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NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

NTSB Order of the Hearing

(14 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

February 1, 2014

Attachment 32 – Advisory Circular 120-108

OPERATIONAL FACTORS

DCA13MA133

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Continuous Descent Final Approach

Date: 1/20/11

Initiated by: AFS-400

AC No: 120-108

Change:

1. PURPOSE. This advisory circular (AC) provides guidance for all operators using the continuous descent final approach (CDFA) technique while conducting a Nonprecision Approach (NPA) procedure. It describes the rationale for using the CDFA technique, as well as recommended general procedures and training guidelines for implementing CDFA as a standard operating procedure (SOP). While the use of CDFA is beneficial to all aircraft operators, we intend this AC for those operators governed by Title 14 of the Code of Federal Regulations (14 CFR) parts 91 subpart K (91K), 121, 125, and 135. This guidance and information describes an acceptable means, but not the only means, of implementing the use of CDFA during NPAs and does not constitute a regulation.

2. RELATED TITLE 14 CFR REGULATIONS.

- Part 91, General Operating and Flight Rules.
- Part 97, Standard Instrument Procedures.
- Part 119, Certification: Air Carriers and Commercial Operators.
- Part 121, Operating Requirements: Domestic, Flag and Supplemental Operations.
- Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More; and Rules Governing Persons On Board Such Aircraft.
- Part 135, Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft.

3. RELATED READING MATERIAL (current editions).

- AC 120-71, Standard Operating Procedures for Flight Deck Crewmembers.
- Federal Aviation Administration (FAA) Aeronautical Information Manual (AIM).
- FAA Instrument Procedures Handbook (FAA-H-8261-1A).

4. BACKGROUND. Controlled flight into terrain (CFIT) is a primary cause of worldwide commercial aviation fatal accidents. Unstabilized approaches are a key contributor to CFIT events. Present NPAs are designed with and without stepdown fixes in the final approach segment. Stepdowns flown without a constant descent will require multiple thrust, pitch, and altitude adjustments inside the final approach fix (FAF). These adjustments increase pilot workload and potential errors during a critical phase of flight. NPAs designed without stepdown fixes in the final segment allow pilots to immediately descend to the MDA after crossing the FAF. In both cases, the aircraft remains at the MDA until descending for the runway or reaching the missed approach point (MAP). This practice, commonly referred to as "dive and drive," can result in extended level flight as low as 250 feet above the ground in instrument meteorological conditions (IMC) and shallow or steep final approaches. Figure 1A, Approach Example Without Using Continuous Descent Final Approach, Appendix 1, illustrates the disadvantages of the "dive and drive" technique.

a. Stabilized Approaches. A stabilized approach is a key feature to a safe approach and landing. Operators are encouraged by the FAA and the International Civil Aviation Organization (ICAO) to use the stabilized approach concept to help eliminate CFIT. The stabilized approach concept is characterized by maintaining a stable approach speed, descent rate, vertical flightpath, and configuration to the landing touchdown point. Depart the FAF configured for landing and on the proper approach speed, power setting, and flightpath before descending below the minimum stabilized approach height; e.g., 1,000 feet above the airport elevation and at a rate of descent no greater than 1,000 feet per minute (fpm), unless specifically briefed. (See AC 120-71.)

b. Approach Designs and Continuous Descent. Precision IAPs and approach procedures with vertical guidance (APV) have a continuous descent approach profile in their design. NPAs were not originally designed with this vertical path, but may easily be flown using the CDFA technique. Flying NPAs with a continuous descent profile will provide a safety advantage over flying approaches using the "dive and drive" technique. Therefore, the goal of implementing CDFA is to incorporate the safety benefits derived from flying a continuous descent in a stabilized manner as a standard practice on an NPA.

c. Definition of CDFA. CDFA is a technique for flying the final approach segment of an NPA as a continuous descent. The technique is consistent with stabilized approach procedures and has no level-off. A CDFA starts from an altitude/height at or above the FAF and proceeds to an altitude/height approximately 50 feet (15 meters) above the landing runway threshold or to a point where the flare maneuver should begin for the type of aircraft being flown. This definition harmonizes with the ICAO and the European Aviation Safety Agency (EASA).

d. Advantages of CDFA. CDFA offers the following advantages:

(1) Increased safety by employing the concepts of stabilized approach criteria and procedure standardization.

(2) Improved pilot situational awareness (SA) and reduced pilot workload.

(3) Improved fuel efficiency by minimizing the low-altitude level flight time.

(4) Reduced noise level by minimizing the level flight time at high thrust settings.

(5) Procedural similarities to APV and precision approach operations.

(6) Reduced probability of infringement on required obstacle clearance during the final approach segment.

5. APPLICABILITY. The FAA recommends CDFA for all of the following NPAs published with a vertical descent angle (VDA) or glideslope (GS):

- Very high frequency (VHF) Omnidirectional Range (VOR),
- VHF omni-directional range station/distance measuring equipment (VOR/DME),
- Non-directional radio beacon (NDB),
- NDB/distance measuring equipment (DME),
- Localizer (LOC), Localizer Back-Course (LOC-BC),
- LOC/DME,
- Localizer-type directional aid (LDA),
- LDA/DME,
- Simplified Directional Facility (SDF),
- SDF/DME,
- Area Navigation (RNAV), and
- Global Positioning System (GPS).

6. OPERATIONAL PROCEDURES AND FLIGHT TECHNIQUES.

a. Equipment Requirement. CDFA requires no specific aircraft equipment other than that specified by 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, GPS distance from the runway, etc., on the approach plate to track their progress along both the lateral and vertical approach paths to the MAP.

b. Approach Requirement. CDFA requires the use of a published VDA or barometric vertical guidance (GS) on the IAP. Figure 2, Instrument Approach Procedure Legend, shows the legend for an IAP and defines the GS and VDA. RNAV approaches with lateral navigation (LNAV)/vertical navigation (VNAV) minima are published with a GS. Non-RNAV NPAs or RNAV approaches with LNAV-only minima are published with a VDA. In rare cases, the VDA or GS may be calculated from a stepdown fix altitude (see subparagraph 6d). Aircraft with FMS, barometric vertical navigation (baro-VNAV), wide area augmentation system (WAAS), or that are similarly equipped typically provide the published VDA or GS when the IAP is selected from the database. Aircraft equipped with Flight Path Angle (FPA) allow the pilot to enter an electronic descent angle based on the published GS or VDA. Pilots flying aircraft without either type of equipment must compute a required rate of descent.

c. Computing Rate of Descent. Both U.S. Government and private fight information publications offer the pilot a way to compute a rate of descent. (The climb/descent table, Figure 3, Rate of Descent Table, is provided in government publications.) Pilots can use this table to translate the published VDA or GS into the required rate of descent. In the example below, LOC/NDB Runway 2 approach at La Porte Municipal Airport (see Appendix 1, Figure 4, Sample Approach: Localizer/Nondirectional Beacon Runway 2), the climb/descent table, aircraft groundspeed, and a published VDA are used to determine the descent gradient and, ultimately, the required rate of descent needed to fly a CDFA.

(1) Find the published VDA. In this example, it is 3.20 degrees.

(2) Find the descent gradient that equates to a VDA of 3.20 degrees (see Appendix 1, Figure 3) (i.e., 340 feet (ft) per nautical mile (NM) (ft/NM)).

(3) Find the descent rate based on groundspeed (see Appendix 1, Figure 3). A groundspeed of 120 knots (kts) requires a rate of descent of 680 fpm to fly the 3.20-degree descent angle.

d. VDA/GS Design. The VDA or GS is calculated from the FAF/precise final approach fix (PFAF) altitude to the threshold crossing height (TCH). The optimum NPA descent angle (VDA or GS) is 3.0 degrees. Descent angles are found in the following range when the optimum VDA is not possible: 2.75º–3.77º (IAPs w/≤ Category (CAT) C minimums), 2.75º–3.50º (IAPs w/CAT D/E minimums). On approaches with stepdown fixes, the goal is to publish a VDA that keeps the Vertical Path (VPATH) above the stepdown fix altitude. However, in some cases, the VDA is calculated from the stepdown fix altitude to the TCH. In this situation, the VDA is published on the IAP following the associated stepdown fix (see Appendix 1, Figure 5, Instrument Approach Procedures with Controlling Stepdown Fix). In most cases, the descent angle between the FAF altitude and the stepdown fix altitude is slightly shallower than the published VDA for the segment between the stepdown fix and the runway. Operators should determine how they would like their pilots to fly the approach.

(1) Examples for Calculating Descent Point for Stepdown Fix Associated VDA. Two examples of how pilots may fly the approach are:

- Descend from the FAF at the shallower rate in order to cross above the stepdown fix altitude and then transition to published VDA, or

- Begin a descent at a point past the FAF that will allow the aircraft to descend at the published VDA and still clear the stepdown fix altitude.

(2) Demonstration of Techniques. Both techniques will be demonstrated below using the Tallahassee Regional, VOR RWY 18 approach (see Appendix 1, Figure 5). In this example, the descent angle from the FAF to the stepdown fix is abnormally shallow compared to the published VDA.

(a) Find the descent angle/descent gradient from the FAF to stepdown fix. Take the FAF altitude (2,000 ft) and subtract the stepdown fix altitude (760 ft). Take the difference, 1,240 ft, and divide by the distance between the FAF and stepdown fix (6.7 (NM)). The descent gradient calculated is 185 ft/NM. This descent gradient translates to a descent angle of less than 2 degrees from the descent/climb table (see Appendix 1, Figure 3). Although the chart does not have values for less than a 2° angle, the descent rate can still be found for 120 kts, or 2 miles per minute. Take 185 ft/NM and multiply by 2 miles per minute and the rate of descent is 370 fpm. This shallower rate can be flown, making necessary adjustments to observe the stepdown fix altitude restriction. At the stepdown fix, the pilot should then transition to the published 2.98° VDA. The published VDA is 2.98 degrees from the stepdown fix of 760 ft. The climb/descent table (see Appendix 1, Figure 3) shows that 2.98 degrees equates to a descent gradient of 316 ft/NM and a descent rate of 632 fpm at 120 kts.

(b) 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 2.98° VDA. This produces a distance of 5.9 NM from the runway threshold or 2.0 DME from the SZW VORTAC. The descent rate remains at 632 fpm at 120 kts from the table (see Appendix 1, Figure 3).

(3) Conclusion. If a pilot descends at 120 kts from 2,000 ft, beginning 5.9 NM from the runway threshold at a 632 fpm descent rate, the aircraft should cross the stepdown fix at 768 ft and the threshold at 46 ft.

NOTE: During any approach, pilots should perform a continuous descent flight path that meets all altitude constraints.

e. 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 on the correct speed for the final approach segment.

f. Derived Decision Altitude (DDA). Pilots must not descend below the MDA when executing a missed approach from a CDFA. 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. Operators conducting approaches authorized by operations specification (OpSpec) C073, IFR Approach Procedures Using Vertical Navigation (VNAV), may use MDA as a DA.

g. Decision Approaching MDA. Flying the published VDA or GS 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 Appendix 1, Figure 1B, Approach Example Using Continuous Descent Final Approach.)

h. Executing a Missed Approach Prior to MAP. When executing a missed approach prior to the MAP and not cleared 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,

i. Approaches With a VDP. Flying the published VDA or GS on an approach constructed with a VDP should have the aircraft cross the MDA at or beyond the VDP.

j. 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.

7. FLIGHTCREW TRAINING.

a. Use of CDFA. The use of CDFA should become a standard procedure in the performance of suitable NPAs. Accordingly, operators should incorporate training on CDFA in those elements of their training programs where non-precision approaches are performed and evaluated.

b. Manuals and SOPs. Operators should revise their flight manuals and/or SOPs to identify CDFA as a standard method of performing NPAs.

c. Training. Additional flight training to use the CDFA technique is not required for pilots qualified to conduct NPA in accordance with the operator's certificate. However, operators should provide flightcrews with appropriate ground training before performing CDFA operations. The ground training may be computer-based, published in-flight operations bulletins, or provided via other similar means deemed acceptable by the principal operations inspector (POI). Crewmembers should receive training specific to the aircraft type, the installed flight guidance, and navigation system, and on how to utilize the system when using the CDFA technique for applicable approach profiles.

d. Training Program Topics. Each operator's CDFA training program should specifically address the following topics:

(1) Emphasis on the stabilized approach concept and the safety benefits of using the CDFA.

(2) Approach characteristics (e.g., circling-only minima) and environmental factors (e.g., icing) that could make the use of CDFA inadvisable.

(3) Use of baro-VNAV, if applicable, to provide a vertical profile during a non-precision approach.

(4) Methods for translating the published GS angle or VDA into the required rate of descent for aircraft not equipped with baro-VNAV.

(5) Means for tracking progress along the final approach vertical profile.

(6) Means for ensuring compliance with any altitude restrictions during the final approach segment, to include start of descent past FAF to meet stepdown fix altitudes.

(7) The altitude additive required for ensuring the aircraft does not descend below the MDA or DDA.

(8) Understanding the impact on approach stabilization by flying to the MAP at the MDA to acquire runway visual references (see Appendix 1, Figure 1A).

(9) Pilot Flying (PF) and pilot-not-flying (PNF) monitoring callouts and other crew coordination activities needed to ensure safe transition from the vertical profile to either landing or a go-around at MDA or DDA.

(10) Procedures for executing a go-around prior to reaching the MAP.

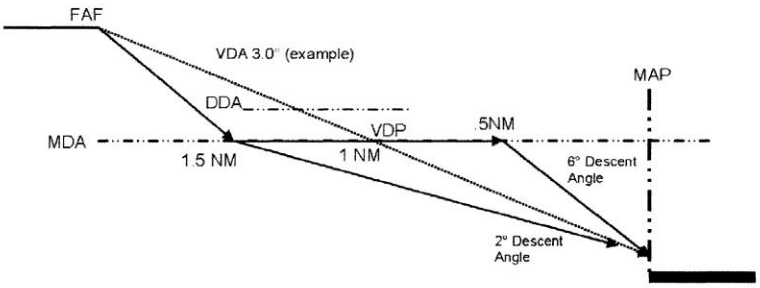
(11) The need to comply with the VGSI, if available, and discussion of the obstacle protection in the visual segment it provides.

/s/ for

John M. Allen
Director, Flight Standards Service

APPENDIX 1. RELEVANT REFERENCES

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

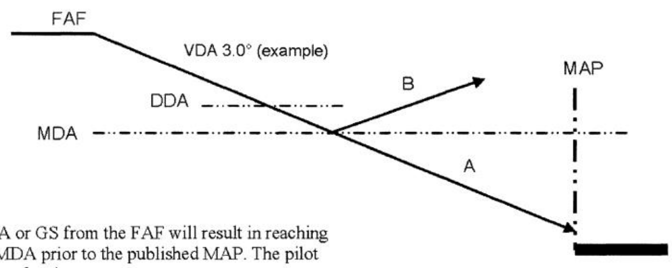


In this example, the aircraft leveled at the MDA (dive and drive) and is proceeding to the MAP in an attempt to acquire the required visual references to continue the approach below the MDA. The 3.0° VDA would be used in this example to fly a CDFA.

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.

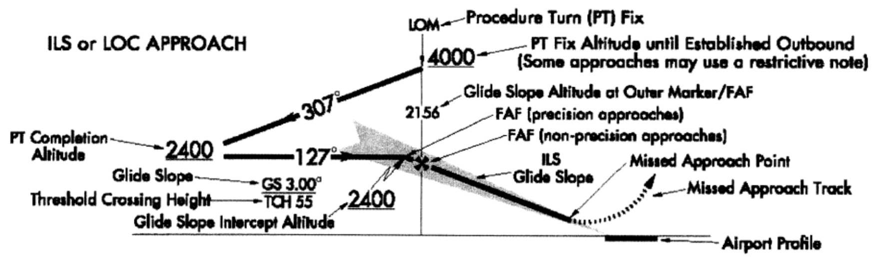


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FIGURE3. RATE OF DESCENT TABLE

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/NONDIRECTIONAL BEACON RUNWAY 2

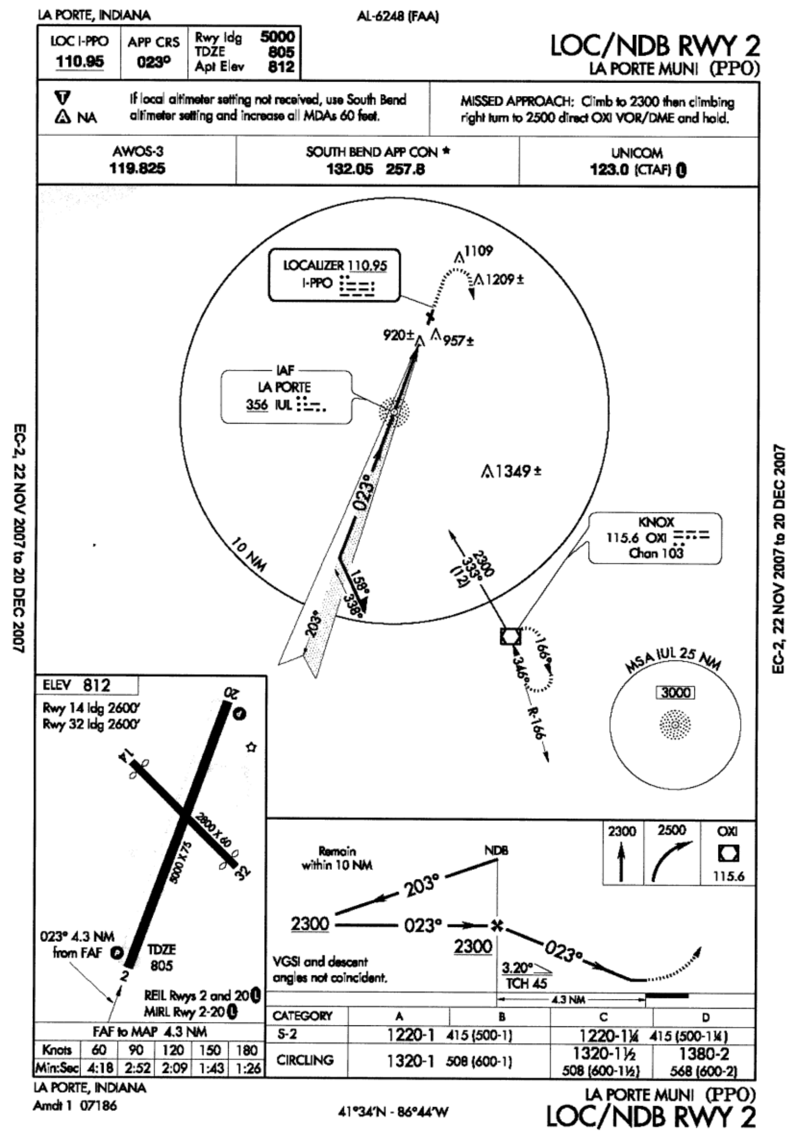

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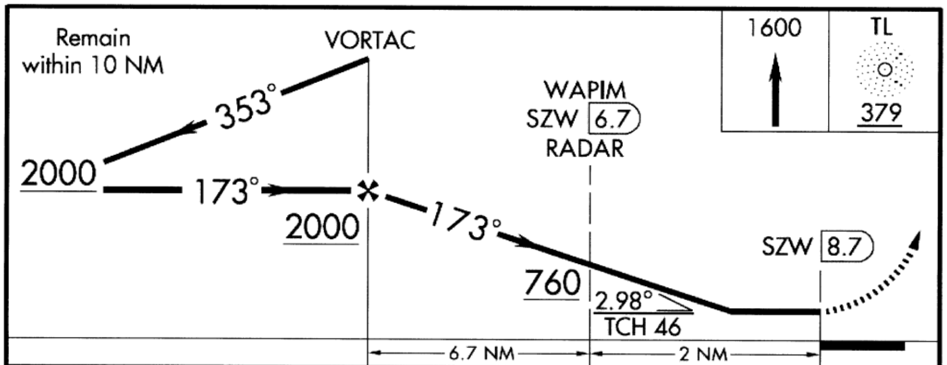
FIGURE 5. INSTRUMENT APPROACH PROCEDURES WITH CONTROLLING STEPDOWN FIX

Rwy ldg 6076
TDZE 81
Apt Elev 81



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