CRUISE

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CRUISE FLIGHT

Overview: Correct planning for cruise flight is extremely important for the safe and timely operation of any aircraft. The tremendous range and endurance capabilities of the aircraft allow for transition through many different flight environments during a single operation and it is not uncommon for flight planning to occur six to nine hours prior to scheduled arrival at a destination airport. The time involved in longer range flying may allow for significant changes in weather or ATC conditions during the course of a flight, so to ensure safe and consistent results, it is important that crews thoroughly understand the inter-relation of the variables involved in cruise flight planning.

The three variables most directly affecting the aircraft's cruise flight performance are: *Planned Landing Weight, Cruise Altitude* and *Cruise Speed.* Increasing or decreasing any one of these variables may have a significant impact on fuel consumption and range capability of the aircraft while in flight. Proper determination of aircraft load weights combined with well thought out selection of flight level and Mach cruise speeds are integral to accurate performance planning.

Definitions: Following are a number of definitions used in cruise flight planning.

Planned Destination: The destination at which the crew intends to land the aircraft.

Planned Alternate: The airport which has been selected as an alternate destination should landing at the Planned Destination airport be closed, or otherwise unsuitable for landing.

Basic Operating Weight: The weight of the aircraft minus any passengers, baggage, cargo or usable fuel. This weight figure includes items such as the weight of the aircraft structure, hydraulic fluid, air conditioning fluids, residual fuel, residual oil, crew, crew luggage, potable water, passenger accommodation fluids, and normal passenger service equipment normally carried on board.

Payload: Weight of all passengers, bags or cargo to be carried aboard the aircraft during flight.

Zero Fuel Weight: The weight of the aircraft after the payload has been added to the Basic Operating Weight. This number yields the weight of the aircraft prior to any useable fuel is loaded.

Final Reserve Fuel: This is the absolute minimum reserve fuel weight that should be tolerated on any flight. Optimally, this number represents the weight of usable fuel still remaining on board the aircraft in the *worst case scenario*. (E.g. the crew is forced to land at the planned alternate airport after a combination of missed approaches and airborne holding at the original destination.) This weight figure would represent the amount of fuel still remaining after engine shutdown.

Alternate Fuel: The fuel weight required to fly the aircraft from the planned destination to the planned alternate airport, should it become necessary.

Holding Fuel: Contingency fuel boarded to allow for airborne holding or multiple approaches to the planned destination airport.

Planned Aircraft Landing Weight: This figure represents the highest potential weight of the aircraft upon landing at the original destination airport. (eg: no missed approaches, no airborne holding and best fuel economy while en-route.) This weight is determined by adding **Final Reserve Fuel, Alternate Fuel** and **Route Reserve Fuel** to the **Zero Fuel Weight.** This weight figure will be used to determine nearly all other aspects of cruise altitude, range and fuel load.

Flight Planned Fuel Load: This figure represents the fuel load which is required to fly the aircraft form the airport of origin to the aircraft of destination, not accounting for any en-route airborne holding or missed approaches. This figure is affected by a combination of planned aircraft landing weight, desired Mach cruise speed, and cruise altitude en-route.

Desired Cruise Speed: The Mach speed selected for use during cruise. Mach cruise speed setting can have a significant impact on the fuel flow encountered during flight. Mach .76 is generally used for Long Range Cruise flight, while Mach .78 is considered a High Speed Cruise.

Maximum Gross Taxi Weight: The maximum weight at which the aircraft may be dispatched for taxi. This is a structural limit weight which is determined by the manufacturer to prevent over-stressing structural members within the aircraft.

Maximum Gross Takeoff Weight: This figure denotes the maximum weight at which the aircraft may be allowed to commence the takeoff roll. This figure is a structural limit weight designed to prevent over-stressing of structural members within the aircraft.

Maximum Gross Landing Weight: This figure denotes the maximum weight at which the aircraft may be allowed to land. This figure is a structural limit weight designed to prevent over-stressing of structural members within the aircraft.

Maximum Allowable Takeoff Weight: Unlike Max Gross Takeoff Weight, this figure is a *variable* figure and changes with each flight. This weight limit factor can be caused by insufficient runway length at the departure airport or density altitude at the departure airport. More commonly this type of limit factor will be experienced on shorter flights where the Planned Landing Weight for the flight is near the structural Max Gross Landing Weight. When this occurs, the departure weight of the aircraft must be restricted in order to prevent arrival at the destination at a weight exceeding the Max Gross Landing Weight of the aircraft.

Maximum Allowable Landing Weight: This figure is a variable figure specific to each flight. This weight could be a limit factor caused by insufficient runway length at the destination airport, or high-density altitude at the destination airport.

Weight Restrictions: During flight planning, it is important that the aircraft weight is maintained within the parameters of **Maximum Gross Landing Weight**, **Maximum Gross Takeoff Weight**, and **Maximum Taxi Weight.** As the fuel planning schematic is being filled in, crews should verify weight compliance. If a maximum structural weight or maximum operational weight is exceeded, the crew should either consider reducing aircraft weight by removal of passengers or cargo. If passengers or cargo cannot be removed, a reduced fuel load should be boarded, with plans made for an en-route fuel stop.

Fuel Planning Schematic 737-600

Basic Operating Empty Weight:	______________
Payload:	______________
Zero Fuel Weight:	(Must be less than 114,000)
Zero Fuel Weight:	______________
Final Reserve Fuel:	______________
Alternate Fuel:	______________
Holding Fuel:	______________
Planned Landing Weight:	(Must be less than 120,500)
Planned Landing Weight:	______________
En-Route Fuel Burn Off:	______________
Planned Gross Takeoff Weight:	(Must be less than 127,000)
Planned Gross Takeoff Weight:	______________
Taxi Fuel Burn Off:	______________
Planned Taxi-Out Weight:	(Must be less than 127,500)

Schematic should be used to ensure compliance with structural weight limits.

Crews should verify that planned takeoff and planned landing weights are not limited by reduced runway lengths or high density altitudes.

Fuel Planning Schematic 737-700

Basic Operating Empty Weight:	______________
Payload:	______________
Zero Fuel Weight:	[ ] (Must be less than 120,500)
Zero Fuel Weight:	______________
Final Reserve Fuel:	______________
Alternate Fuel:	______________
Holding Fuel:	______________
Planned Landing Weight:	[ ] (Must be less than 128,000)
Planned Landing Weight:	______________
En-Route Fuel Burn Off:	______________
Planned Gross Takeoff Weight:	[ ] (Must be less than 133,000)
Planned Gross Takeoff Weight:	______________
Taxi Fuel Burn Off:	______________
Planned Taxi-Out Weight:	[ ] (Must be less than 133,500)

Schematic should be used to ensure compliance with structural weight limits.

Crews should verify that planned takeoff and planned landing weights are not limited by reduced runway lengths or high density altitudes.

Fuel Planning Schematic 737-800

Basic Operating Empty Weight:	______________
Payload:	______________
Zero Fuel Weight:	(Must be less than 136,000)
Zero Fuel Weight:	______________
Final Reserve Fuel:	______________
Alternate Fuel:	______________
Holding Fuel:	______________
Planned Landing Weight:	(Must be less than 144,000)
Planned Landing Weight:	______________
En-Route Fuel Burn Off:	______________
Planned Gross Takeoff Weight:	(Must be less than 155,500)
Planned Gross Takeoff Weight:	______________
Taxi Fuel Burn Off:	______________
Planned Taxi-Out Weight:	(Must be less than 156,000)

Schematic should be used to ensure compliance with structural weight limits.

Crews should verify that planned takeoff and planned landing weights are not limited by reduced runway lengths or high density altitudes.

Fuel Planning Schematic 737-900

Basic Operating Empty Weight: ______________

Payload: ______________

Zero Fuel Weight: [ ]

(Must be less than 138.300)

Zero Fuel Weight: ______________

Final Reserve Fuel: ______________

Alternate Fuel: ______________

Holding Fuel: ______________

Planned Landing Weight: [ ]

(Must be less than 146,300)

Planned Landing Weight: ______________

En-Route Fuel Burn Off: ______________

Planned Gross Takeoff Weight: [ ]

(Must be less than 174,200)

Planned Gross Takeoff Weight: ______________

Taxi Fuel Burn Off: ______________

Planned Taxi-Out Weight: [ ]

(Must be less than 174,700)

Schematic should be used to ensure compliance with structural weight limits.

Crews should verify that planned takeoff and planned landing weights are not limited by reduced runway lengths or high density altitudes.

FUEL LOAD ESTIMATION 737-600

DISTANCE: When Trip Length in Nautical Air Miles falls between levels on mileage scale, interpolate time and fuel required for trip. Example: 1700 NAM @ FL330 equals 4:09 and 19,200lbs.

Table is based on following speed schedule:

CLIMB: 250 KIAS to 10,000 feet; 280KIAS or 0.78M to cruise altitude
CRUISE: 0.78M cruise sped at Altitude
DESCENT: Mach .78 to FL250; 280 KIAS between FL250 and 10,000; 240KIAS below 10,000ft

Example: For 2200 NAM @ FL370, fuel required would equal 23,600lbs and flight time is estimated to equal 5:08.

AIR DIST (NAM)	PRESSURE ALTITUDE (1000FT)									
	29		31		33		35		37	
	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME
200	3.1	0:38	3.1	0:37	3.1	0:37	3.1	0:36	3.1	0:36
400	5.3	1:08	5.3	1:07	5.3	1:06	5.1	1:05	5.1	1:04
600	7.5	1:39	7.5	1:37	7.3	1:34	7.3	1:33	7.1	1:31
800	9.9	2:09	9.7	2:06	9.5	2:03	9.3	2:00	9.0	1:59
1000	12.1	2:39	11.9	2:36	11.5	2:31	11.2	2:28	11.0	2:26
1200	14.3	3:09	14.1	3:04	13.7	2:59	13.4	2:56	13.2	2:53
1400	16.8	3:38	16.3	3:33	15.9	3:27	15.7	3:23	15.2	3:20
1600	19.2	4:07	18.5	4:01	18.1	3:55	17.6	3:50	17.2	3:47
1800	21.4	4:37	20.9	4:30	20.3	4:23	19.8	4:18	19.4	4:14
2000	23.8	5:06	23.1	4:58	22.5	4:51	21.8	4:45	21.4	4:41
2200	26.2	5:34	25.6	5:26	24.9	5:18	24.3	5:12	23.6	5:08
2400	28.7	6:03	28.0	5:53	27.1	5:45	26.5	5:39	25.8	5:34
2600	31.1	6:31	30.2	6:21	29.5	6:12	28.7	6:06	28.0	6:01
2800	33.7	6:59	32.6	6:49	31.7	6:39	30.9	6:33	30.2	6:28
3000	36.2	7:28	35.1	7:16	34.2	7:06	33.1	7:00	32.4	6:55
3200	38.6	7:55	37.5	7:43	36.6	7:33	35.5	7:26	34.8	7:21
3400	41.2	8:22	40.1	8:10	39.0	8:00	37.9	7:53	37.3	7:48
3600	43.9	8:50	42.5	8:37	41.4	8:27	40.1	8:20	39.7	8:14
3800	46.5	9:17	45.2	9:04	43.9	8:53	42.5	8:46	42.1	8:41
4000	48.9	9:44	47.6	9:31	46.3	9:20	45.0	9:13	44.3	9:07
4200	51.8	10:11	50.3	9:58	48.7	9:47	47.6	9:39	47.0	9:34
4400	54.5	10:38	52.9	10:24	51.4	10:13	50.0	10:06	49.6	10:00
4600	57.1	11:05	55.6	10:51	53.8	10:39	52.7	10:32	52.2	10:27
4800	60.0	11:31	58.2	11:17	56.4	11:06	55.1	10:59	54.9	10:53
5000	62.6	11:58	60.8	11:44	59.1	11:32	57.8	11:25	57.5	11:20

FUEL LOAD ESTIMATION 737-700

DISTANCE: When Trip Length in Nautical Air Miles falls between levels on mileage scale, interpolate time and fuel required for trip. Example: 1700 NAM @ FL330 equals 4:10 and 19,650lbs.

Table is based on following speed schedule:

CLIMB: 250 KIAS to 10,000 feet; 280KIAS or 0.78M to cruise altitude
CRUISE: 0.78M cruise sped at Altitude
DESCENT: Mach .78 to FL250; 280 KIAS between FL250 and 10,000; 240KIAS below 10,000ft

Example: For 2200 NAM @ FL370, fuel required would equal 24,200lbs and flight time is estimated to equal 5:10.

AIR DIST (NAM)	PRESSURE ALTITUDE (1000FT)									
	29		31		33		35		37	
	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME
200	3.3	0:38	3.3	0:37	3.3	0:37	3.3	0:37	3.3	0:37
400	5.5	1:09	5.5	1:07	5.4	1:06	5.3	1:05	5.3	1:04
600	7.8	1:39	7.7	1:37	7.5	1:35	7.4	1:33	7.3	1:32
800	10.1	2:10	9.9	2:07	9.7	2:04	9.5	2:01	9.3	2:00
1000	12.4	2:40	12.1	2:36	11.8	2:32	11.6	2:29	11.4	2:27
1200	14.7	3:09	14.4	3:05	14.1	3:00	13.7	2:57	13.5	2:54
1400	17.1	3:39	16.7	3:33	16.3	3:28	15.9	3:24	15.6	3:22
1600	19.5	4:08	19.0	4:02	18.5	3:56	18.1	3:52	17.7	3:49
1800	21.9	4:38	21.3	4:31	20.8	4:24	20.2	4:20	19.9	4:16
2000	24.3	5:07	23.6	4:59	23.0	4:52	22.4	4:47	22.0	4:43
2200	26.8	5:36	26.1	5:27	25.4	5:19	24.7	5:14	24.2	5:10
2400	29.3	6:04	28.5	5:55	27.7	5:47	27.0	5:42	26.5	5:37
2600	31.8	6:32	30.9	6:23	30.1	6:14	29.3	6:09	28.8	6:04
2800	34.3	7:01	33.3	6:50	32.4	6:42	31.6	6:36	31.1	6:31
3000	36.8	7:29	35.8	7:18	34.8	7:09	33.8	7:03	33.3	6:58
3200	39.4	7:57	38.3	7:45	37.2	7:36	36.3	7:30	35.8	7:24
3400	42.1	8:24	40.9	8:12	39.7	8:03	38.7	7:57	38.3	7:51
3600	44.7	8:52	43.4	8:40	42.2	8:30	41.1	8:23	40.7	8:17
3800	47.3	9:19	46.0	9:07	44.7	8:57	43.6	8:50	43.2	8:44
4000	49.9	9:47	48.5	9:34	47.2	9:24	46.0	9:17	45.7	9:11
4200	52.7	10:13	51.2	10:01	49.8	9:50	48.7	9:43	48.1	9:37
4400	55.5	10:40	53.9	10:27	52.4	10:17	51.3	10:10	50.6	10:04
4600	58.3	11:07	56.6	10:54	55.1	10:43	54.0	10:36	53.1	10:30
4800	61.0	11:34	59.3	11:21	57.7	11:10	56.6	11:03	55.6	10:57
5000	63.8	12:01	62.0	11:48	60.4	11:37	59.3	11:29	58.0	11:24

FUEL LOAD ESTIMATION 737-800

DISTANCE: When Trip Length in Nautical Air Miles falls between levels on mileage scale, interpolate time and fuel required for trip. Example: 1700 NAM @ FL330 equals 4:12 and 19,900lbs.

Table is based on following speed schedule:

CLIMB: 250 KIAS to 10,000 feet; 280KIAS or 0.78M to cruise altitude
CRUISE: 0.78M cruise sped at Altitude
DESCENT: Mach .78 to FL250; 280 KIAS between FL250 and 10,000; 240KIAS below 10,000ft

Example: For 2200 NAM @ FL370, fuel required would equal 24,500lbs and flight time is estimated to equal 5:07.

AIR DIST (NAM)	PRESSURE ALTITUDE (1000FT)									
	29		31		33		35		37	
	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME
200	3.3	0:38	3.3	0:37	3.3	0:37	3.3	0:36	3.3	0:37
400	5.5	1:09	5.5	1:08	5.4	1:06	5.3	1:05	5.3	1:04
600	7.7	1:40	7.7	1:08	7.5	1:36	7.5	1:33	7.3	1:31
800	10.1	2:11	9.9	2:09	9.7	2:05	9.5	2:01	9.4	1:58
1000	12.6	2:42	12.1	2:39	11.9	2:34	11.6	2:29	11.5	2:25
1200	15.0	3:12	14.6	3:08	14.3	3:02	13.9	2:56	13.7	2:52
1400	17.4	3:42	16.9	3:37	16.5	3:30	16.1	3:23	15.8	3:19
1600	19.8	4:12	19.2	4:06	18.7	3:58	18.3	3:51	18.0	3:46
1800	22.3	4:42	21.6	4:35	21.2	4:26	20.5	4:18	20.2	4:13
2000	24.7	5:11	24.0	5:04	23.4	4:55	22.7	4:45	22.3	4:40
2200	27.1	5:40	26.4	5:32	25.8	5:22	25.1	5:12	24.5	5:07
2400	29.8	6:09	28.8	5:59	28.2	5:49	27.6	5:39	26.8	5:34
2600	32.4	6:38	31.5	6:27	30.6	6:17	29.8	6:06	29.2	6:00
2800	34.8	7:06	33.9	6:55	33.1	6:44	32.2	6:33	31.5	6:27
3000	37.5	7:35	36.4	7:23	35.5	7:11	34.4	7:00	33.7	6:54
3200	40.1	8:03	39.0	7:49	37.9	7:38	36.9	7:26	36.3	7:20
3400	42.8	8:30	41.7	8:16	40.6	8:05	39.4	7:53	38.8	7:47
3600	45.6	8:58	44.3	8:43	43.0	8:31	41.8	8:20	41.5	8:13
3800	48.3	9:26	46.9	9:10	35.5	8:58	44.3	8:46	43.9	8:39
4000	50.9	9:53	49.6	9:37	48.1	9:25	46.8	9:13	46.3	9:06
4200	53.8	10:20	52.2	10:09	50.1	9:51	49.5	9:39		
4400	56.6	10:47	55.1	10:30	53.4	10:18	52.2	10:05		
4600	59.5	11:14	57.8	10:56	56.2	10:44	54.8	10:32		
4800	62.3	11:41	60.6	11:23	58.9	11:10	57.4	10:58		

FUEL LOAD ESTIMATION 737-900

DISTANCE: When Trip Length in Nautical Air Miles falls between levels on mileage scale, interpolate time and fuel required for trip. Example: 1700 NAM @ FL330 equals 4:00 and 22,500lbs.

Table is based on following speed schedule:

CLIMB: 250 KIAS to 10,000 feet; 280KIAS or 0.78M to cruise altitude
CRUISE: 0.78M cruise sped at Altitude
DESCENT: Mach .78 to FL250; 280 KIAS between FL250 and 10,000; 240KIAS below 10,000ft

Example: For 2000 NAM @ FL370, fuel required would equal 25,800lbs and flight time is estimated to equal 4:36.

AIR DIST (NAM)	PRESSURE ALTITUDE (1000FT)									
	29		31		33		35		37	
	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME
200	3.7	0:38	3.3	0:38	3.7	0:37	3.7	0:38	3.7	0:38
400	6.3	1:06	6.3	1:05	6.2	1:05	6.1	1:04	6.1	1:04
600	8.8	1:35	8.8	1:33	8.6	1:32	8.5	1:31	8.4	1:31
800	11.4	2:03	11.2	2:01	11.0	1:59	10.9	1:58	10.8	1:57
1000	14.1	2:31	13.8	2:28	13.5	2:26	13.3	2:25	13.2	2:24
1200	16.8	2:59	16.4	2:55	16.1	2:53	15.8	2:51	15.7	2:50
1400	19.5	3:26	19.1	3:22	18.6	3:20	18.3	3:18	18.3	3:17
1600	22.2	3:54	21.7	3:50	21.2	3:47	20.8	3:44	20.8	3:43
1800	24.9	4:21	24.3	4:17	23.8	4:13	23.3	4:11	23.3	4:09
2000	27.6	4:49	27.0	4:44	26.3	4:40	25.8	4:38	25.8	4:36
2200	30.5	5:15	29.7	5:10	29.0	5:06	28.5	5:04		
2400	33.3	5:42	32.5	5:37	31.8	5:33	31.3	5:30		
2600	36.2	6:09	35.3	6:03	34.5	5:59	34.0	5:57		
2800	39.0	6:36	38.1	6:30	37.2	6:25	36.7	6:23		
3000	41.9	7:03	40.9	6:56	39.9	6:52	39.4	6:49		
3200	44.9	7:29	43.8	7:23	42.9	7:18				
3400	47.9	7:56	46.8	7:49	45.8	7:44				
3600	51.0	8:22	49.7	8:15	48.7	8:10				
3800	54.0	8:48	52.7	8:41	51.7	8:36				
4000	57.0	9:15	55.6	9:07	54.6	9:02				
4200	60.2	9:40	58.8	9:33						
4400	63.4	10:06	62.0	9:59						
4600	66.6	10:32	65.2	10:25						
4800	69.8	10:58	68.3	10:51						
5000	73.1	11:24	71.5	11:17						

FUEL PLANNING METHODOLOGY

Overview: Accurate fuel planning is critical to the safe outcome of every flight. Proper and effective fuel planning will reduce the opportunity for enroute diversion and will significantly increase safety margins when flying into inclement weather.

Crews should pay careful attention to the projected forecast and factor the "unknown" potential for changes along their route of flight. Landing with adequate fuel still on the aircraft is always preferable to landing with minimum fuel remaining.

The following outlines in detail the steps necessary to ensure sound fuel planning criteria.

Determine Trip Length: The first step toward planning an accurate fuel load is to determine the geographic distance covered by the route of flight. For example, assume that the flight being operated between KIAD (Washington DC) and KSFO (San Francisco) 2200nm apart.

Knowing the geographic distance of the planned flight route is only half of the requirement, however. Next, it is important to take into account the wind conditions as these may significantly change the equation!

For example, the prevailing winds along this route tend to be from the west which results in a nearly continual headwind along the route. Determining the effect of these winds is a three step process:

Using the *Trip Length* column on the **Flight Planning Table**, determine the approximate time it will take to fly the route. (In this case, a 2,200 NM trip will take approximately 5:20.)

Next, consulting an enroute wind forecast, the winds along the route of flight must be estimated. (For the purpose of this example, let us assume the winds are expected to be 75nm/hr directly opposite our direction of flight.

It is not hard to conceptualize that a 75 knot headwind along the route of flight will dramatically slow down our progress over the ground and thus lengthen the amount of time it takes to reach KSFO.

Since we anticipate taking longer to reach KSFO, it is also easy to conceptualize that we will burn more fuel as a result of the headwind since we will be flying a longer period of time.

To determine the effect this wind will have on the flight, we multiply our expected flight time in still air (already determined in the previous step) by the expected headwind speed. Thus: (5:20 hours x 75kts) = 400.

This figure is called an "wind component adjustment" and will always be positive when flying into a headwind, or negative when flying with a tailwind.

By adding the wind component adjustment to our known flight plan distance, we are able to determine the Nautical Air Miles to be flown:

(2,200nm + 400) = 2,600 NAM.

Nautical Air Miles can be described as the number of miles that will be flown through air. Obviously, we will traverse 2200nm when flying from KIAD to KSFO, but since the air mass through which we are flying is moving in the opposite direction, we will spend more time flying through this air mass in order to cover the additional 400nm of air that is moving west to east along our route of flight.

Nautical Air Miles is a more accurate way to estimate the time and fuel required to accomplish a given route segment because it takes into account the primary determining factor of flight time: winds!

Estimate Fuel Required: Once again using the Fuel Load Estimation table, we now enter the table using Nautical Air Miles as our distance requirement. Enter the Fuel Estimation Table, being careful to select the correct flight length in NAM, as well as the planned cruising altitude. In this example, we will select FL370.

With a NAM trip distance of 2,600 NAM and a planned cruise altitude of 37,000 feet, we can expect to burn 28,000lbs of fuel during a 6:04 flight.

It is important for crews to understand that this is an estimate of fuel required, and that the Fuel Planning Schematic Charts provided earlier in this chapter should be used to double check the required fuel load.

Planning to reach the Alternate: To improve the accuracy of the fuel load planning, we must consider not only the amount of fuel required to reach our destination, but we also must consider how much fuel is required for contingencies related to weather or air traffic control.

For example, assuming that weather conditions require that our flight plan include an alternate destination in the eventuality that we cannot land at KSFO as a result of fog.

We have chosen KRNO as an alternate destination, and it is obviously important that we have enough fuel remaining after our approach to KSFO that we will be able to reach KRNO should it be necessary!

To estimate the fuel required to reach KRNO, we employ nearly the identical process using the FUEL ESTIMATION TABLE.

KRNO is approximately 200nm from KSFO, thus according to the table we can anticipate burning 3,300lbs of fuel during a 0:38 minute flight from KSFO to KRNO.

We now have two fuel calculations to keep track of:

- Fuel needed to reach the destination: 28,000lbs
- Fuel needed to reach our alternate 3,300lbs.

This gives us a fuel requirement of 31,300lbs to make the flight to KSFO and still have enough fuel to reach KRNO should that become necessary.

Holding your fuel: After reviewing our flight plan, assume that we feel there is a strong likelihood that we will be placed in holding before landing at KSFO as a result of the forecast fog. It is always a good idea to plan for holding fuel, as this allows you to spend some time “loitering” while waiting for your opportunity to shoot the approach and landing at your final destination.

Determining how much fuel to add for holding is a decision that is normally made in consultation between the airline dispatcher and the crew. The decision is made based on experience, knowledge of the airplane and the severity of the conditions into which the airplane is to be flown.

In our example, we will assume that an additional 2000lbs of fuel is added in case we are required to hold before landing at KSFO.

Now we have a total of THREE fuel items to keep track of:

- Fuel needed to reach the destination: 28,000lbs.
- Fuel needed to reach our alternate 3,300lbs.
- Holding Fuel: 2,000lbs.

The total fuel we need is now up to 33,300lbs.

Getting to the runway: When planning an accurate fuel load, it is also important to consider the amount of fuel that is burned during taxi from the gate to the runway.

For the Next Generation 737 series, 500lbs is generally considered sufficient for taxi fuel.

The lowest the gauge should read: The last (and some argue most important!) factor to consider during the fuel planning is this: “what is the lowest amount of fuel that I want to have on the airplane after landing?”

For example, if we burn 500lbs of fuel during taxi, then 28,000lbs of fuel enroute to KSFO, but get stuck in holding until we’ve burned all 2,000lbs of hold fuel, then divert to KRNO and use 3,300lbs of fuel just getting there, WE HAVE NOW RUN OUT OF FUEL!

In aviation it is highly important to always plan for the worst case scenario, so we are going to add just a tiny bit more fuel to our fuel calculation. Generally speaking each aircraft has a “no lower than” fuel figure that is used by the crew as a last fallback measure to ensure that the aircraft never lands with the low-fuel lights illuminated.

This figure is called “Minimum Landing Fuel” or, more succinctly, the lowest amount of fuel you will ever have on the airplane at the time of touchdown.

This figure is generally around 0:45 of fuel remaining in all tanks, and is the figure you would only expect to see in the *very* worst case scenario. For the Next Generation 737 series, this fuel amount is normally 1,800lbs.

Working the problem backward: Now that we have conducted all of these calculations to determine how much fuel we need, it is sometimes helpful to consider the fuel process from the end of flight and move forward.

We have the following figures that we need to consider:

What’s the lowest amount of fuel I want to see on the gauges after having to hold enroute, shoot an approach (or two!) divert to an alternate destination, shoot an approach (or two!) and land?

That figure is 1,800lbs.

Next we consider how much fuel it takes to reach our alternate destination:

That figure is 3,300lbs.

Next we consider how much fuel is required in the outside change that we wind up being held enroute:

That figure is 2,000lbs.

Next we consider how much fuel is required to fly the planned route of flight:

That figure is 28,000lbs.

Finally we consider how much fuel is required to get from the departure gate to the runway:

That figure is 500lbs.

So we have:

Reserve Fuel: 1,800lbs
Alternate Fuel: 3,300;bs
Holding Fuel: 2,000lbs
Enroute Fuel: 28,000lbs
Taxi Fuel: 500lbs.

Total fuel required for the flight equals: 35,100lbs!

It is important that crews plan their fuel loads based on the most reasonable expectations for the flight.

If the forecast is calling for clear and unrestricted weather, than obviously it isn’t necessary to plan for holding, or an alternate- and this dramatically reduces the fuel requirement for the flight.

Most professional pilots would much prefer to carry too much fuel than too little, however as it is easier to take your time and make a sound decision when you are not worried about running out of fuel!

Plan ahead!

FMC Fuel Management: While entering flight data into the FMC, crews may find it beneficial to enter a RESERVES figure into the INIT PERF page of the FMC. This figure should generally consist of Final Reserve Fuel + Alternate Fuel. By entering this figure into the FMC, the crew will allow the on-board system to serve as a last resort fallback should fuel usage exceed that originally planned for the flight. The FMC will provide such warning by alerting the crew to INSUFFICIENT FUEL.

THIS ALERT SHOULD NEVER BE IGNORED!

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