COSCAP South East Asia
Cooperative Development of Operational Safety & Continuing Airworthiness Programme

ADVISORY CIRCULAR FOR AIR OPERATORS

Subject: **NON-PRECISION INSTRUMENT APPROACH USING CONTINUOUS DESCENT FINAL APPROACH (CDFA) TECHNIQUES**

Date: **Nov 2012**

Initiated By: **COSCAP-SEA**

AC No: **008A-CDFA**

1. PURPOSE

This advisory circular (AC) provides guidance for all operators using the continuous descent final approach (CDFA) technique while conducting conventional or RNAV[1] Non-Precision Approach (NPA)[2] procedures. It describes the rationale for using the CDFA techniques and documents the related regulations and guidance material to be applied including some of those relating to Standard Operating Procedures (SOP) and Flight Crew Training (FCT).

Disclaimer:

This AC does not constitute a regulation. The information contained in this AC is subject to change without notice. Neither COSCAP nor ICAO makes representation as to its accuracy. It has been prepared by COSCAP for ICAO for information purposes only.

2. RELATED REGULATIONS

- *Insert State Regulations here*

3. RELATED READING MATERIAL

- FAA AC 120-108
- FAA AC 120-71A
- ICAO Doc 8168
- ICAO Doc 9613
- CASA CAAP 178-1(1)
- COSCAP AC SEA 002
- FAA-H-8261-1A

[1] RNAV in this context refers to area navigation-RNAV (GNSS), RNP APCH. Technically, to comply with the PBN Manual any description of RNAV should have an associated value. E.g. RNAV 10, RNAV 4 etc.

[2] Non Precision Approaches will be referred to as 2D (two dimensional) approaches from November 2014.

BACKGROUND

NPAs are designed to permit safe descent to a Minimum Descent Altitude (MDA). Unlike a Decision Altitude (DA) associated with a precision approach (or an Approach Procedure with Vertical Guidance (APV)) where the loss of height during the initial stage of a missed approach is taken into account, obstacle clearance is not assured if descent below the MDA occurs, and flight crew need to ensure that the aircraft's descent is arrested prior to reaching the MDA.

NPAs terminate in a visual segment that may provide for:

- a "straight-in" landing
- a circling approach that requires manoeuvring to align the aircraft with the landing runway
- a visual leg from a point where the MDA is reached to the circling area of the aerodrome.

Traditionally NPAs were flown as a series of descending steps conforming to the minimum published altitudes. This technique is colloquially referred to as the "dive and drive" method. Unfortunately many Controlled Flight into Terrain (CFIT) accidents have been attributed to this technique, due to human errors such as descending before a step is reached or failing to arrest descent. In addition the aircraft's descent is more difficult to manage due to changes in airspeed, rate of descent, and configuration. This can create a higher workload and contribute to reduced situational awareness.

Where NPAs are published with a vertical descent angle (VDA)[3], it facilitates the use of a stabilized descent technique while clearing all minimum altitudes.

CDFA approach techniques contribute to a stabilized approach and are characterized by a stable:

- Airspeed
- Descent rate
- Flight path

In the landing configuration to the point where the flare manoeuver begins.

A CDFA approach is not only safer but also:

- Improves fuel efficiency by minimizing the flight time at low altitudes
- Reduces noise levels
- Reduces the probability of infringement of the required obstacle clearance during the final approach segment

4. APPLICABILITY

This AC does **not** apply to:

- APV approaches
- Precision approaches such as ILS, GLS, MLS

APV and Precision Approaches will be collectively referred to as 3D (three dimensional) approaches from Nov 2014.

[3] Also referred to as an approach path angle

5. OPERATIONAL PROCEDURES AND FLIGHT TECHNIQUES.

a. **Equipment Requirement.**

CDFA requires no specific aircraft equipment other than that specified in the title of the NPA procedure. Pilots can safely fly suitable NPAs with CDFA using basic piloting techniques, aircraft flight management systems (FMS), and RNAV systems. Pilots can use points defined by a DME fix, crossing radial, GNSS distance from the runway, etc., on the approach plate to track their progress along both the lateral and vertical approach paths to the Missed Approach Point (MAP). Although an RNAV system may be used to assist in flying a conventional approach, it is necessary for the navigation system upon which the procedure is based to be monitored (NDB, VOR, etc.) to ensure that the obstacle clearance requirements of the approach are met, and that the procedure is flown within the tolerances of the navigation system on which the procedure is based.

b. **Identifying the Type of Approach**

Whenever the approach minimum is expressed as an MDA the Instrument Approach Procedure (IAP) is a Non-Precision Approach (Refer Figures 1A and 1B). A NPA <u>does not provide</u> vertical guidance[4]. That is the approach <u>must not</u> be flown with <u>flight directors as command instruments</u>.

- It is recommended that Operators provide tailored approach charts to their flight crew clearly identifying the type of approach and the minima applicable.

c. **Preparation.**

Before conducting a NPA ensure:

a) The aircraft's navigation, flight management and instrument systems have been approved for NPA operations and

b) Where required, GNSS Receiver Autonomous Integrity Monitoring (RAIM) is available and verified by NOTAM or a prediction service, and

c) Where required the Actual Navigation Performance (ANP) meets the RNP standard applicable to the instrument procedure being flown and

d) The aircraft manufacturer has approved the aircraft for NPA operations and the aircraft complies with the minimum equipment listed to enable the conduct of NPA's and

e) The crew are appropriately qualified and meet all recency requirements and

f) The operator has approved the conduct of NPA for the aircraft type and the aerodrome and

g) The airport meets the applicable runway and lighting standards, if any.

d. **Recommended Operating Procedures**

A. Lateral Navigation/ LNAV

- **GNSS or IRS or VOR;LLZ; NDB**
  - A NPA can be flown with lateral guidance provided by conventional navigation aids such as VOR; NDB; LLZ as well as by using an approved RNAV system. All RNAV operations are critically dependent on valid data. The operator must have in place quality processes that ensure database validity.

B. Vertical Information

- **Altimeter**

[4] This is not always clearly documented by the flight management system manufacturers.

- The approach is flown to the NPA MDA by reference to the altimeter.
- Where an accurate local QNH source is / is not available the approach minima may need to be adjusted.
- In addition to normal SOPs it is necessary for each crewmember to independently verify the destination altimeter subscale setting

C. Visual

- Non-standard temperature effects and Subscale setting round down can cause vertical errors from the nominal path. Crews must understand this effect and be aware that a lack of harmonisation with visual approach slope aids may occur, and indeed should be anticipated.
- Operators must ensure that flight crew are aware of the effects of non-standard temperatures and altimeter subscale round down.

e. **Computing Rate of Descent.**

CDFA requires use of the published Instrument Approach Procedure (IAP), approach path angle / vertical descent angle (VDA).
The published VDA may be incorporated in a navigation database to enable profile deviation information to be presented to the pilot via the flight directors or the flight management guidance computers interface. Any such presentation is to be regarded as advisory only.

Aircraft which are equipped with a Flight Path Angle (FPA) capability allow the pilot to precisely fly the nominated VDA manually or using the autopilot.

Pilots flying aircraft without such capability must compute a required rate of descent. The table presented in Figure 3 to the Annex offers flight crew a way to compute a rate of descent or, knowing the altitude change required per NM- the angle of descent.

Exercise:
Refer to LOC/NDB Runway 2 approach at La Porte Municipal Airport shown as Figure 4.

(1) Find the published VDA[5].
(2) From the table find the descent gradient that equates to a VDA of 3.20 degrees[6]
(3) From the table convert that gradient to a descent rate based on groundspeed[7]

f. **VDA Design.**

The VDA is calculated from the Final Approach Fix (FAF) altitude to the threshold crossing height (TCH). The optimum NPA descent angle (VDA) is 3.0 degrees although VDA may vary within the range 2.75 to 3.77 degrees.
In some cases, the VDA is calculated from a step-down fix altitude to the TCH. In this situation, the VDA is published on the profile chart **after** the associated step-down fix (see Figure 5). In most cases, the descent angle between the FAF altitude and the step-down fix altitude is slightly shallower than the published VDA for the segment between the step-

[5] In this example, it is 3.20 degrees
[6] 340 feet (ft.) per nautical mile (NM) (ft./NM)).
[7] A groundspeed of 120 knots (kts) requires a rate of descent of 680 fpm to fly the 3.20-degree descent angle.

down fix and the runway. Operators should determine how they would like their pilots to fly such approaches.

- Option 1: Descend from the FAF at the shallower rate in order to cross above the step-down fix altitude and then transition to published VDA, or

- Option 2: Begin descent at a point past the FAF to allow the aircraft to descend at the published VDA and still clear the step-down fix altitude. Refer to the Tallahassee Regional, VOR RWY 18 approach (see Figure 5 below).
    - To calculate the descent point beyond the FAF:
        - First determine the desired altitude to lose: (FAF (2,000 ft.) – (Airport Elevation (81 ft.) + TCH (46 ft.))) = **1,873 ft.**
        - Take the desired altitude to lose (1,873 ft.) and divide by the descent gradient (**316 ft**. /NM) that equates to the 2.98º VDA.
        - This produces a distance of **5.9** NM from the runway threshold or 2.0 DME from the SZW VORTAC.
        - The descent rate will be **632 fpm at 120 knots**.

CAUTION 1: When approach profile information is provided in association with a NPA the strict adherence by the flight crew to the limiting or minimum altitudes is essential for obstacle clearance**.**

CAUTION 2: When conducting a NPA using a flight director system which provides lateral and vertical displacement information, that information should be considered advisory ONLY.

g. **Timing-Dependent Approaches.**
Control of airspeed and rate of descent is particularly important on approaches solely dependent on timing to identify the MAP. Pilots should cross the FAF already configured for landing and at the correct speed for the final approach segment.

h. **Derived Decision Altitude (DDA).**
Pilots must not descend below the MDA when executing a missed approach from a NPA. Operators should instruct their pilots to initiate the go-around at an altitude above the MDA (sometimes referred to as a DDA) to ensure the aircraft does not descend below the published MDA.

i. ***Decision Approaching MDA.***
Flying the published VDA will have the aircraft intersect the plane established by the MDA at a point before the MAP. Approaching the MDA, the pilot has two choices: continue the descent to land with required visual references, or execute a missed approach, not allowing the aircraft to descend below the MDA. (See Annex, Figure 1B- Approach Example Using Continuous Descent Final Approach.)

j. **Executing a Missed Approach Prior to MAP.**
When executing a missed approach prior to the MAP and not cleared otherwise by an air traffic control (ATC) climb-out instruction, fly the published missed approach procedure. Proceed on track to the MAP before accomplishing a turn.

- **Visibility Minima Penalty.**
The appropriate OpSpec, management specification (MSpec), or letter of authorization (LOA) will specify what visibility penalty will apply to the

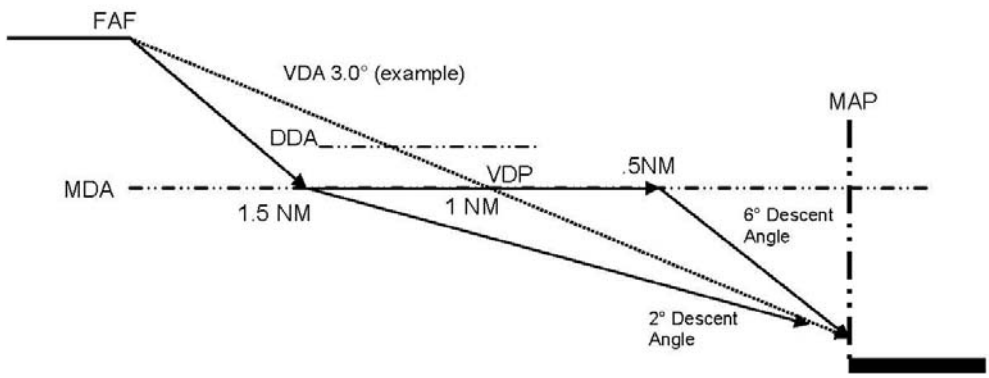
published approach minima if operators do not use CDFA on NPAs.

6. **SOP and FCT**

Operators should revise their SOP and FCT to identify CDFA as a standard method of conducting NPA. Operator's must consult the relevant State regulations, OEM instructions and bulletins, and other advisory documents such as the FAA AC 120-71A and COSCAP AC SEA 002A to develop procedures specific to their needs. SOP and FCT should as a minimum cover the topics shown in Figure 6 of the Annex.

ANNEX

FIGURE 1A.
APPROACH EXAMPLE WITHOUT USING CONTINUOUS DESCENT FINAL APPROACH

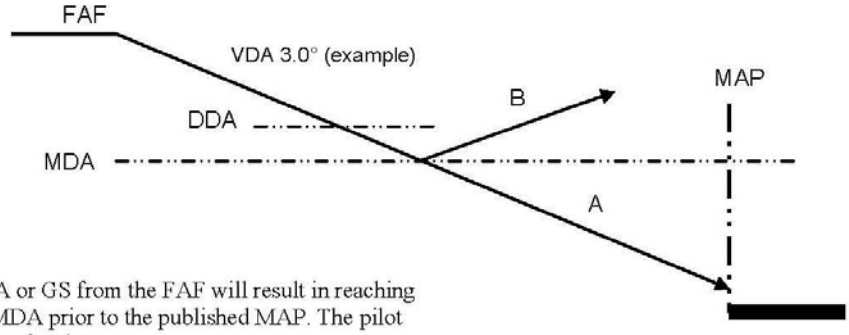


In this example, the aircraft leveled at the MDA (dive and drive) and is proceeding to the MAP in an attempt to acquire the required visual references to continue the approach below the MDA. The 3.0° VDA would be used in this example to fly a CDFA.

A. As the aircraft approaches the published MAP, the required descent angle to the runway threshold steepens. At approximately.5 NM from the MAP, the required angle has increased to 6°. At a groundspeed of 120 kts, a 1270 FPM rate of descent would be required to cross the threshold at a planned TCH of 50 ft. The steep final angle, low-power setting and high descent rate may result in an unstable approach and unsafe condition in the transition to landing.

B. If a pilot descends .5NM early, a 2° descent angle is required. At a groundspeed of 120 kts., this corresponds to a 425 FPM rate of descent. Higher power settings and increased deck angles are required, the aircraft is closer to the ground and the TCH may be reduced to an unsafe height for large aircraft.

FIGURE 1B.
APPROACH EXAMPLE USING CONTINUOUS DESCENT FINAL APPROACH



Flying the VDA or GS from the FAF will result in reaching the DDA and MDA prior to the published MAP. The pilot has two courses of action:

A. If required visual cues are acquired, continue visually to the landing runway.

B. If required visual cues are not acquired, execute a missed approach. Do not descend below the MDA. Proceed on track to the MAP before accomplishing a turn.

FIGURE 2.
INSTRUMENT APPROACH PROCEDURE LEGEND

09071
LEGEND

INSTRUMENT APPROACH PROCEDURES (CHARTS)

PROFILE VIEW

Two different methods are used for vertical guidance:
a. "GS" indicates an electronic glide slope or barometric vertical guidance is present. In the case of an Instrument Landing System (ILS) and Wide Area Augmentation System (WAAS) LPV approach procedures, an electronic signal provides vertical guidance. Barometric vertical guidance is provided for RNP and LNAV/VNAV instrument approach procedures. All ILS, LPV, RNP, and LNAV/VNAV will be in this format GS 3.00°/TCH 55, located in the lower left or right corner.

b. Other charts without electronic or barometric vertical guidance will be in this format ∠3.00°/TCH 55, indicating a non-precision vertical descent angle to assist in preventing controlled flight into terrain. On Civil (FAA) procedures, this information is placed above or below the procedure track following the fix it is based on.

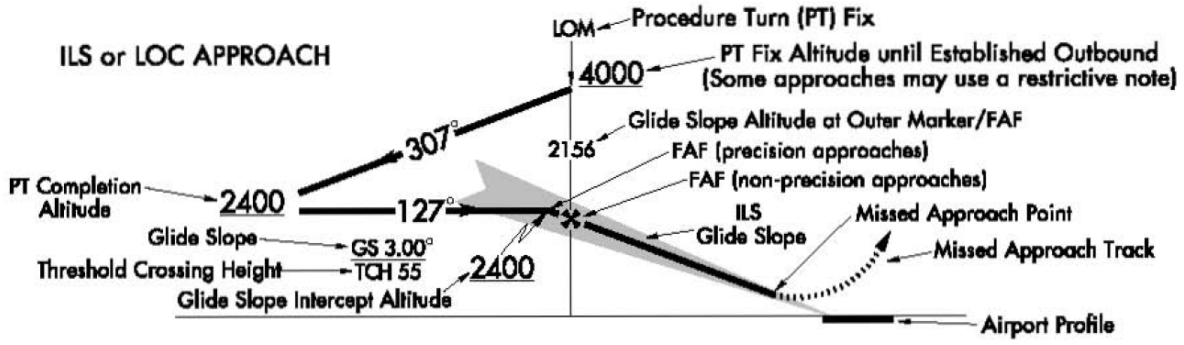


FIGURE 3.
RATE OF DESCENT TABLE

CLIMB/DESCENT TABLE 10042

INSTRUMENT TAKEOFF OR APPROACH PROCEDURE CHARTS
RATE OF CLIMB/DESCENT TABLE

(ft. per min)

A rate of climb/descent table is provided for use in planning and executing climbs or descents under known or approximate ground speed conditions. It will be especially useful for approaches when the localizer only is used for course guidance. A best speed, power, altitude combination can be programmed which will result in a stable glide rate and altitude favorable for executing a landing if minimums exist upon breakout. Care should always be exercised so that minimum descent altitude and missed approach point are not exceeded.

CLIMB/ DESCENT ANGLE (degrees and tenths)	ft/NM	GROUND SPEED (knots)										
		60	90	120	150	180	210	240	270	300	330	360
2.0	210	210	320	425	530	635	743	850	955	1060	1165	1275
2.5	265	265	400	530	665	795	930	1060	1195	1325	1460	1590
VERTICAL PATH ANGLE 2.7	287	287	430	574	717	860	1003	1147	1290	1433	1576	1720
2.8	297	297	446	595	743	892	1041	1189	1338	1486	1635	1783
2.9	308	308	462	616	770	924	1078	1232	1386	1539	1693	1847
3.0	318	318	478	637	797	956	1115	1274	1433	1593	1752	1911
3.1	329	329	494	659	823	988	1152	1317	1481	1646	1810	1975
3.2	340	340	510	680	850	1020	1189	1359	1529	1699	1869	2039
3.3	350	350	526	701	876	1052	1227	1402	1577	1752	1927	2103
3.4	361	361	542	722	903	1083	1264	1444	1625	1805	1986	2166
3.5	370	370	555	745	930	1115	1300	1485	1670	1860	2045	2230
4.0	425	425	640	850	1065	1275	1490	1700	1915	2125	2340	2550
4.5	480	480	715	955	1195	1435	1675	1915	2150	2390	2630	2870
5.0	530	530	795	1065	1330	1595	1860	2125	2390	2660	2925	3190
5.5	585	585	880	1170	1465	1755	2050	2340	2635	2925	3220	3510
6.0	640	640	960	1275	1595	1915	2235	2555	2875	3195	3510	3830
6.5	690	690	1040	1385	1730	2075	2425	2770	3115	3460	3805	4155
7.0	745	745	1120	1490	1865	2240	2610	2985	3355	3730	4105	4475
7.5	800	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800
8.0	855	855	1280	1710	2135	2560	2990	3415	3845	4270	4695	5125
8.5	910	910	1360	1815	2270	2725	3180	3630	4085	4540	4995	5450
9.0	960	960	1445	1925	2405	2885	3370	3850	4330	4810	5295	5775
9.5	1015	1015	1525	2035	2540	3050	3560	4065	4575	5085	5590	6100
10.0	1070	1070	1605	2145	2680	3215	3750	4285	4820	5355	5890	6430

FIGURE 4.
SAMPLE APPROACH: LOCALIZER / NON-DIRECTIONAL BEACON RUNWAY 02

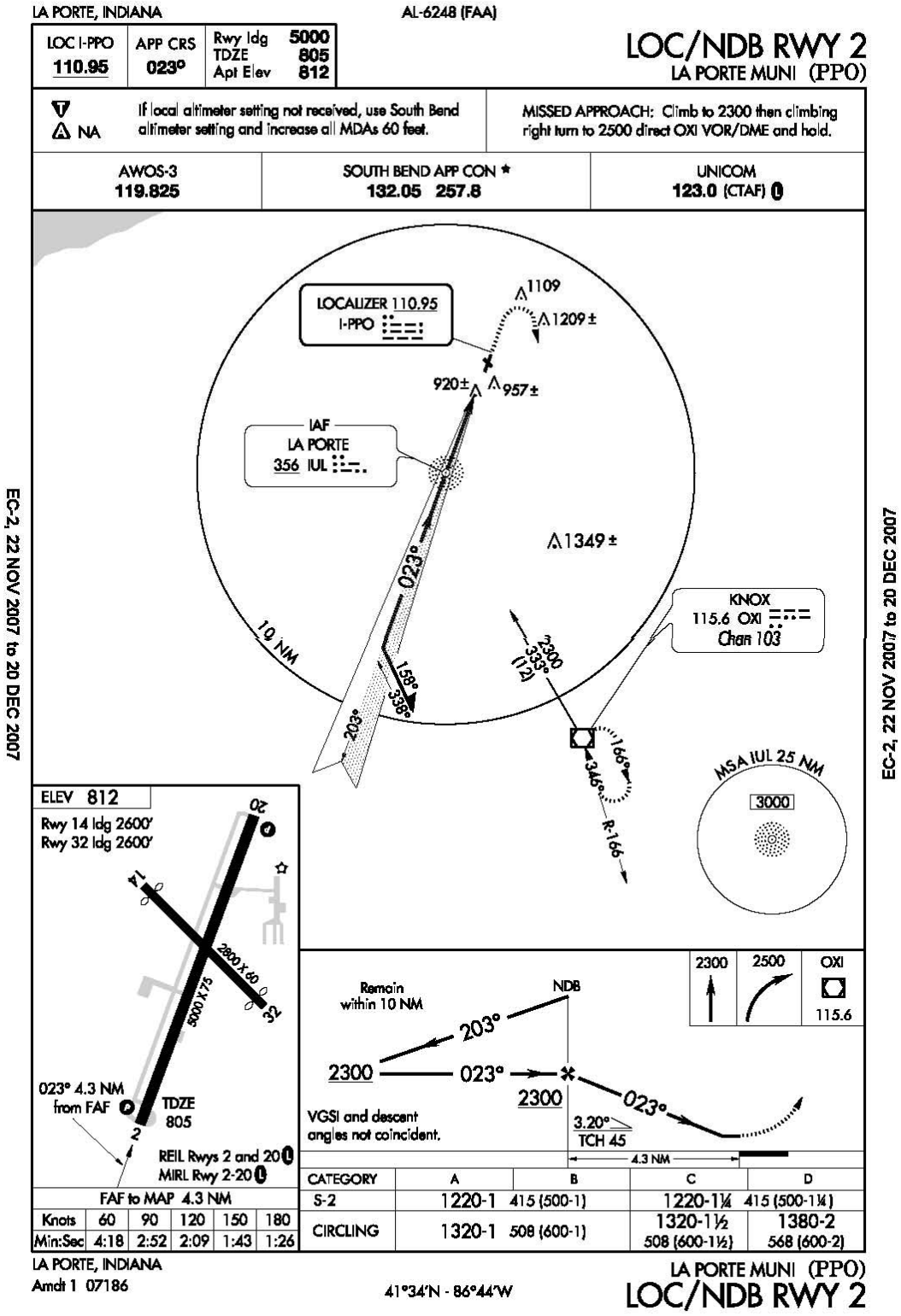
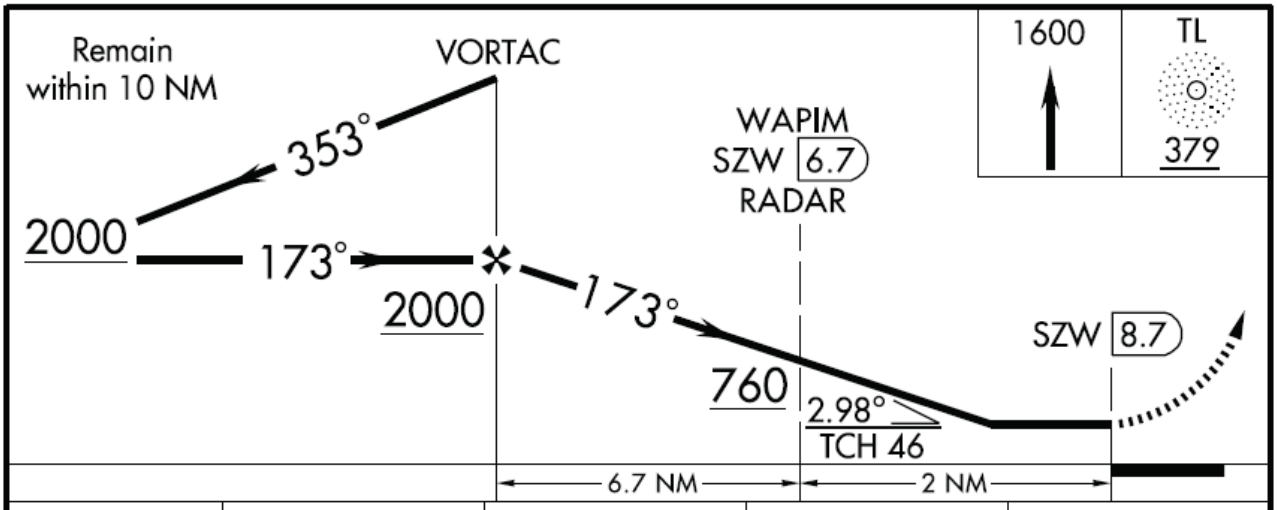


FIGURE 5.
INSTRUMENT APPROACH PROCEDURES WITH CONTROLLING STEPDOWN FIX



CATEGORY	A	B	C	D
S-18	760-1	679 (700-1)	760-2 679 (700-2)	760-2¼ 679 (700-2¼)
CIRCLING	760-1	679 (700-1)	760-2 679 (700-2)	760-2¼ 679 (700-2¼)
WAPIM FIX MINIMUMS				
S-18	540-1	459 (500-1)	540-1¼ 459 (500-1¼)	540-1½ 459 (500-1½)
CIRCLING	540-1	459 (500-1)	580-1½ 499 (500-1½)	640-2 559 (600-2)

TALLAHASSEE, FLORIDA
Amdt 11A 09043

TALLAHASSEE RGNL (TLH)
VOR RWY 18

FIGURE 6.

SOP and FCT to Support CDFA

The following topics should be included in (but not limited to) an operator's SOP and / or FCT as required to support CDFA operations. This is not a prescriptive list. Operators must consult the relevant State, OEM, and other advisory documents to develop standard operating procedures and training programs specific to their operation.

Automation
1) The automation use philosophy
2) Requirements or limitations on coupling the autopilot to flight guidance systems
3) Use of automation as appropriate to the task
4) Flight Management Systems/ Flight Director/ Autopilot: interaction; degradations; reversions
5) Monitoring of automated systems and Flight Mode Annunciator (FMA) changes and alerts
6) Reversion to basic modes
Altimetry
1) Altitude awareness-situation awareness
2) Determination of Minimum Safe Altitudes (MSA) and Minimum Descent Altitudes (MDA)
3) Use of an appropriate, current and accurate barometric subscale
4) Transition level and international differences
5) Altitude awareness crew callouts / auto callouts
6) Components of total altimeter system error
7) Corrections for wind and temperature
8) Monitoring rate of climb / descent during last 1000 feet of altitude change
9) Use of radio altimeter
10) Metric operations
Contingencies
1) The effect of failures on an aircraft's navigation capability
2) The effect of system failures on the operating minima/aircraft approach capability
3) Procedure to recover from automation failure
4) Reversion to basic modes of operation
Human Factors
1) Managing ATC as a 'crew resource'
2) Cross checking FMS routing with ATC clearance
3) Timely conduct of approach briefing
4) Briefing to include:
a. Location specific CFIT risk stated / addressed
b. Location specific crew qualification considered
c. Altimeter corrections considered
d. Avoidance of rushed approaches
e. Statement of the expected descent and approach profile (gradient)
f. Statement of the expected meteorological conditions
g. Statement of the expected aircraft configuration
h. Expected aircraft heading and attitude at MDA
i. Approach monitoring philosophy
j. Actions and callouts when approach 'gates' are missed
5) Go-around / missed approach actions
6) Aircraft clean-up profile
7) Flight deck discipline
8) PF/PNF duties and responsibilities

9) Sterile cockpit
10) Maintaining vigilance – situational awareness
11) Monitoring / cross checking
Legal
1) Flight planning requirements applicable to CDFA operations
2) Crew qualification
3) Aircraft approach capability
4) Navigation authorization
5) Appropriate operating clearances
6) Airport capability
Navigation
1) The capability and limitation of the aircraft's navigation system
2) Accurate interpretation of approach chart pictorial and textual navigation requirements.
3) Approach procedure design criteria
4) International differences in chart design: PANS OPS, TERPS,
5) The type of operation and airspace classes for which the navigation system is approved
6) Functional integration of navigation system with other aircraft systems
7) Verification that the navigation system self- tests satisfactorily
8) Verification that the aircraft navigation data is current
9) Initialization
10) Verification of the accuracy of the navigation system
11) Fly direct to/ intercept a track / accept vectoring/ rejoin approach procedure
12) De-selection / re-selection of navigation aids
13) Perform gross navigation error checks using conventional navigation aids
14) The effect of bank angle restrictions on an aircraft's navigation capability
15) Contingency procedures for navigation system failures
16) Components of total system error
17) Determination of cross-track error / deviation
18) Position update logic and priority
Operations
1) A minimum of one four hour simulator session is required
2) Demonstrated ability to fly a stabilized approach
3) The requirement to observe the speed constraints in radius to fix (RF) legs
4) Fly the appropriate engine inoperative airspeed to allow compliance with bank angle limits
5) The appropriate use of auto-thrust / manual thrust to manage airspeed
6) The use of aircraft radar, TAWS, EGPWS, or other avionics systems to support the flight crew's track monitoring and weather and obstacle avoidance.
7) Correct interpretation of electronic displays and symbols on flight and navigation display
8) The effect of altitude, wind and groundspeed on aircraft performance
9) The go-around procedure and the flight modes required
10) Appropriate aircraft configuration to allow compliance with bank angle or speed restrictions during the approach or missed approach.
11) The effect of activating TOGA while in a turn
12) Appropriate response to the loss of GNSS during a procedure
13) Performance issues associated with reversion to radio updating and limitations on the use of DME and VOR updating