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Analysis of Optimized Descents for Selected Beechcraft 1900D Flights

The use of continuous descent from cruise altitude at an optimum descent power setting has a number of benefits for commercial operators including reduced fuel burn and associated costs, increased engine life and thus reduced maintenance costs, and finally increased safety margin by allowing the aircraft to stay as high as possible for as long as possible in mountainous terrain. The need for dive and drive descents is also eliminated, unless otherwise instructed by Air Traffic Control (ATC) or prescribed by an instrument procedure.

A selected number of Beechcraft 1900D flights flown by a Canadian regional airline were analyzed to calculate their actual block fuel burn and block times. Six flights were chosen from scheduled operations on December 3rd, 2013 based on online data available on FlightAware.com. Using the FlightAware's flight trajectory data, forecast upper winds and temperature data from NAV CANADA's AWWS website, METAR data and aircraft performance data contained within the Pilot's Operating Manual (POM), it was possible to estimate the block fuel burn of each flight using reasonable assumptions.

Another set of fuel burn and time calculations was performed based on optimized descents from the actual cruise altitude to the beginning of the actual final approach. The descent was optimized by extending the Top of Descent point and then using a descent profile of 1,500 fpm at 200 KIAS per the POM. The results comparing the actual (baseline) flights to the flights with optimized descents are presented in Table 1. Note that when approaching a terminal area, ATC will typically instruct a crew when to start their descent, however a crew may also request their descent if they have accurate performance data and traffic permits. Approaches may be conducted under instrument or visual flight rules.

Flight Reference	Cruise Altitude (ft)	Block Time (min)	Opt. Descent Block Time (min)	Delta Block Time (min)	Block Fuel Burn (lb)	Opt. Descent Block Fuel Burn (lb)	Delta Block Fuel Burn (lb)
Flight A	12,100	49.5	49.2	-0.4	667.4	652.8	-14.7
Flight B	17,000	66.3	67.1	0.8	946.8	940.1	-6.8
Flight C	18,000	82.0	83.1	1.1	1245.2	1211.3	-33.9
Flight D	24,000	72.0	73.0	1.0	976.6	935.0	-41.6
Flight E	9,200	30.0	30.2	0.2	389.8	388.6	-1.2
Flight F	24,000	77.1	75.7	-1.5	957.2	931.2	-26.0
	Average:	62.8	63.0	0.23	863.8	843.1	-20.7

Table 1 – Baseline vs. Optimized Descent Block Time & Fuel Burn for Selected 1900D Flights [December 3, 2013]

The results show that the block time increased by average of 0.2 minutes for optimized descents versus baseline, however the average total fuel burn decreased by 20.7 lb. The fuel burn was reduced for every optimized descent, however the higher the cruise altitude, generally the greater the fuel savings.

Assuming that the cost of the increased block time is negligible, an estimate of the annual cost savings based on a cost of $1.50/L for Jet A and fifty daily 1900D daily flights is presented in Table 2.

Flight Type	Average Fuel Burn/Flight (lb)	Average Fuel Cost/Flight [$1.50/L] ($)	Annual Fuel Cost [50 flights/day] ($)
Actual-Baseline	863.8	$731.01	$13,340,875.30
Opt. Descent	843.1	$713.49	$13,021,176.16
Delta	-20.7	-$17.52	-$319,699.14
Delta %	-2.4	-2.4	-2.4

Table 2 – Estimated Annual 1900D Fleet Fuel Burn Savings Using Optimized Descents

Therefore, the annual fuel burn savings for this airline's fleet 1900D fleet are estimated to be just under $320,000.00 using optimized descents alone. The average block fuel burn saving is 2.4% assuming every flight is optimized. Furthermore, the life of the PT6A-67D engines will very likely be extended due to greater time spent at a reduced throttle setting during descent and due to less thermal cycles because of less level-offs during descent. However, operational constraints such as ATC instructions, airspace, terrain, traffic or weather may preclude every descent from being optimized.

Another consequence of more efficient operations in descent is a reduction in greenhouse gas emissions, specifically CO_2. Approximately 1.2 million pounds of CO_2 emission reductions could be realized annually by this airline by employing more optimized descents.

Flight Type	Average Fuel Burn/Flight (lb)	Average CO2 Emissions/Flight (lb)	Annual CO2 Emissions [50 flights/day] (lb)
Actual-Baseline	863.8	2,699.4	49,263,593.8
Opt. Descent	843.1	2,634.7	48,083,046.9
Delta	-20.7	-64.7	-1,180,546.9
Delta %	-2.4	-2.4	-2.4

Table 3 – Estimated Annual 1900D Fleet CO_2 Emission Reductions Using Optimized Descents

To conclude, the use of continuous descents at an optimum descent power setting (200 KIAS/1,500 fpm) will result in less fuel burn and hence fuel cost savings, as well as a probable increase in engine life which will result in reduced engine maintenance costs if the turboprop engines are maintained on an *on-condition* basis. CO_2 emissions will also be commensurately reduced, thereby minimizing the impact of operations on the environment. The increase in block time costs using optimized descents is estimated to be minimal. Furthermore, continuous descents to the beginning of approach have higher safety margins. Using a 1,500 fpm at 200 KIAS descent profile ensures that the aircraft stays as high as possible for as long as possible, an important consideration when operating in mountainous terrain. Dive and drive descent profiles, which increase crew workload and the risk of error, are also avoided.

There are a number of means to achieve more optimized descents, including:

- Changes to Standard Operating Procedures (SOP);
- Requesting and executing flight plans based on a 1,500 fpm at 200 KIAS descent profile and accurate upper winds and temperature (FD) forecasts;
- Use of Electronic Flight Bag solutions that provide the flight crews with advisory guidance based on actual, not forecast winds to calculate the Top of Descent point e.g. Specific Range Solutions'. *iPad Top of Descent App*.

