Continuous Descent Approach for Aviation

Overall effect on California petroleum use		Affects Petroleum Demand Through Intermediate Indicators:	
Magnitude	Low-Medium	**Primary**	System Operation Efficiency
Certainty	Medium-High	**Secondary**	
Applicable Level of Government	Federal		
Relevant Laws or Cases Affecting Factor	14 CFR Part 97		
Overall Time-Horizon of Reversal	Medium-term, with the implementation of the Next Generation Air Transportation System.		
Relevant Topics	aviation, next generation air transportation system		
Summary	Existing air traffic regulations and procedures are greatly limited by imprecise information about aircraft location and delayed command and control of aircraft. These limitations manifest in a multi-segment approach procedure that requires aircraft to level off at various stages. Continuous descent approach would allow aircraft to glide in for landing, reducing fuel consumed during the approach phase of flights.		

Introduction

Aircraft fuels account for 14.7% of statewide petroleum consumption, up from 10% in 1979 (Energy Information Administration, 2012). Air travel accounts for about 8.3% of total miles traveled by Californians (U.S. Federal Highway Administration, 2011). However, because air trips travel over longer distances than most surface transportation trips, air travel only accounts for 0.07% of all trips Californians make.

U.S. airlines average around 45 passenger miles per gallon and around 53 available passenger seat miles per gallon (Airlines for America, 2011, Air Transport Association, 2005). As such, U.S. commercial aircraft provide slightly better per-passenger fuel economy than an average-occupancy automobile for equivalent trip lengths. In a parallel to surface transportation, high-capacity aircraft generally provide more available seat miles per passenger gallon than do low-capacity aircraft.

With fuel costs increasing as a proportion of total operation and capital costs, airlines have a strong incentive to increase the fuel efficiency of their fleets. Newer aircraft are becoming more fuel efficient per available seat mile.

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Short-term strategies to reduce petroleum use include reducing flight distances – more point-to-point travel and fewer diversions due to weather or waypoints – and increasing occupancy, resulting in fewer flights per day. Airlines can also make existing aircraft more fuel efficient by reducing weight and retrofitting the airframe to add devices such as winglets.

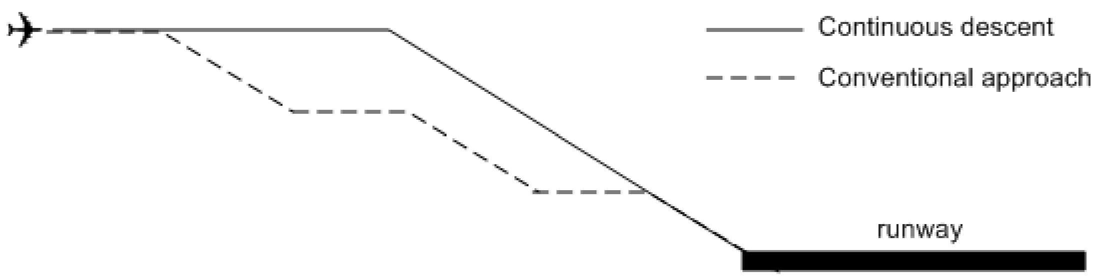
Medium and long-term strategies to reduce petroleum from aviation include gains in aircraft efficiency: more efficient engines and more aerodynamic aircraft. Long-term strategies largely focus on fuel switching—to biofuels—and mode-switching – replacing shorter aircraft trips with high-speed rail.

Continuous descent approach

Changing the operating rules for aircraft landings offers one near-term strategy to reduce aviation petroleum use from the existing aircraft fleet. Continuous descent approach, or optimized profile descent, allows aircraft to glide to the runway at a near-constant slope, in a seemingly straight line.

Current approach rules require an aircraft proceed to and level-off at predefined waypoints and altitudes – creating a descent reminiscent of descending a staircase. Descending to new altitudes and leveling off consumes additional fuel versus gliding at a near-constant slope.

Figure 1- Continuous descent versus conventional approach



FAA approach regulation

Safety considerations and the limitations of existing situational awareness and communications infrastructure limit current approach rules. [14 CFR Part 97] outlines the U.S. Federal Aviation Administration's authority to regulate instrument aircraft approach. The U. S. Federal Aviation Administration's Instrument Procedures Handbook (2007) details these guidelines. The instrument approach procedure involves several segments, each with different rules and minimum altitudes. Each approach segment is segregated by a waypoint (fix) and specifies a minimum altitude. If an aircraft reaches the minimum altitude prior to passing a waypoint, the pilot must level off the aircraft. This leveling off requires additional fuel use versus a continuous descent approach.

Existing regulations require some tradeoffs with aircraft and system operations and efficiency. One challenge to continuous descent approach is that gliding aircraft have higher ground speeds at higher altitudes – motivating the need for active air traffic management in order to maintain minimum aircraft separation. The current U.S. air traffic control system produces imprecise information about aircraft locations from radar-based systems and centralized commands are limited by delays in voice communications. As such, the rules for approach and aircraft separation attempt to accommodate imprecise information and control delays within an acceptable margin of safety.

The U.S. Federal Aviation Administration and airlines operating in U.S. airspace are implementing a Next Generation Air Transportation System. The system will produce more precise information on real-time aircraft location through use of GPS-enabled aircraft positioning. The system will also reduce communications and control delays through use of data communications – obviating the need for voice controls to issue certain aircraft positioning commands. With the Next Generation Air Transportation System, controllers will be able to issue multiple instructions simultaneously.

Real-time identification of aircraft positioning and communication of control instructions will also allow commercial aircraft to take shorter routes between origin and destination, traveling along more direct routes versus the flight paths currently instituted to ensure proper separation of cross-traffic.

Continuous descent approach in California

The FAA began testing continuous descent approach at Los Angeles International Airport (LAX) in September of 2007. A study used a combination of real-world observations and modeling results to consider the environmental benefits and logistical challenges of implementing continuous descent approach in one of the nation's busiest air spaces (Dinges, 2008). Because the existing air traffic control system poses a logistical challenge to implementing continuous descent approach across all flights, only a portion of flights used the approach technique at the time of the study.

The study highlighted marked decreases in noise levels in neighborhoods along approach corridors. These noise reductions would be become more significant as more flights used the approach technique: reducing 45 dB exposure by as much as 20.2% with all flights using the approach technique (Dinges, 2008).

The study also considered fuel use under a variety of continuous descent approach implementation scenarios. With 100% of aircraft using the approach technique, the study expected fuel savings of up to 24.2% for the arrival phase. However, because of a low proportion of aircraft using the continuous descent approach technique, actual observed fuel savings were low: about 0.3%. According to the study's author, the lower observed value was due in part to differences between real-world implementation and the hypothetical modeled scenarios (Dinges, 2008).

One challenge to maintaining proper aircraft separation is controlling the speed of the approach. Approach rules require minimum separation distances at high altitudes and minimum in-trail separation distances prior to landing. Nikoleris, Chatterji, and Coppenbarger (2012) recommend reducing descent speed as much as possible and then reducing cruise speed in order to maximize fuel savings amidst approach congestion. Boeing 757 aircraft have unique wake characteristics, which also present a challenge for separating aircraft on approach in congested airspace.

Estimating fuel savings from statewide use of continuous descent approach

Researchers have considered both modeling and real-world data to estimate the fuel savings benefits from continuous descent approach.

The study at Los Angeles International Airport estimated up to a 24.2% reduction in fuel use for the landing phase (aircraft operations under 10,000 feet) (Dinges, 2008).

An aircraft's takeoff phase uses the most energy per aircraft mile of travel. The cruise phase uses less. The approach phase is generally the most efficient, because the aircraft can gain speed on descent. Amortizing the approach savings over the entire flight produces estimates for the overall aviation fuel savings that would result from implementation. Robinson, et al. (2010) find national fuel savings potential to be 3% of total fuel consumption. Alcabin, et al. (2010), find similar results.

In California, aviation fuels comprise 14.7% of statewide petroleum consumption, 3% of which equals 0.4% of statewide petroleum use.

Potential fuel savings could be somewhat muted in California due to complex airspace in the San Francisco and Los Angeles areas – which each have several commercial airports with flight patterns that may constrain an aircraft's ability to make the most fuel-efficient glide-in on approach (Alcabin et al, 2009). Additionally, it's possible that this constraint will reduce the proportion of aircraft that can utilize continuous descent approach. Jin, et al. (2013) recommend that limited applications of continuous descent approach prioritize heavy aircraft in order to maximize overall fuel savings.

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