

737 FLIGHT PLANNING

INTRODUCTION

The Flight Planning section is provided to assist in determining fuel requirements when a computer flight plan is unavailable. The following data is based on the B737-200 with JT8D-17 engines.

The following tables are supplied to assist in manual flight planning:

- Simplified Flight Planning .74 mach cruise
- Optimum altitude and short distance cruise altitude

FLIGHT PLANNING ALLOWANCES

GROUND OPERATIONS

Average APU (Auxiliary Power Unit) fuel flow rate under normal operation is 260 LBS per hour.

Taxi fuel allowance is 42 LBS/minute. Average taxi fuel is 400 LBS. During peak departure times, taxi times may range from 30 to 45 minutes at large international airports.

CLIMB

The FAA requires that 250 KIAS (Knots Indicated Airspeed) or minimum speed to maintain control not be exceeded below 10,000 feet. Above 10,000 feet, speed is increased to 280 KIAS and M.73 at the mach changeover point.

A standard climb will burn approximately 3000 LBS, which will increase optimum and maximum altitudes by nearly 400 feet from takeoff to Top of Climb.

ALTITUDE SELECTION

The best fuel mileage for a given speed is achieved at optimum altitude. The fuel mileage penalty for operation of off-optimum altitudes at Mach .74 is listed below:

2000 feet above optimum, fuel penalty 1%
2000 feet below optimum, fuel penalty 2%
4000 feet below optimum, fuel penalty 6%
8000 feet below optimum, fuel penalty 15%

If operation below optimum altitude is required due to ATC requirements or outside circumstances, operation at LRC cruise speed will minimize excess fuel burn and prevent low arrival fuels. The fuel mileage penalty for LRC:

2000 feet above optimum, fuel penalty 1%
2000 feet below optimum, fuel penalty 1%
4000 feet below optimum, fuel penalty 3%
8000 feet below optimum, fuel penalty 7%

CRUISE

Long Range Cruise (LRC) is the recommended speed to minimize trip fuel. LRC is a speed that will provide 99% of the maximum fuel mileage but is slightly faster than MRC. For cruise operation within 2000 feet of optimum altitude, LRC can be approximated by flying a constant Mach .74 speed schedule.

STEP CLIMBS

There is an optimum altitude to fly a plane, based on its weight. As the weight of the plane changes, so does its optimum altitude. Therefore, as fuel burns during cruise, the optimum altitude increases. In addition, as fuel burns off, the airplane's tendency is to climb.

Typically, airlines are not allowed to do a climbing cruise, i.e. allow the airplane to slowly climb as fuel burns off. Rather they must fly at specified altitudes. For this reason, a step climb procedure is used. The object is to climb as high as feasible after takeoff to reach an altitude, where fuel consumption is minimal (optimum altitude). Under normal circumstances, 4000 feet step-climbs are utilized to save fuel over long distance flights.

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The normal procedure to accomplish this is to first climb to an altitude, which is slightly above (1000 to 2000 feet) the optimum altitude at takeoff. Then maintain this cruising altitude, until the optimum altitude has drifted upwards to an altitude approximately 2000 feet above your present altitude. This process takes approximately 3 hours (required time to burn off the necessary fuel weight).

The aircraft is then climbed 4000 feet, to again be higher than the optimum altitude (this procedure is known as bracketing). This allows the aircraft to straddle the optimum altitude, while minimizing the number of en-route step climbs (burn per step-climb is approximately 200 LBS of fuel).

If the step-climb altitude cannot be sustained for at least 200 nm prior to the top of descent point, the fuel benefits are negated.

Following the above procedure will save approximately 5-10% fuel, when compared to flying at one constant altitude over the entire trip.

DESCENT

This data includes the effect of a speed restriction of 250 KIAS or minimum speed to maintain control below 10 000 feet and includes a straight-in approach with gear down and landing flaps 30 at the outer marker. Add additional fuel for flaps down maneuvering at the rate of 100 LBS per minute. Add additional fuel for flaps and gear down maneuvering at the rate of 125 LBS per minute.

MISSED APPROACH

Approximately 1200 LBS of fuel is burned during the missed approach maneuver and VFR pattern back to landing, based on applying go-around power from the landing configuration, returning for landing and flying a 3 mile final.

SIMPLIFIED FLIGHT PLANNING .74 MACH CRUISE

The Simplified Flight Planning (SFP) charts are provided to determine the trip fuel and time from brake release to touchdown, when a computer generated flight plan is unavailable. The data is based on a flight profile of 250/280KIAS/.73 Mach climb, .74 Mach cruise speed, and .73 Mach/280/250 KIAS descent and a planned **landing weight of 85,000 LBS**. Burn is based upon a 4000 foot step climb procedure, maintaining an altitude within 2000 feet of the optimum.

	FL	TAS	FL	TAS	FL	TAS	FL	TAS	FL	TAS	FL	TAS
	370	424	350	426	330	430	310	434	290	430	270	417
NAM	TIME	BURN	TIME	BURN	TIME	BURN	TIME	BURN	TIME	BURN	TIME	BURN
2000	4:52	27.9	4:50	30.4	4:47	29.5	4:44	29.4	4:46	29.5	4:54	29.9
1750	4:17	24.6	4:15	25.4	4:13	25.0	4:10	25.1	4:11	26.0	4:18	26.3
1500	3:42	21.4	3:40	22.1	3:38	21.7	3:36	21.8	3:37	22.0	3:42	22.3
1250	3:06	18.2	3:05	17.9	3:03	17.8	3:01	17.9	3:02	18.1	3:06	18.5
1000	2:31	14.3	2:30	14.2	2:29	14.2	2:27	14.3	2:27	14.5	2:31	14.8
750	1:56	10.8	1:55	10.8	1:53	11.1	1:52	11.2	1:52	11.3	1:54	11.4
500	1:20	8.0	1:20	8.0	1:19	7.9	1:18	7.9	1:17	7.9	1:18	8.0
250	0:45	5.1	0:44	5.0	0:43	4.9	0:43	4.8	0:42	4.7	0:42	4.6

Table created using FSBuild 2.2

BURN is only valid for a landing weight of 85,000 lbs. For each 10,000 lbs above/below 85,000 lbs, add/subtract 3% of fuel burn for each flight hour.

e.g. For a 2hr flt w/ a landing weight of 95,000 lbs, increase the BURN by 6% (3% per hr for a 2hr flt) to account for the additional weight carried.

NAM (Nautical Air Miles) = ground distance multiplied by the ratio (TAS/Ground Speed), where headwind and tailwind have negative and positive effects respectively. Average TAS (True Airspeed, knots) can be obtained from the .74 table above. E.g. FL370, TAS = 424.

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To determine trip fuel and time enter the chart with the air distance for the trip. Air distance is the ground distance corrected for anticipated enroute wind component. Fuel burn is listed below the reference Flight Level (FL).

OPTIMUM/MAX ALTITUDE AND SHORT DISTANCE CRUISE ALTITUDE

The optimum altitude for best fuel mileage is presented for LRC or .74 Mach speed schedules at various cruise weights. The fuel mileage penalty for operating off-optimum altitude is listed under the Altitude Selection section.

GROSS WEIGHT (1000 LBS)	OPTIMUM ALTITUDE	MAX. ALTITUDE (1.3g)
130	29000	31600
120	31000	33300
110	33000	35200
100	35000	37000
90	37000	37000
80	37000	37000
70	37000	37000
60	37000	37000

The distance to perform a climb and descent may limit the short distance operation. The short distance chart shows the highest altitude at which the level cruise portion of flight is at least one minute.

DISTANCE (NM)	GROSS WEIGHT (1000 LBS)			
	80	90	100	110
100	220	200	190	180
150	310	290	270	250
200	370	350	330	310
250	370	370	350	330
300	370	370	350	330

1. temperatures above ISA+10 will reduce flight level 2000 ft unless short cruise segment is included.
2. Enter table with flight distance and gross weight.
3. Follow designated speed schedule (280/M.73 to flight level (adjusted to nearest level for direction of flight), then begin descend according to speed schedule (M.73/280/250 below 10,000 ft).

e.g. 200nm trip, at 100,000 lbs gross weight = FL330 short range cruise altitude.

BASIC FLIGHT PLANNING

Regulations require that flight planning take into account both meteorological conditions and any delays that are expected in flight. The flight must carry sufficient fuel and oil to ensure a safe completion; in addition, reserve fuel shall be carried to provide for contingencies.

TAXI FUEL - Normal fuel allowances for engine start and taxi out including APU use. When statistical taxi times are unavailable, default values may be used (400 LBS). Additional taxi fuel should be loaded for known delays.

TRIP FUEL - Fuel required from start of takeoff, through climb, cruise, descent and approach to touchdown at destination assuming departure on the departure procedure from the most used runway and arrival on the longest likely approach. This data is obtained from the SFP .74 Mach cruise chart. Note: effects of temperature deviation on trip fuel are negligible.

ALTERNATE FUEL - Fuel to execute a missed approach at the planned destination; thereafter, to divert to the alternate airport, execute an approach and landing. The alternate is normally the nearest suitable alternate. In addition, certain International operators add a 5% contingency amount to the Alternate Fuel. The simplified flight planning chart does not include the 5% adjustment.

RESERVE FUEL - The minimum planned fuel remaining in the tanks at normal landing weight. This amount is calculated at 45 minutes normal cruise fuel consumption. A requirement to include a possible unusable fuel, may require a 20% increase in reserve fuel. A default reserve value of 4500 LBS can be used for manual flight planning purposes.

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CONTINGENCY FUEL - Amount of fuel to provide for the increased fuel consumption on the occurrence of potential contingencies, including errors in forecast wind/temperature, as well as ATC restrictions on Flight Level, route, and speed schedule.

The normal contingency fuel ranges from a minimum of 500 LBS to a maximum of 5900 LBS.

EXTRA FUEL - Fuel carried in addition to required fuel is known as extra fuel. Extra fuel may be carried for operational or economic reasons. Typical extra fuel is carried for possible destination holding or economic fuel tankering.

The following is an example of the steps used to determine the proper fuel loading using the flight planning charts and allowances (in the event a computer flight plan is unavailable). A gross error check can be accomplished by multiplying the estimated flight time by 6000 lbs, for approximate trip fuel.

Example:

Departure = KORD (Chicago-O'hare)
Destination = KDEN (Denver)
Alternate = none
Dry Operating Weight = 66,200 LBS
Payload = 17,640 LBS
Zero Fuel Weight = 83,840 LBS

1. Add the Reserve Fuel (4500#) and Contingency fuel (min of 500#) to the Zero Fuel Weight (ZFW), to determine the planned landing weight at the alternate airport.

83,840 ZFW + 4500 RSV + 500 CONT = 88,840 LBS planned landing weight at the destination.

2. Determine the trip fuel using the simplified flight planning chart and calculate the required contingency fuel.

Departure = KORD (Chicago-Ohare)
Destination = KDEN (Denver)
Route = KORD IOW J10 LBSF SAYGE4 KDEN
Altitude = FL350
Ground Distance (KORD to KDEN) = 779 nm
Average TAS = 426 knots @ M.74 cruise @ FL350
Wind Component = 30 knots headwind
Average Groundspeed = 396 knots
Air Distance = 838 nm (779 nm corrected for 30 kts of headwind)
Planned Landing Weight @ Destination = 88,840 LBS
Trip Fuel = 12,414 LBS
Contingency = 500 LBS
Air Time = 2:07

The total required fuel should include taxi fuel, trip fuel, alternate fuel if applicable, reserve fuel, and contingency fuel.

Taxi Fuel = 400 LBS
Trip Fuel = 12,414 LBS
Alternate Fuel = N/A
Reserve Fuel = 4500 LBS
Contingency Fuel = 500 LBS
Total Block Fuel = 17,814 LBS