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Fuel Conservation Strategies: Descent and Approach

The descent and approach phases of flight represent the flight crew's final opportunities to reduce fuel consumption during flight. By carefully planning the airplane's descent and appropriately using drag and high lift devices, the flight crew can ensure a safe landing while saving fuel.

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This article is the fourth and final in a series exploring fuel conservation strategies. It discusses strategies for saving fuel during the descent and approach phases of flight. The first article in this series, "Cost Index Explained," appeared in the second-quarter 2007 AERO. It was followed by "Cruise Flight" in the fourth-quarter 2007 issue and "Takeoff and Climb" in the fourth-quarter 2008 issue.

Fuel conservation is a significant concern of every airline. An airline can choose an approach procedure and flap setting policy that uses the least amount of fuel,

but it should also consider the trade-offs involved with using this type of procedure.

In this article, two types of approaches are analyzed: the standard approach and the low-drag or delayed-flaps approach. The cost of a missed approach is also discussed.

THE STANDARD APPROACH

Boeing flight crew training manuals and/or flight crew operating manuals (FCOM) define standard approach profiles for every Boeing model. These profiles include specific flap settings and when to select

them during various parts of the approach (see fig. 1).

THE LOW-DRAG OR DELAYED-FLAPS APPROACH

If the approach is not being conducted in adverse conditions that would make it difficult to achieve stabilized approach criteria, the final flap selection may be delayed until just prior to 1,000 feet above field elevation (AFE) to conserve fuel and reduce noise and emissions or to accommodate speed requests by air traffic control. This approach is known as a low-drag,

Figure 1: Standard approach profile for 737 models

Boeing flight crew training manuals and/or operating manuals include specific instructions for standard approaches.

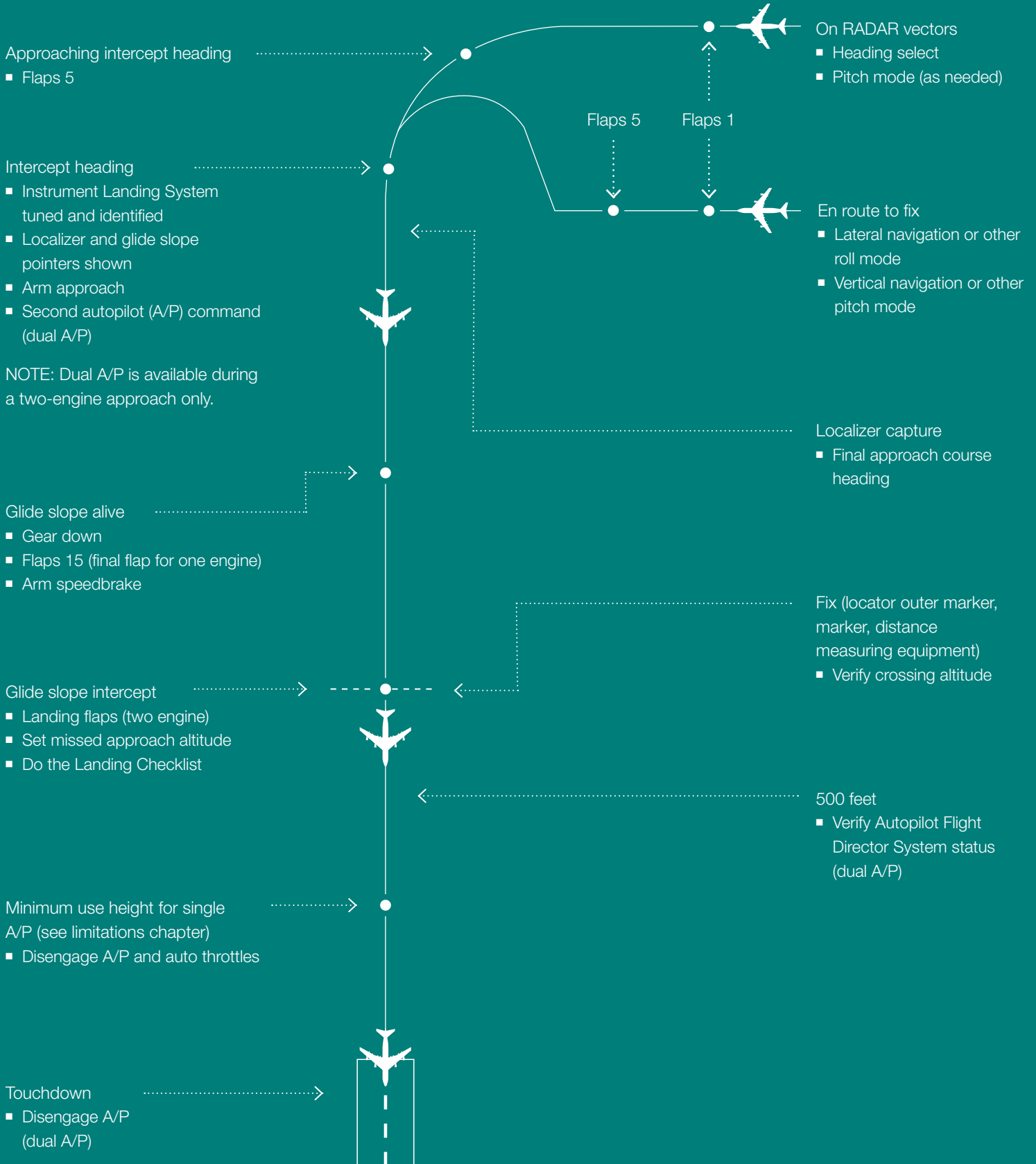


Figure 2: Fuel savings estimates for delayed-flaps approach procedure

The delayed-flaps approach uses 15 to 380 fewer pounds of fuel than the standard approach with the same flap setting.

AIRPLANE ENGINE	LANDING WEIGHT LBS (KG)	LANDING FLAP (DEG)	PROCEDURE	FUEL BURNED LBS (KG)	FUEL DIFFERENTIAL LBS (KG)
737-800 CFM56-7B24	120,000 (54,431)	30	Standard	230 (104)	
			Delayed	213 (97)	17 (8)
		40	Standard	266 (121)	
			Delayed	230 (104)	36 (16)
747-400 CF6-80C2B1F	450,000 (20,411)	25	Standard	590 (268)	
			Delayed	540 (245)	50 (23)
		30	Standard	610 (277)	
			Delayed	550 (250)	60 (27)
767-300 CF6-80C2B4	270,000 (122,469)	25	Standard	400 (181)	
			Delayed	370 (168)	30 (14)
		30	Standard	440 (200)	
			Delayed	390 (177)	50 (23)
777-200 GE90-94B	450,000 (204,411)	25	Standard	850 (385)	
			Delayed	790 (358)	60 (27)
		30	Standard	920 (417)	
			Delayed	820 (372)	100 (45)

delayed-flaps, or noise-abatement approach. The actual steps to use vary by airplane model and are described in the FCOM, flight crew training manual, or airline standard operating policy. These are the general steps for the 737, 757, 767, and 777:

- 737: Intercept the glide slope with gear down and flaps 15 at flaps 15 speed.
757/767/777: Intercept the glide slope with gear down and flaps 20 at flaps 20 speed.

Note: The thrust required to descend on the glide slope may be near idle.

- Approaching 1,000 feet AFE, select landing flaps, reduce the speed to the final approach speed, and then adjust thrust to maintain it.
- Perform the Landing Checklist.

Note for the 757/767/777: In particularly noise-sensitive areas, use the technique above but delay extending the landing gear until 1,500 feet AFE.

FUEL SAVINGS ASSOCIATED WITH DELAYED-FLAPS APPROACH

Depending on the flap setting and airplane model, the delayed-flaps approach uses 15 to 380 fewer pounds of fuel than the standard approach with the same flap setting (see fig. 2). To repeat, this approach should only be conducted in conditions that do not make it difficult to achieve a stabilized approach criteria.

Figure 3: Additional fuel burn attributed to missed approaches

The fuel burned during one missed approach is equivalent to 2 to 28 times the fuel burn required for a descent and approach.

AIRPLANE/ENGINE	ADDITIONAL FUEL BURN LBS (KG)
737-800 CFM56-7B24	280 (127)
747-400 CF6-80C2B1F	1,400 (635)
767-300 CF6-80C2B4	610 (277)
777-200 GE90-94B	880 (399)

Planning an approach to minimize fuel consumption

Seven key points should be considered when planning an approach and descent to minimize fuel consumption:

1. Plan the descent carefully.
2. Start the descent at the proper point.
3. Fly the most economical speed.
4. Use idle thrust for descents.
5. Avoid flying extended periods at low altitudes.
6. Configure flaps and gear for landing at the optimal time.
7. Use the most appropriate final flaps setting for landing.

THE COST OF A MISSED APPROACH

Although reduced-flap, delayed-flap, or low-drag approach procedures can save an airline significant amounts of fuel over time, if these procedures are inappropriately applied resulting in a missed approach, the subsequent additional fuel burn required for the missed approach and additional flight pattern with nullify all the fuel saving efforts employed on the entire flight. It cannot be overemphasized that the first priority of the crew is to fly the descent and approach safely and to be in a position to land at the appropriate time.

The typical missed-approach procedure is to apply go-around thrust, retract the flaps and gear while climbing to a minimum of 1,500 feet AFE, and accelerate to a minimum of flaps-up maneuvering speed. Depending on the airplane model and landing flap configuration, the fuel burned during one missed approach is equivalent to 2 to 28 times the fuel burn required for a

descent and approach (see fig. 3). There will also be the fuel required to fly an additional traffic pattern.

SUMMARY

Flight crews can vary their approach procedures and flap selections to match the flight's strategic objectives, which almost always include fuel conservation, noise abatement, and emissions reduction. Decisions on which type of approach to use vary with each airline, and sometimes even for each flight.

Boeing Flight Operations Engineering assists airlines' flight operations departments in planning low-drag approaches for any airport in the world. For more information, please contact FlightOps. Engineering@boeing.com. 