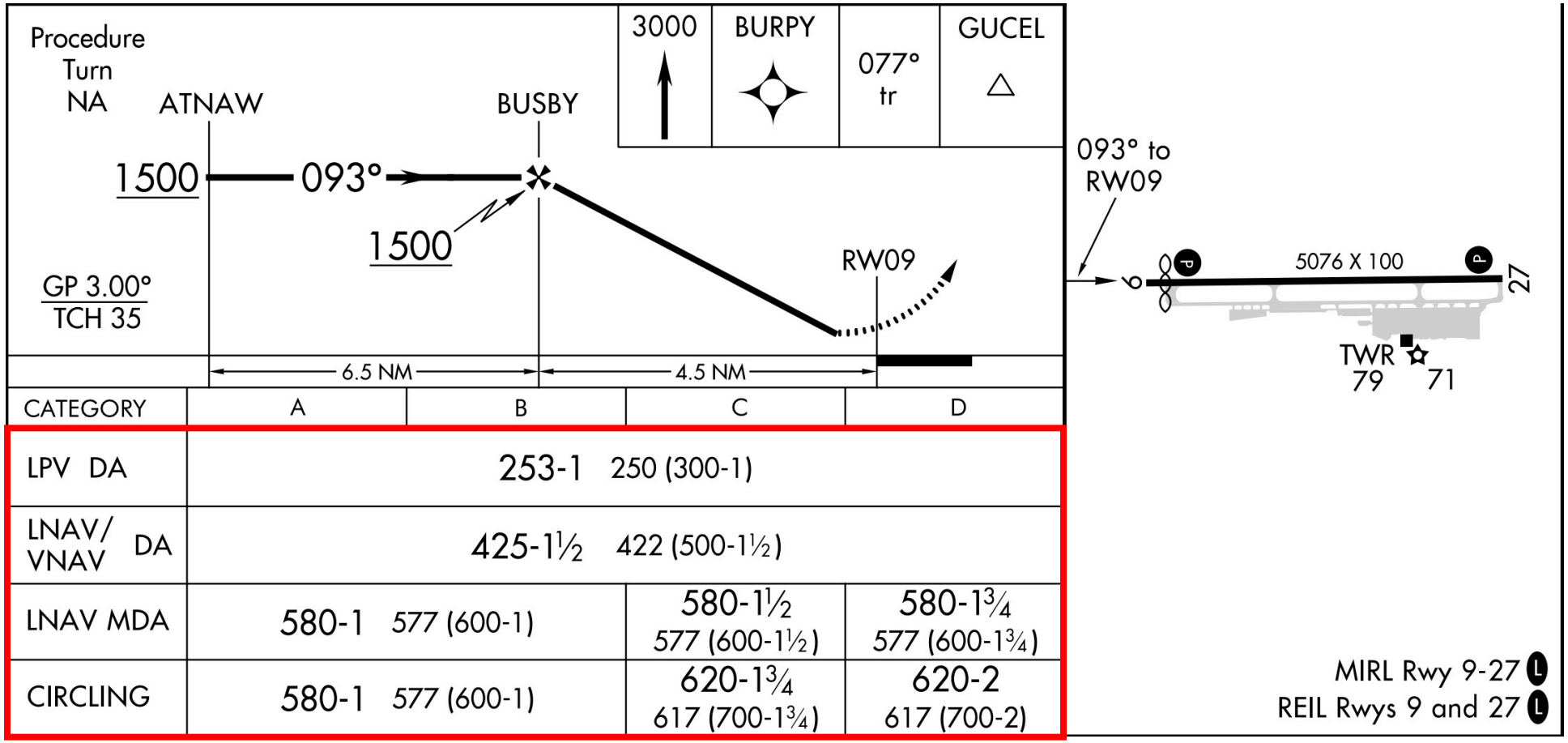
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/ VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

And our minimums will be X depending on aircraft capability

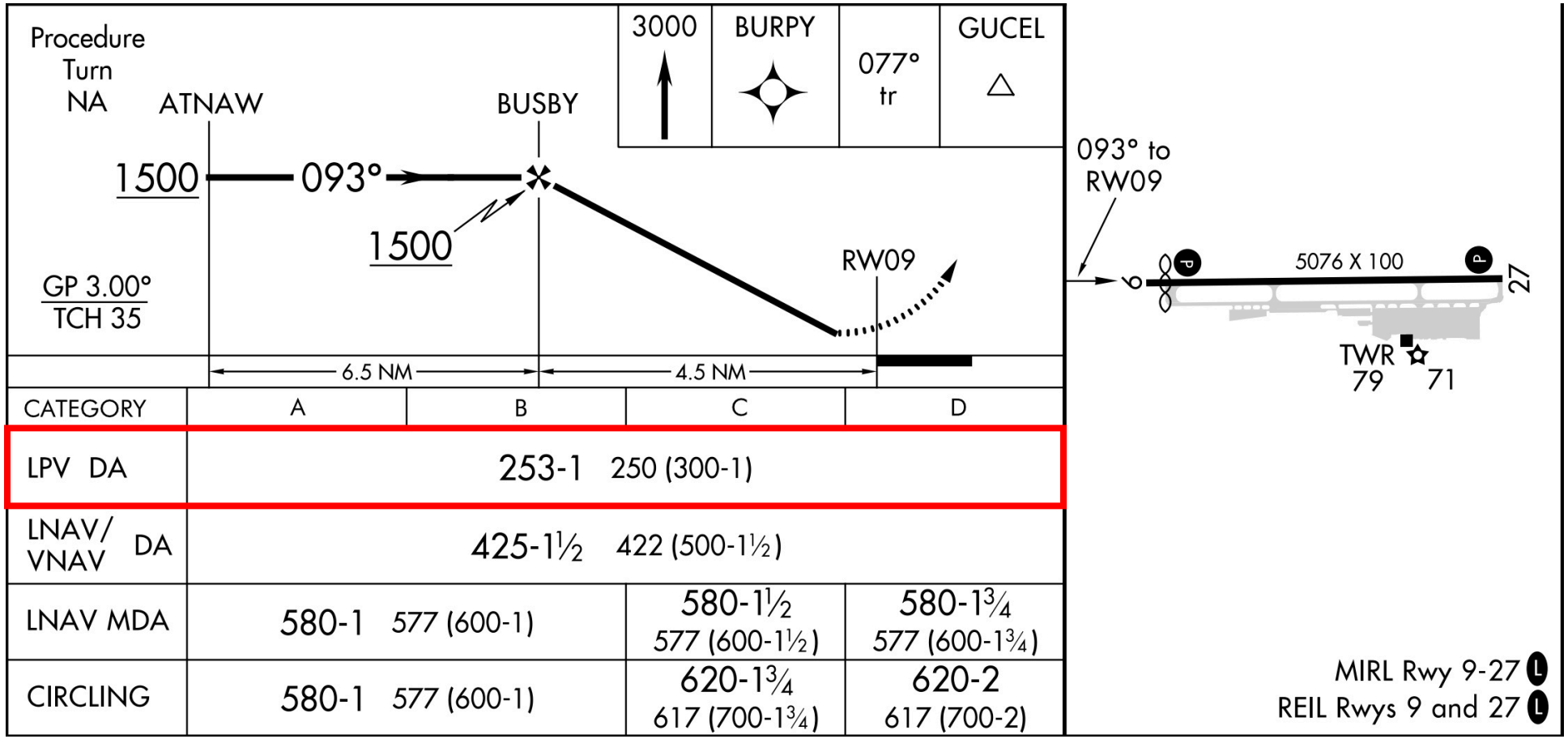
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/ VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

With what equipment can we expect these?

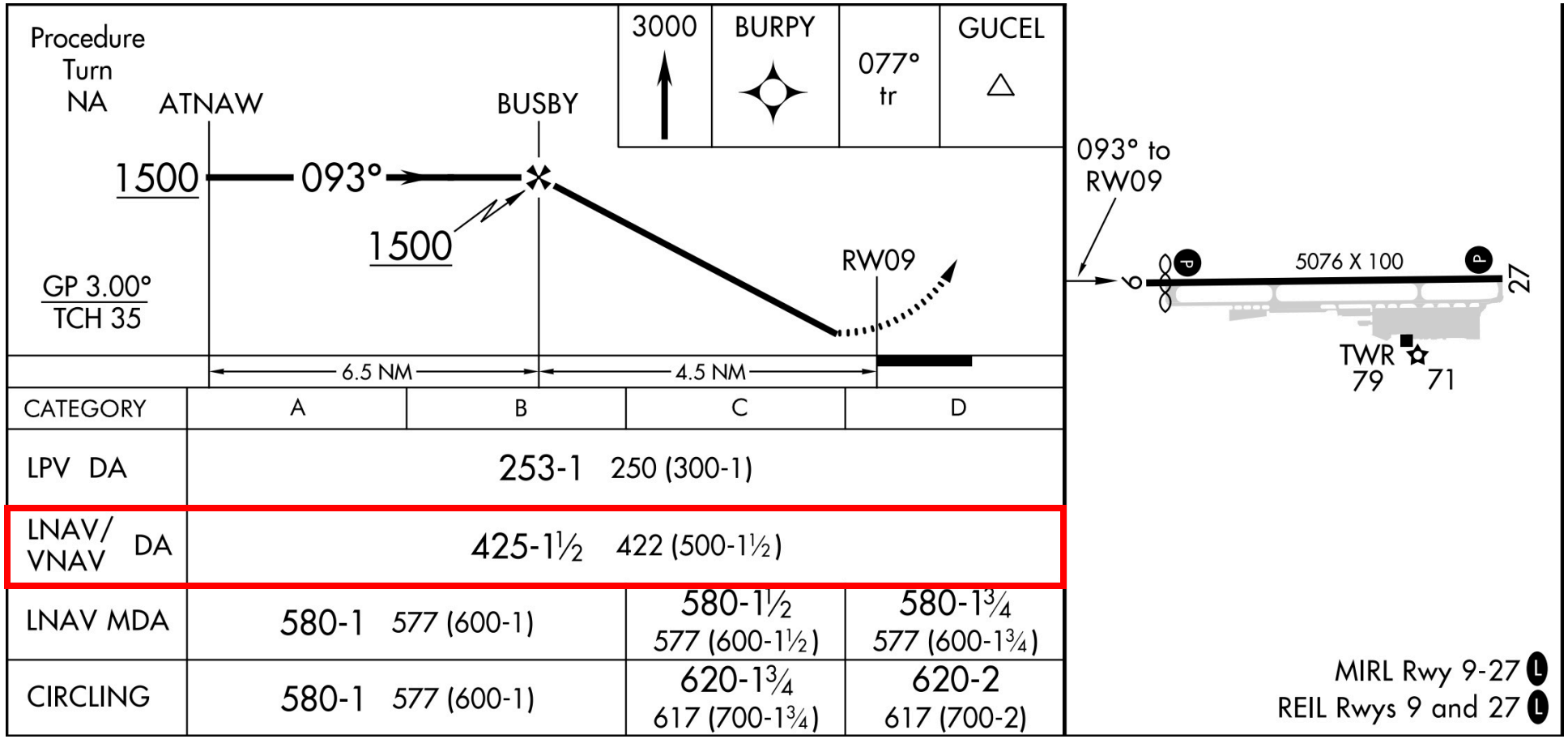
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/ VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

Modern WAAS GPS

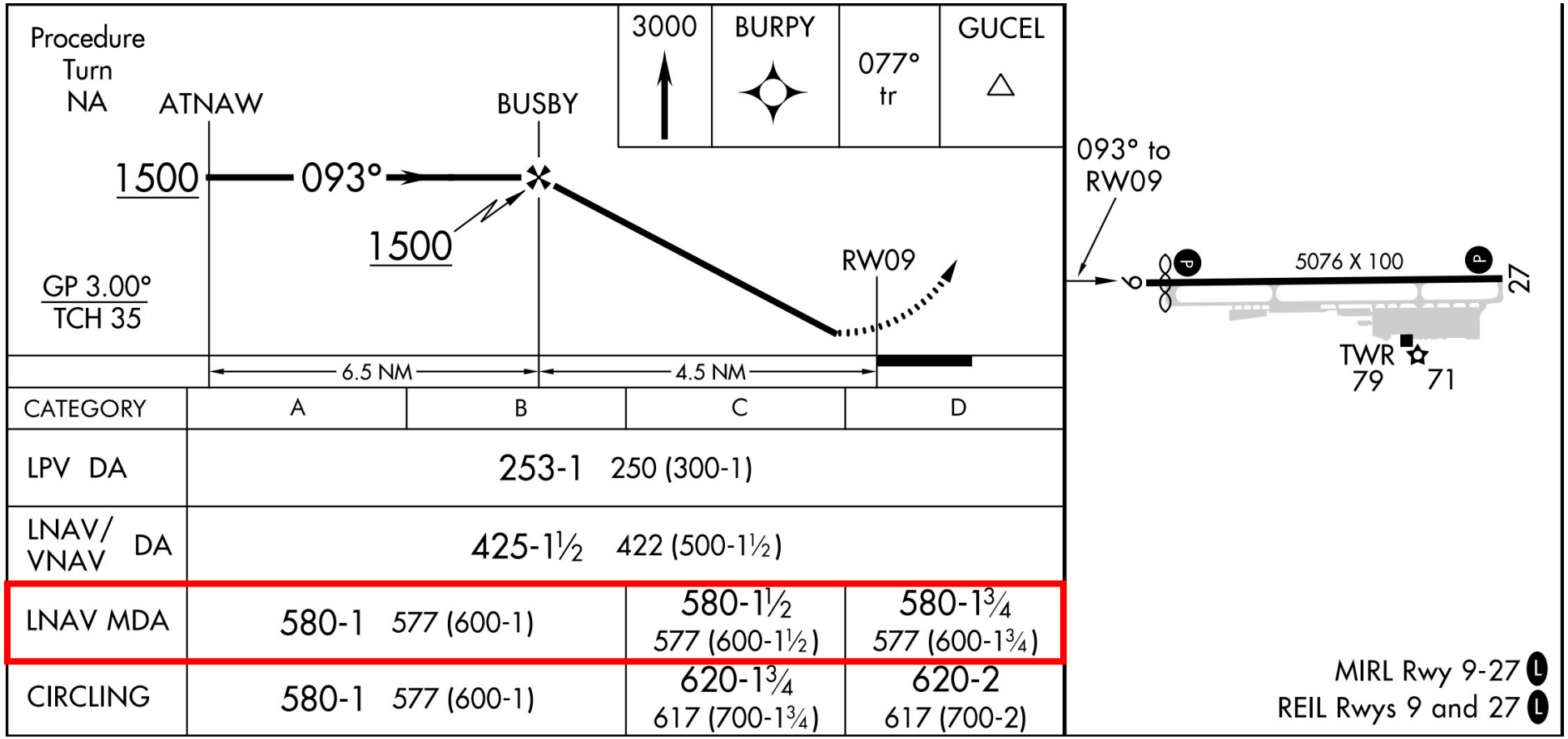
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/ VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

Baro-aided GPS

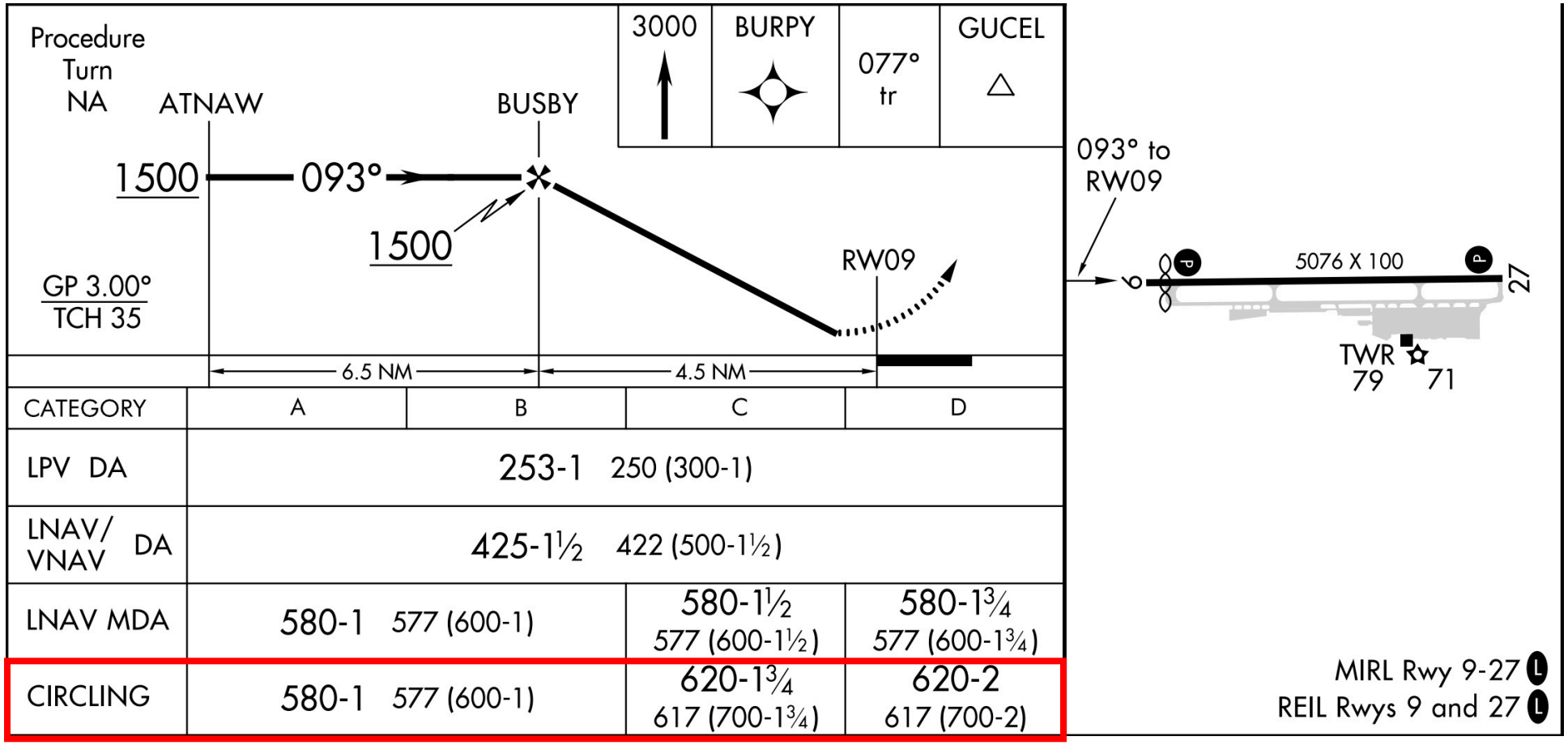
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/ VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

Non-WAAS GPS

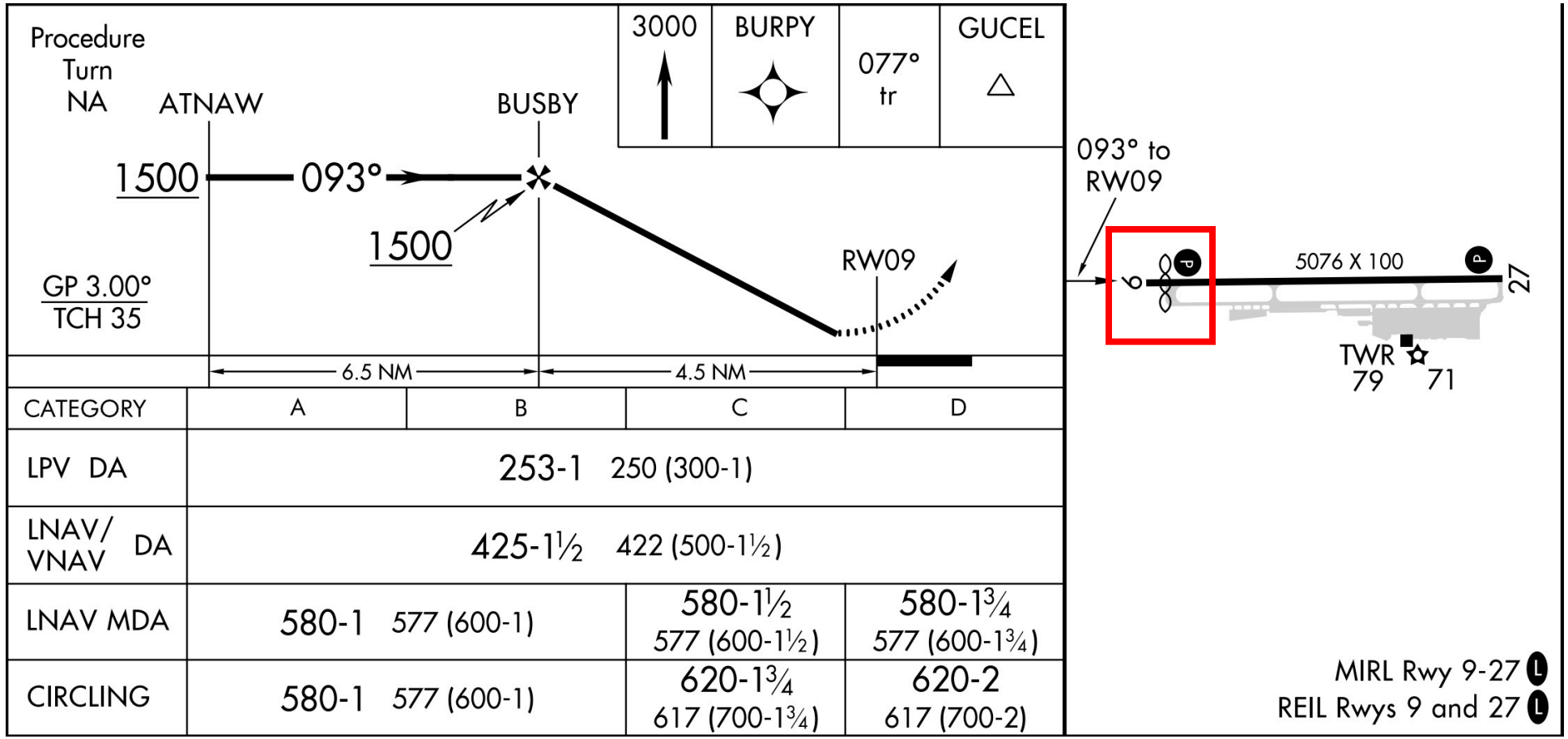
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

If we wanted to land on 27 for some reason but needed to come from the west

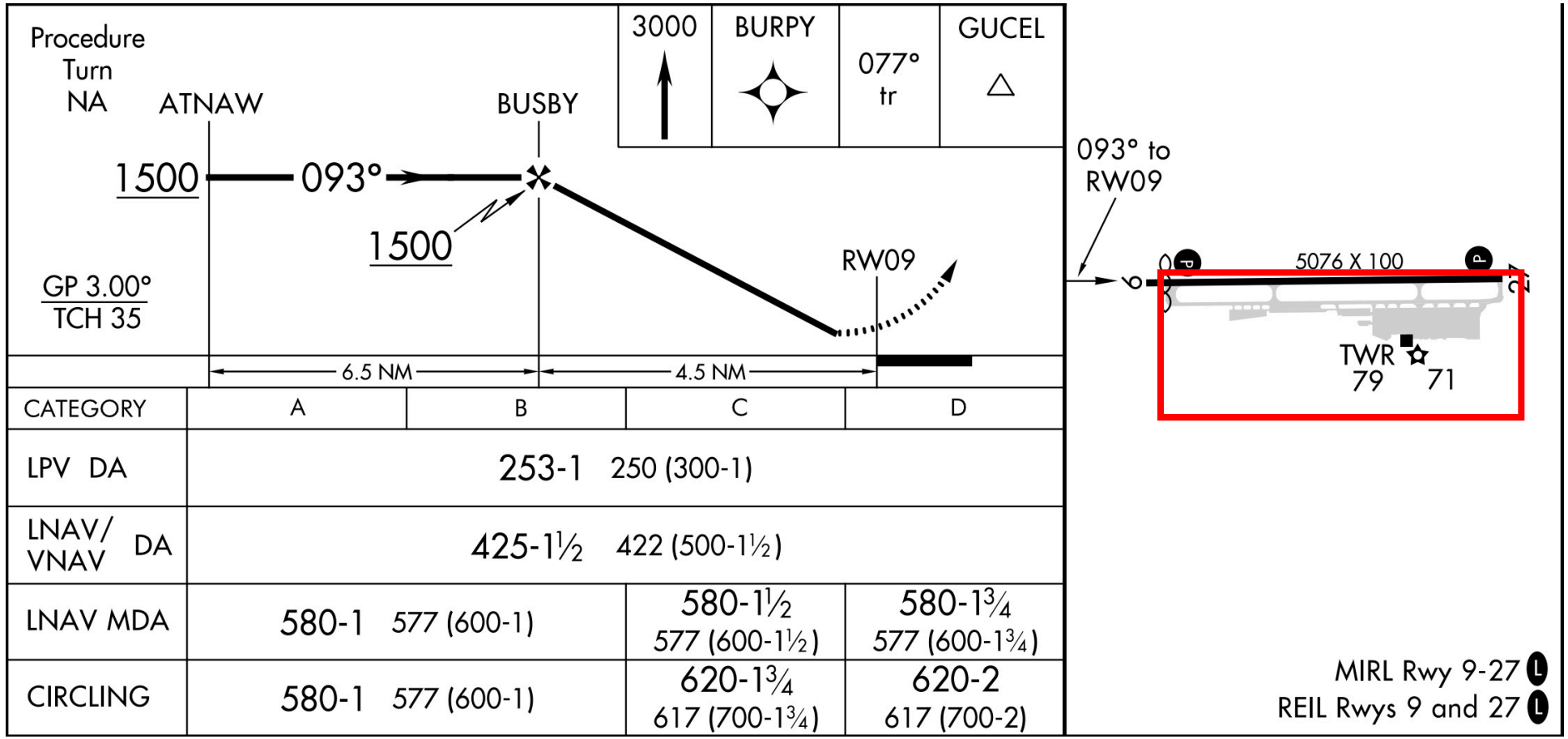
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/ VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

We will have a displaced threshold with a PAPI on the left

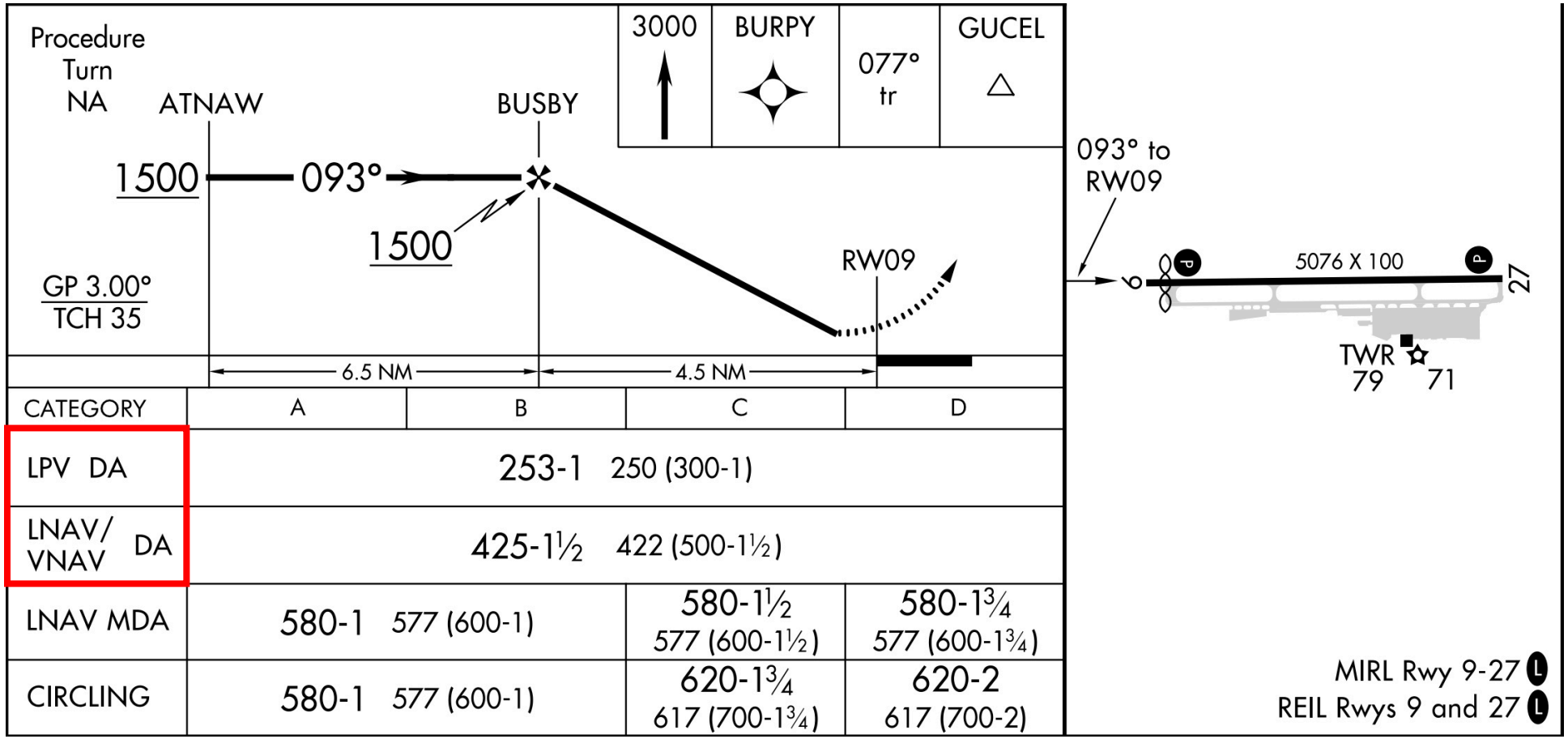
Approach Plate Example



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

And the airport complex to the right

Decisions decisions…



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
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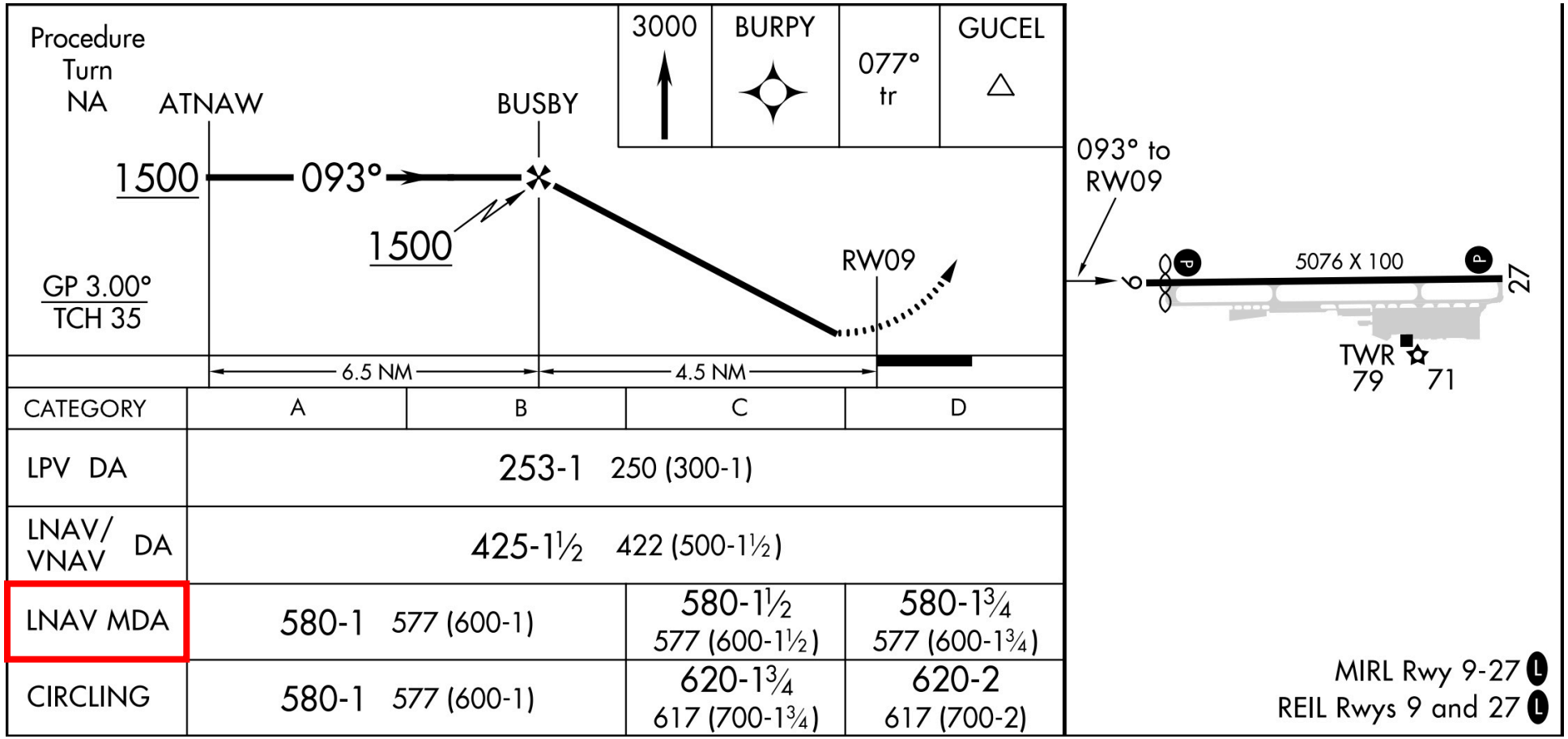
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

For approaches with vertical guidance, this DA is where we'll decide to continue on the glideslope or go missed

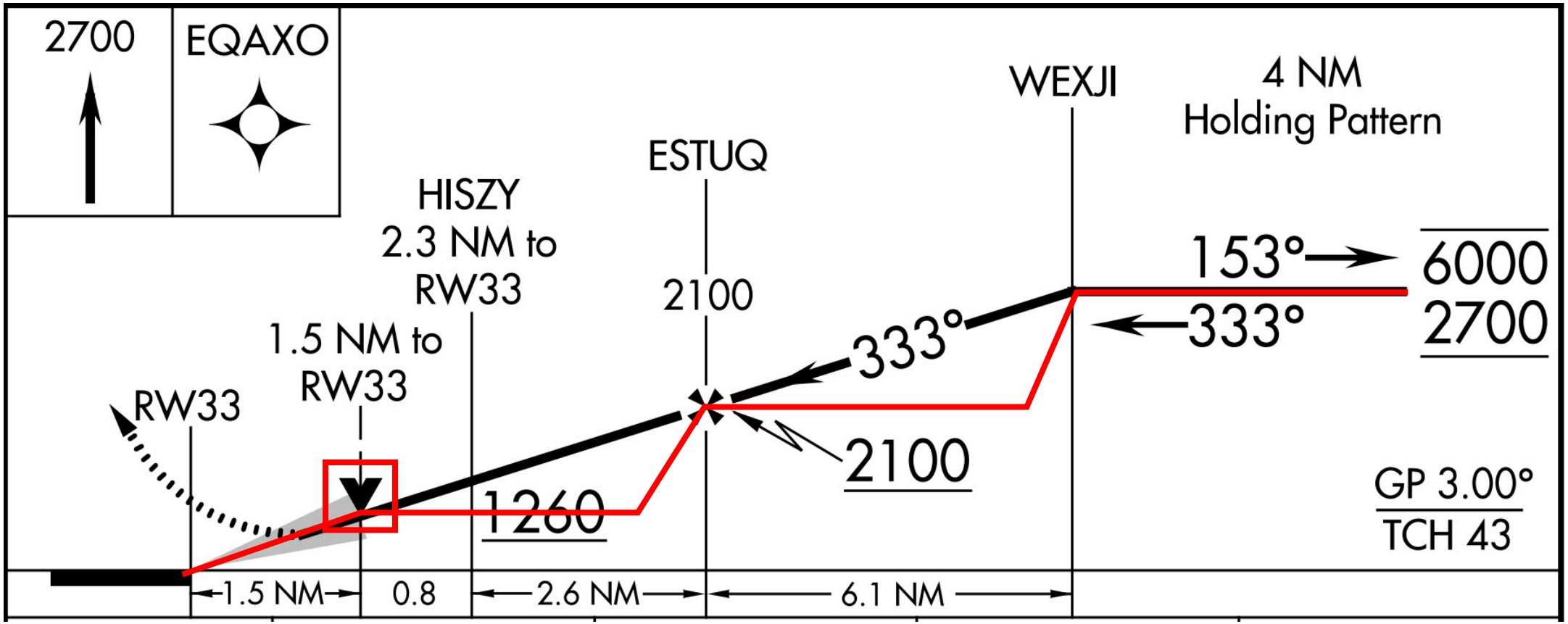
Decisions decisions…



CATEGORY	A	B	C	D
LPV DA	253-1 250 (300-1)			
LNAV/ VNAV DA	425-1½ 422 (500-1½)			
LNAV MDA	580-1 577 (600-1)		580-1½ 577 (600-1½)	580-1¾ 577 (600-1¾)
CIRCLING	580-1 577 (600-1)		620-1¾ 617 (700-1¾)	620-2 617 (700-2)

For approaches without vertical guidance, we can go no lower than MDA unless we meet the requirements to descend below minimums

Decisions decisions…



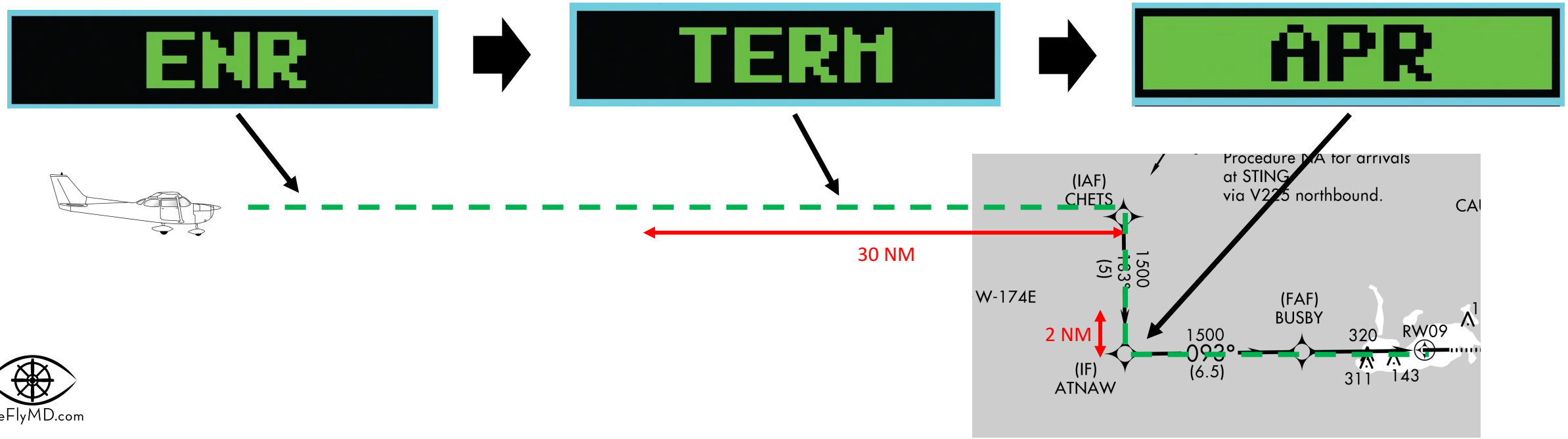
And remember, for approaches with a Visual Descent Point (VDP) this is the location where we could make a normal, stabilized descent from MDA (if we were ”diving and driving” for example)

Leaving MDA/DA – 91.175(c)

- The aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using *normal maneuvers* (i.e., you don't have to nosedive to make the runway)
- The flight visibility is not less than the visibility prescribed in the standard instrument approach being used (i.e., you're legal)
- At leas one of the following visual references for the intended runway is distinctly visible and identifiable to the pilot:
  - The approach light system, except that the pilot may not descend below 100 feet above the touchdown zone elevation using the approach lights as a reference unless the red terminating bars or the red side row bars are also distinctly visible and identifiable.
  - The threshold.
  - The threshold markings.
  - The threshold lights.
  - The runway end identifier lights.
  - The visual glideslope indicator.
  - The touchdown zone or touchdown zone markings.
  - The touchdown zone lights.
  - The runway or runway markings.
  - The runway lights.

Remember to stay ahead

- Make sure GPS you're using is behaving as expected
  - It should not say "Enroute" while you're approaching MDA
- Know how to tell what sensitivity the GPS is using and be sure to double check it



Questions?

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