Managing an Oxygen Contingency
Part 3

Alright, this could be the final article of oxygen 101. Let's get to the main issue at hand, and that is tying up the loose ends between fuel, oxygen and specific flight parameters.

If you remember our biggest obstacle was to develop a method that would allow us to convert oxygen bottle pressure to time remaining (duration) keeping in mind that time becomes the common denominator between the fuel and oxygen resources. The way that we balance these resources is by changing the altitude of the aircraft. Fly higher…more fuel…less oxygen. Fly lower…. more oxygen…. less fuel. This flexibility becomes an invaluable commodity to cope with any oxygen contingency. I suppose another way to define an oxygen contingency would be any time you don't have enough fuel at 10,000 ft to continue the flight and safely land, you may need to climb higher to conserve fuel, this certainly would fall under an oxygen contingency.

In the last issue of the LEC times, we left off with plotting time lines for fuel and oxygen so that the user could visually see the effects altitude has on these two resources. We need to apply this now to a specific flight profile to define the limits of these resources. The flight profile limitation is a time line that is comprised of ETP's, again affected by altitude. You will soon visually see the relationship of these 3 plotted values and how they impact time and altitude.

In fig. 1 we have plotted our fuel duration time line at various altitudes and like wise for the oxygen duration time line. What is missing from this equation is a time line comprised, of 4 different ETP's (equal time points) plotted at cardinal altitudes of 10,000, 15,000, 20,000 & 25,000 feet. This time line represents the worst case as outlined in the critical fuel scenario.

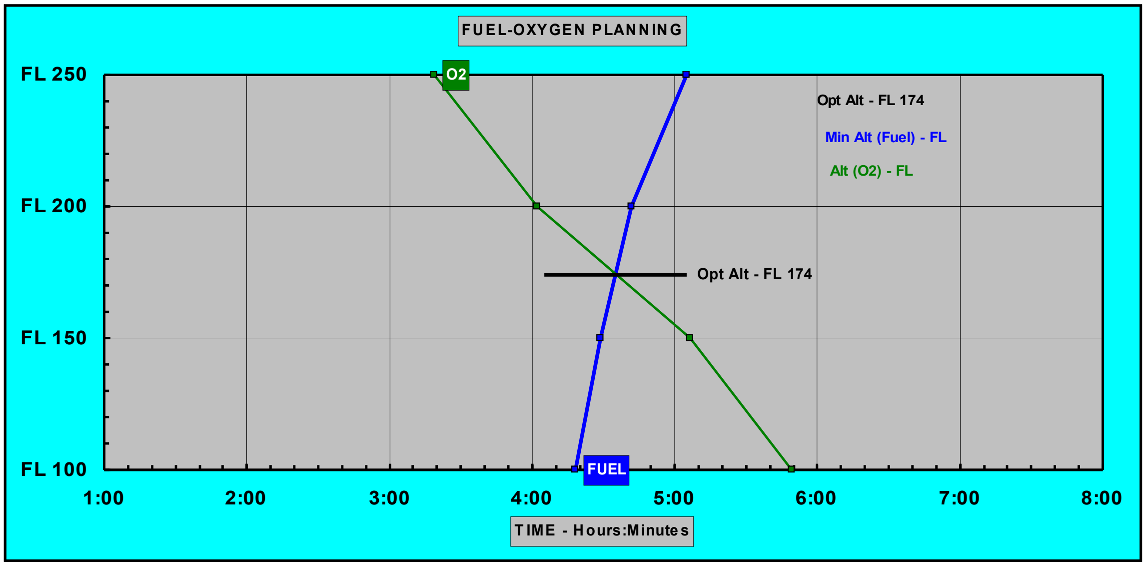

Fig. 1

Fig. 2 displays a red line (ETP time line) which defines the limit for this particular flight. Any resource (fuel or oxygen) to the right of the ETP red line indicates that you have adequate resources (time/duration) for this flight and that is observed by the increase in time along the horizontal X axis. Where the fuel and oxygen line intersect with the ETP line now become the altitude (duration) limits. In the fig. 2 a <u>minimum fuel altitude</u> for this flight would be 13,600 ft and a <u>maximum oxygen altitude</u> would be at FL 220. Where fuel and oxygen are equal in time is displayed as the <u>optimum altitude</u>.

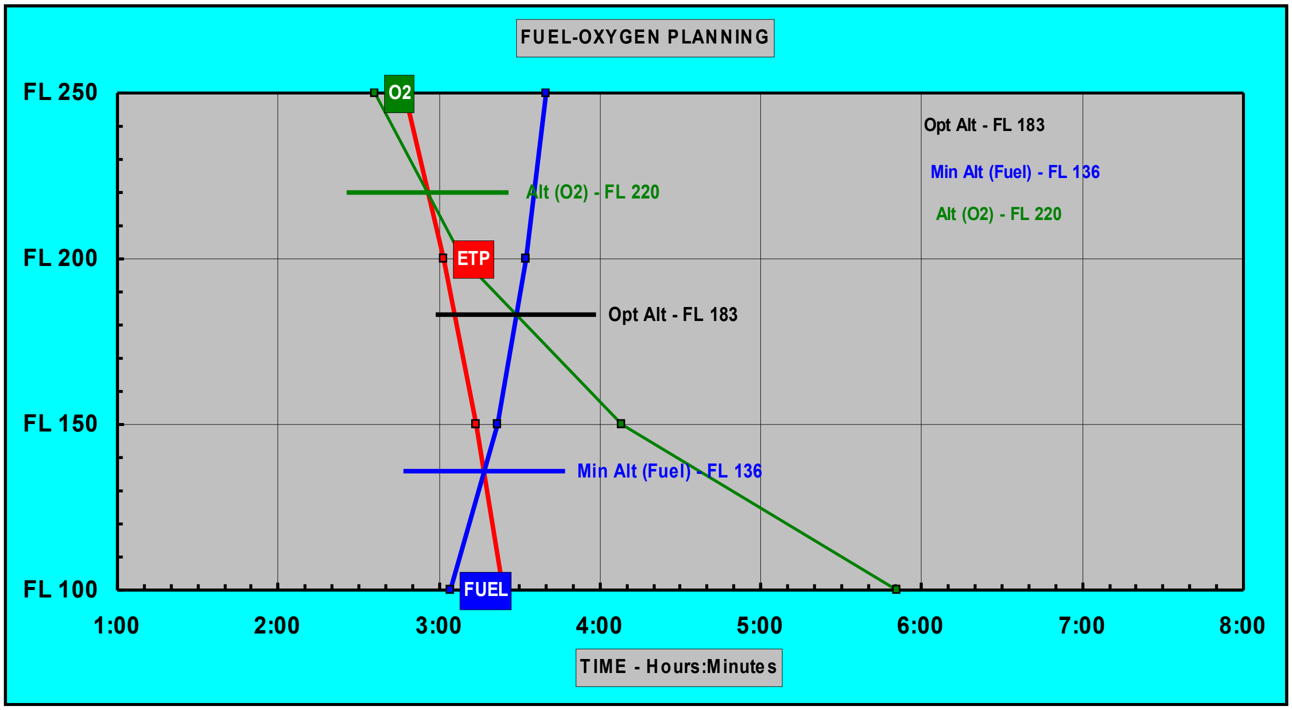

Fig. 2

The three of these variables are moving targets and although you may be dispatched with adequate reserves, it is essential to have the ability to monitor and compensate these three variables any time while in flight. This is an essential tool for any pilot that operates in an ETOP's flight environment.

This type of program is very easy to use as it only requires 3 simple inputs from the pilot.

1. How many people are breathing oxygen.
2. How much fuel is on board in pounds.
3. What is the oxygen on board in pressure………. the rest is automagic.

In the above example (fig.2) if landing fuel at the alternate airport is a concern perhaps due to weather, the ability to fly as high as FL 220 can increase the fuel reserve. Conversely if a crew member or passenger is experiencing any type of decompression sickness (DCS) the Captain has the ability to manage this oxygen situation by opting to fly at a lower altitude, in this instance 13,600', with adequate fuel to safely land.

Having a well defined oxygen plan is key to oxygen management. Let's look at some more oxygen contingencies that we can encounter.

- Partial loss of the cabin. This was referenced in article one and actually happened to me on a flight from Manaus to Teterboro. What would you do if you had a pressurization leak and you could only maintain a cabin altitude of 13,000 feet? Having an oxygen plan could make this a non-event in that if you know how much oxygen duration you have at any given altitude. You could still maintain your current aircraft altitude so no impact to your fuel or flight plan and this would simply be an inconvenience to the flight deck to utilize oxygen for the remainder of the flight due to flying at a higher ***cabin altitude***..

- Flight with one crew member on oxygen for regulatory requirements. As an FAR 121 air carrier crewmember, one pilot has to be on oxygen for flights above FL410. It may not happen often, but if it does, oxygen management needs to be considered. A question you might want to know would be how much oxygen is required for an emergency descent from altitude. I certainly would not want to reduce that oxygen reserve below that value needed for an emergency decent.

- Cracked windscreen. The AFM for the B-737 recommends that you raise the cabin altitude to reduce the cabin differential pressure. There could be instances depending where you are and how far you are from a suitable alternate where you might want to raise the cabin altitude above 10,000 feet for increased safety concerns.

- If you fly to New Delhi (Himalayas), to Europe (Greenland corridor) or in to South America (Andes Mountains) there are times depending on your route du jour that you may be dispatched with escape routes. Even if you don't utilize an escape route and you fly in those areas you may want to know a little bit more about your oxygen duration if a pressurization event takes place and descent to 10,000 feet would be undesirable or impossible.

- A smoke and fire event. This could be your biggest nightmare in that flow rates used for this scenario could be more than 10 times the normal oxygen flow rate. This event is time critical for the pilot to manage in that his options are few and all predicated on time. You certainly do not want to run out of oxygen before you execute some type of exit plan.

- Monitor your oxygen supply. This concept is based on flow rates, oxygen bottle size, number of oxygen bottles installed in the aircraft etc to predict a duration. This establishes a benchmark, a "how goes it" if you will for the oxygen system. If you have a leak in the system, it could be detected using this type of program. For example, in fig.3 if you start at 1600psi with two crew members using the system it will indicate that you have 4:03 of oxygen duration. If you check it again in 5 minutes and the oxygen bottle pressure now reads 1400psi then an assumption can be made that there is an oxygen leak of some sort in the system. In the case of the B-777 which has two 115 cubic ft. oxygen bottles installed, if you were to see this drop in pressure and time doubled this could be a good assumption that one of the oxygen bottles is not connected to the system, it's turned off, or perhaps discharged. Remember that there is only one pressure indication displayed on the EICAS for oxygen pressure, if one bottle is connected it will only read that oxygen bottles pressure. Pressure alone is no indication of duration.

FLIGHT LEVEL

150

Boeing 757 **N0000**

S/N 123 **115 Cu. Ft. Bottle**

NTPD	**LITERS**	**CREW SYSTEM**			
1800	3169	6:08	4:33	3:37	3:00
1600	2817	5:28	4:03	3:13	2:40
1400	2465	4:47	3:32	2:49	2:20
1200	2113	4:06	3:02	2:25	2:00
1000	1761	3:25	2:32	2:01	1:40
800	1408	2:44	2:01	1:36	1:20
600	1056	2:03	1:31	1:12	1:00
400	704	1:22	1:01	:48	:40
200	352	:41	:30	:24	:20
CREW		**1**	**2**	**3**	**4**
	REDUCTION FOR ON-BOARD DESCENT AND RESIDUAL				
		445	539	664	789

> I am sure there are other events that by employing some type of oxygen management program would reduce a pilot's exposure to uncertainty. Having the right tools for the right job is essential in any profession.

Almost finished. Let's not forget last issues thought provoking assignment.

Question:
At the end of last months article we posed a situation where after experiencing a rotor burst followed by a decompression and a descent to 10,000' how could we as pilots determine if we had induced drag because part of the cowling or some aircraft structure was hanging out in the jet stream. This is an important aspect as it will impact your fuel due to an increased drag profile resulting in an increased fuel consumption which could develop into an oxygen contingency by virtue of having to extend the aircraft range by flying at a higher altitude for fuel conservation. To do so, you need to know your oxygen duration.

The answer can be found in chapter 5 (performance) of the AFM. Find a manufacturers cruise mode that fits your situation. If it is single engine LRC, use that as your reference point. Pick the weight you are at and set the fuel flows that correspond to that weight. That fuel flow setting should produce a speed that is close to the AFM numbers. (this speed can be refined applying the drag factor found in the main body of the flight plan). If the speed and fuel flows correspond to the weight for that cruise mode then it is safe to assume that you do not have any additional induced drag.

However if after setting the required fuel flows the aircraft is not flying the airspeed profile for that weight……you can again prudently assume that you have something degrading the aircraft performance.

How can I as the pilot determine the increased amount of fuel consumption?

Answer:

Continue to add power until your TAS is equal to what is called for in the AFM for the current aircraft weight. Once you have stabilized that speed and note the new fuel flows, go back to the AFM, follow up the chart in the same column increasing the weight of the aircraft until you find the fuel flow that corresponds to the fuel flow you are currently flying to maintain this cruise mode. Let's say you are 20,000lbs above the actual weight of the airplane. The induced drag is equal to flying 20k over your actual weight. To properly assess your fuel increase you should continue to reference the performance cruise information for an aircraft that is acting as though it is 20k pounds heavier than it is. In other words you will have to use fuel flows for a heavier weight to determine the aircraft fuel range. *

After you have analyzed your fuel situation, if you do not have enough fuel at 10,000' you need to extend the range of the aircraft and flying higher is the first thought that's comes to mind. To do so you need to have sufficient oxygen, and this is where having an oxygen plan available becomes a very powerful and useful tool for the flight deck. Can we trick the FMS and change the fuel weight to help us quickly analyze the situation? Perhaps a question for our fleet managers as well as company engineering

Well, I guess this is it for oxygen101- managing an oxygen contingency. I hope that these articles have been successful in stimulating the thought process concerning the importance of oxygen management.

I know as a young pilot some 25 years ago when Bill Mack and I started this research/development initiative how important it was to have this very basic, very essential information available flying the world perhaps maybe a half dozen times a year. Now 25 years later this information has not lost its importance in the work place, it has actually increased due to the frequency of flying.

This technology is available and is slowly making its way into the industry. It would be an improvement over what we are currently referencing today.

I hope you have gained some insight into the complexity of this system as well as the importance it plays on many of our daily flights. Thank you for your attention and remember to fly safe and fly smart. Never stop thinking!!

- *Aircraft performance has always been measured as a function of specific range (nautical miles /pounds of fuel). Specific range has always been provided in chapter 5 of the AFM until recently. Without the AFM (aircraft flight manual) specific range as a bench mark, it is not an easy task to determine the performance of the aircraft without this information.

- ***Astronauts & Engineering:*** Specific range (SR) is determined by dividing the True Air Speed (TAS) by the fuel flow (FF).
- TAS/FF=SR
- If SR is a three place decimal (.256) each 1,000 of fuel equals a 256 mile distance/range.
- If SR is a four place decimal (.3665) each 10,000 # of fuel equals 3665 miles distance/range