



Fuel Calculation

A thorough fuel calculation is part of every flight preparation. Especially on flights over great distances it is important to know which distance one can travel with which fuel capacity. Knowing how long the flight can last may help to plan flights and to react to special situations (bad weather, planned airport not approachable, etc.). If you have the possibility to attach drop tanks keep in mind that additional fuel consumption comes with the increased flight time and distance.

The intent of this article is the explanation of the methods of fuel calculation for the L-39ZO used in the Air Force of the former GDR. However, some of these particulars are valid for other versions of the L-39, too.

Conditions

The data given in the tables are valid on the following conditions:

Empty Weight	3 500 kg (7716 Lbs)
Fuel Density	0,78 kg/Liter (6.5 Lbs/US-Gal)
Standard Atmosphere	temperature 15°C (59° F)
	pressure 1013,2 mbar (29.92 in. Hg)
	sea level
	temperature variation -2° per 1 000 ft
Conversion	1 US-Gal = 3,7853 Liter
	1 NM = 1,852 km

Fuel capacities

The following fuel methods are considered:

- A-1: fuselage tank
- A-2: fuselage tank + tip tanks
- B-1: fuselage tank + tip tanks + 2 drop tanks with 150 Liter / each
- C-1: fuselage tank + tip tanks + 2 drop tanks with 350 Liter / each

These methods result in the following fuel capacities:

	Fuselage Tank			Tip Tank			Drop Tank 150 l			Drop Tank 350 l			Amount		
	kg	Liter	Gal	kg	Liter	Gal	kg	Liter	Gal	kg	Liter	Gal	kg	Liter	Gal
A-1	824	1056	279										824	1056	279
A-2	824	1056	279	156	200	53							980	1256	332
B-1	824	1056	279	156	200	53	234	300	79				1214	1556	411
C-1	824	1056	279	156	200	53				546	700	185	1526	1956	517



Standard consumption data

For the phases of flight that are performed always the following fuel consumption data are defined:

	kg	Liter	Gal
Start up, Taxiing, Run up	70	90	23
Landing (Traffic Pattern)	40	51	13
Landing (ILS 5 000 ft)	95	122	32

The landing takes place with a remaining fuel amount of:

	kg	Liter	Gal
Landing with remaining Fuel	150	192	50

Additions

The fuel consumption during cruise increases because of the drop tanks. You can calculate the increase by multiplying with the following factors:

Method	Factor
A-1	1,00
A-2	1,00
B-1	1,20
C-1	1,40

If flights are performed in a formation, the fuel consumption increases. It can be calculated with additions or with factors.

add for		kg	Liter	Gal	Factor
Take off	2 Aircraft	40	51	13	
	4 Aircraft	55	71	18	
Climb	2 Aircraft				1,10
	4 Aircraft				1,15
Cruise	2 Aircraft				1,00
	4 Aircraft				1,07
Break, Landing	2 Aircraft	40	51	13	
	4 Aircraft	55	71	18	

For climbing you have to apply the factors to the distance, the time and the fuel consumption, for cruise to the fuel consumption only.

Speeds

To reach the data shown in the tables and graphics, certain speeds are determined for the different phases of flight.



Climb

The climbing is performed with maximum engine power and with the following speeds depending on the pressure altitude:

pressure altitude	climb speed
up to 19 000 ft	220 KIAS
up to 25 000 ft	190 KIAS
up to 32 000 ft	175 KIAS

Cruise

The speeds for maximum flight time and maximum flight distance result from the graphs for the necessary thrust in horizontal flight depending on the pressure altitude. These speeds are shown in the graphic of the fuel consumption in kg/min. For various pressure altitudes they are:

Speeds for maximum endurance

pressure altitude	KTAS	KIAS
3 000 ft	150	145
10 000 ft	170	145
16 000 ft	190	145
26 000 ft	220	145

Speeds for maximum range

pressure altitude	KTAS	KIAS
3 000 ft	225	215
6 500 ft	230	210
10 000 ft	235	205
13 000 ft	250	200
16 500 ft	255	195
20 000 ft	270	190
23 000 ft	275	185
26 000 ft	285	180

Descent

The descent will be performed with a speed of 220 KIAS and the engine on idle power.

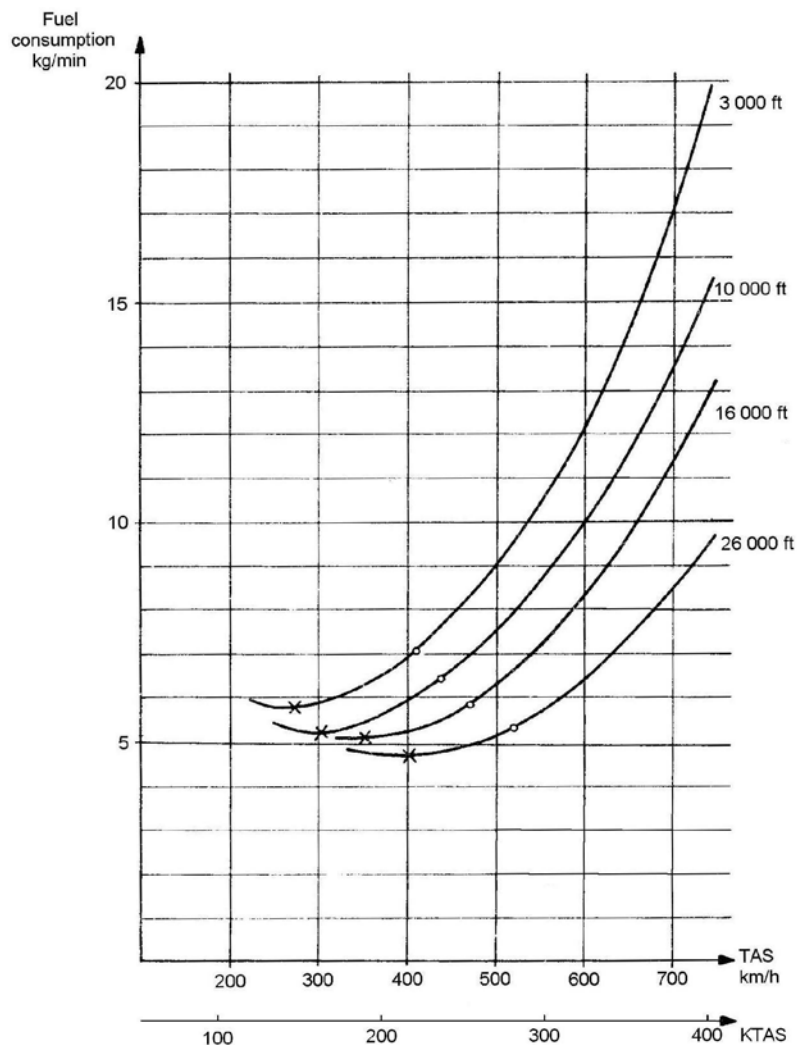


Fuel consumption

Climb

up to pressure altitude	distance		A-1 and A-2				distance		B-1 and C-1			
			time min	fuel consumption					time min	fuel consumption		
	km	NM		kg	Liter	Gal	km	NM		kg	Liter	Gal
3 000 ft	7	3,8	0,8	35	44,9	12	8	4,3	1,0	40	51,3	14
6 500 ft	13	7,0	1,7	45	57,7	15	17	9,2	2,1	50	64,1	17
10 000 ft	20	11	2,6	60	76,9	20	27	15	3,3	65	83,3	22
13 000 ft	29	16	3,6	75	96,2	25	39	21	4,7	85	109	29
16 500 ft	40	22	4,8	90	115	30	54	29	6,5	100	128	34
20 000 ft	53	29	6,2	105	135	36	75	40	9,0	125	160	42
23 000 ft	67	36	8,2	120	154	41	103	56	12,5	150	192	51
26 000 ft	84	45	10	140	179	47	150	81	18,0	180	231	61

Cruise



The graphs show the fuel consumption in kg/min depending on the pressure altitude over the actual speed KTAS. The speed for maximum endurance for the respective pressure altitude is marked as „X“, the speed for maximum range is marked as „o“.



Descent

from pressure altitude	distance		A-1 and A-2 time fuel consumption				distance		B-1 and C-1 time fuel consumption			
	km	NM	min	kg	Liter	Gal	km	NM	min	kg	Liter	Gal
26 000 ft	85	46	8,6	40	51,3	14	64	35	12,8	44	56,4	15
23 000 ft	70	38	7,3	35	44,9	12	55	30	11,6	38	48,7	13
20 000 ft	57	31	6,0	25	32,1	8	48	26	10,2	34	43,6	12
16 500 ft	45	24	4,5	20	25,6	7	40	22	8,8	29	37,2	10
13 000 ft	35	19	3,6	15	19,2	5	32	17	7,2	23	29,5	8
10 000 ft	26	14	2,9	12	15,4	4	24	13	5,6	18	23,1	6
6 500 ft	17	9	1,8	10	12,8	3	16	9	3,8	13	16,7	4
3 000 ft	9	5	1,0	7	8,9	2	9	5	1,9	8	10,3	3

Calculation

Because most L-39 operators are interested in how long they can stay airborne with their aircraft or how far they can fly, we now explain how to calculate the maximum endurance and maximum range for the respective fuel method and planned cruise altitude using the above mentioned data.

Starting from the available fuel capacity the following consumption data will be subtracted first:

- consumption for start up, taxiing and run up
- consumption for planned landing procedure
- remaining fuel for landing

Now the data for fuel consumption for the climb to and the descent from the planned cruise altitude will be taken from the given tables and subtracted from the before calculated fuel capacity.

The result is the fuel capacity that is available for the time or the distance at the planned altitude.

From the graphic the fuel consumption in kg/min will be taken, either for maximum endurance or maximum range. This fuel consumption will be multiplied with the factor according to the respective drop tanks. With this the time will be calculated during which the aircraft can fly at the planned altitude with the available fuel capacity.

To calculate the maximum endurance for a fuel method the times for climb and descent will be added to the calculated flight time at planned altitude. This maximum endurance will be reached when observing the above mentioned speed.

For determining the maximum range at the planned altitude, take the fuel consumption for maximum range and the available fuel capacity to calculate the time at the planned altitude. Take this time and the speed for the maximum range at the respective altitude to calculate the distance that is covered at that altitude. Add the distances for climb and descent to determine the maximum range for this fuel method.

For a few selected pressure altitudes the following data of maximum endurance and maximum range result for the aircraft L-39ZO for the possible fuel methods:



Maximum endurance

pressure altitude	A-1	A-2	B-1	C-1
3 000 ft	1:30	1:57	2:11	2:26
10 000 ft	1:39	2:09	2:28	2:45
20 000 ft	1:38	2:09	2:31	2:51

Maximum range

pressure altitude	A-1	A-2	B-1	C-1
3 000 ft	284 NM	368 NM	409 NM	454 NM
10 000 ft	325 NM	420 NM	468 NM	523 NM
20 000 ft	414 NM	539 NM	605 NM	690 NM

Summary

The used data were gathered from the Instruction A 101/1/101 for the Operation and the Procedures of the Aircraft L-39ZO of the Air Force of the former GDR. The calculated data were confirmed during military flight operation under observance of the determined flight methods.

This article may help to perform a quick and clear fuel calculation. It also helps to decide when it makes sense to use drop tanks or when the disadvantage of the increased fuel consumption outweighs the advantage.