



# AERONAUTICAL DATA SYSTEMS

## History

Aeronautical Data Systems was formed many years ago to continue development and marketing of an Oxygen Planning Product (OPP). The OPP is a unique program developed to assist the flight crew in determining whether their proposed flight across the oceanic areas or large precipitous landmasses could be safely flown. It would be disastrous to conduct a flight without due consideration of what the FAA defines as the “Worst Case Scenario”. Since that time new developments have evolved from this research and by employing an oxygen management system it will increase the safety and operational efficiency of flight operations in today’s flying environment.

## The “Situation”

For the international flight crew a “worst case scenario” is at the Equal Time Point (ETP), where time to return and time to continue flight are at their maximum. At this point the aircraft experiences an engine rotor burst with debris that penetrates the pressure vessel. The crew suddenly has a single engine, depressurized aircraft to get safely home. The most important commodity the crew has is the fuel on board (FOB). Fuel on board becomes the “driver” for this scenario. With more fuel available, a lower altitude can be tolerated, thus less oxygen will be required for the passengers and crew to successfully survive and continue flight to a suitable alternate airport. With less fuel available, the jet aircraft must fly higher to increase the specific range of the aircraft. This situation requires the flight crew to “balance” the available resources to safely and expeditiously complete the flight.

## The Solution

The OPP addresses two critical pieces of information (FOB and Oxygen duration) which enable the flight crew to quickly and accurately assess the “Worst Case Scenario”, make their judgement and have the ability to continue monitoring the resources to bring the flight to a successful conclusion. By having such a system available, it is now possible to upload the necessary resources required to make such a flight prior to departure and by doing so ostensibly eliminate this situation.

## Aircraft Performance



The first part of the OPP is the aircraft performance graphic display (figure 1). The graphic base axis is the geographic distance scale, the left hand vertical scale displays the fuel required to travel the required distance plus reserve fuel, the right hand scale is the ETE (estimated time enroute) to travel the required distance and becomes the basis for oxygen duration necessary at the cruise altitude.

## Oxygen Duration

The second part of the OPP is the tabulated oxygen duration chart (figure 2). It is arranged so that the number of passengers and crew are displayed across the base line and the chart is read vertically to the indicated oxygen bottle pressure and the calculated duration for those conditions is displayed. The conversion of cubic feet of oxygen at bottle pressure to liters of oxygen is automatically calculated on the tabulated chart. The liters available and the applicable oxygen flow rates are used to determine /calculate the oxygen duration.

In addition to the above primary use of the OPP there are some features that are valuable to the flight crew as they continue the flight. The first is the matrix of FAA approved Aircraft Flight Manual (AFM) performance data. Including the True Air Speed (TAS), Fuel Flow (FF) and the Specific Range (SR) for the weight, altitude and temperature the aircraft would be subject to. No other book or manual is necessary for the pilot to manage the situation, all the information necessary to monitor the situation and safely continue flight is readily accessible. If an emergency descent was necessary due to decompression, the calculation of oxygen expended by crew and passengers during the descent is included on the oxygen duration chart. The oxygen supply available should be reduced by the amount of oxygen expended when calculating oxygen duration.



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The ADS, OPP provides the flight crew with the necessary information to determine, *before* starting his flight, (Know *Before* you go!) if the planned flight can be conducted prudently and above all **safely**.

## How To!

With a computerized flight plan in hand the pilot simply projects an estimate of the FOB at the ETP and the distance to be flown to the closest suitable alternate or diversion airport. The distance is entered on the distance scale of the performance chart for the applicable altitude, move this point vertically to the estimated wind factor, move left to the vertical scale and read the fuel required at that altitude, if there is sufficient fuel with adequate reserve, the immediate emergency is over! If not, the crew must consult the next higher performance chart, read the chart as above, and when a “suitable” altitude is determined, (an altitude where fuel available equals the fuel required, with reserve) the crew now reads the right hand scale to determine the ETE at that altitude.

The crew must now address the oxygen requirements, at the “suitable” altitude, for the ETE and oxygen available for the crew and passenger complement. As stated in the description above the oxygen tabulated data is read from the base line (number of passengers and crew) vertically to the indicated oxygen bottle pressure intersection. Note: the oxygen bottle size and pressure are converted into liters of oxygen available as all oxygen mask flow rates are calculated in liters per minute. In the tabulated duration box the oxygen duration (time) for these conditions is indicated.

Every pilot is always cognizant of his fuel on board. The only thing worse than not having an adequate fuel supply would be a shortage of oxygen. Up to now the tools necessary to provide the pilot with a fast, accurate and concise method of evaluating a decompression problem have been lacking. The OPP provide the pilot the necessary information to cope with this contingency and safely continue the conduct of his flight. Once the flight crew is made aware of the OPP and recognizes the value of the OPP and given the fact that some operators MUST comply with regulatory requirements, the necessity for an OPP will become imminent.

## COMPUTERIZED PRESENTATION PROGRAM

The computer program (figure 3) is a continued improvement of the OPP. The computer program provides a synergy resulting in a more attractive and functional product. The OPP can and has been sold alone, however the computer program cannot be sold without the input data from the ADS OPP analysis

Before we continue some definitions and formulae are in order, here they are:



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ETP: Point where the over water distance is at the maximum and the time to continue to the coast in airport or return to the coast out airport is equal. Fuel and oxygen duration must exceed the ETE or results could be disastrous!

ETE: Distance divided by the TAS or GS expressed as a time.

OXYGEN DURATION: Liters of oxygen available divided by the total flow rate expressed as a time.

FUEL DURATION: Fuel available divided by fuel flow expressed as a time.

RANGE: Fuel available divided by fuel flow times the TAS/GS expressed as a distance.

## **RULES OF THUMB**

Range must always be longer than the ETP distance.

Oxygen duration must always exceed the ETE.

The ETE is the elusive quantity – it is a “proverbial” moving target. Anything affecting the aircraft TAS or GS changes the ETE. For example:

1. Aircraft gross weight.
2. Altitude.
3. Temperature.
4. Wind component.
5. An increase in aerodynamic drag profile.

Any change in the ETE must be continually addressed for both fuel and oxygen duration.

The software program developed by ADS assists the flight crew in making the initial decision and continually monitoring the results of any changes in the flight profile.

## **HOW?**

Calculate and display five ETP's, yes five! Read on.



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1. High-level ETP: Provides the flight crew with the ETP between “suitable” airports. It is calculated at the high altitude cruise TAS/GS. It is the decision point for the flight crew to either return to the “coast out” airport or to continue flight to the “coast in” airport.

FL 100 ETP: The ETP is calculated at the long-range cruise TAS/GS at ISA temperature. The TAS/GS varies with aircraft weight, altitude and temperature. If a decompression situation were encountered requiring an emergency descent, the aircraft would level off at FL 100 to assess the situation. A further course of action would then be contemplated. If fuel available exceeds the fuel required, the immediate emergency is over as no oxygen is required at FL 100. If fuel available does not exceed the fuel required the aircraft must climb to a higher altitude to increase the SR (specific range) in order to continue flight. Oxygen duration at FL 150 and higher must be addressed.

2. FL 150 ETP: Calculated as above. This altitude is utilized as an oxygen planning ETP.
3. FL 200 ETP: Calculated as above. This altitude is utilized as an oxygen planning ETP.
4. FL 250 ETP: Calculated as above. This altitude is utilized as an oxygen planning ETP and additionally as an engine inoperative ETP.

- A plot of the five ETP’s creates a sloping line from the cruise (HL) ETP down and to the right of our matrix to the FL 100 ETP. The slope of the plots is a function of TAS versus altitude that varies the plots with each change of altitude and TAS.
- The fuel duration plot is now overlaid on our grid. The fuel line slope is from the lower left to the upper right of the grid. Fuel plots are a function of the specific range at each altitude and aircraft weight. The higher the altitude the higher the specific range.
- The oxygen duration plot is now overlaid on our grid. The oxygen duration plots begin at the lower right and continue to the upper left. Biases of the oxygen duration include, crew regulatory oxygen, therapeutic use, emergency descent and residual oxygen calculations.

## Quick Analysis

The point where the fuel plot crosses the ETP plot indicates the **minimum altitude for fuel.**



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The point where the oxygen plot crosses the ETP plot indicates the **maximum altitude for oxygen.**

The point where the fuel and oxygen lines cross indicates the **optimum altitude for resource (fuel & O2) conservation.**

If the fuel plot at FL 100 falls to the right of the ETP line **fuel available exceeds fuel required.**

The smaller the triangle formed by the min altitude for fuel and the max altitude for oxygen indicates a possible critical circumstance, requiring continual monitoring of the situation.

Utilizing the computer program provides multiple solutions instantly and with greater accuracy and precision. The basic input to solve any of these solutions has been reduced to three simple inputs from the flight deck. The pilot needs only to know:

- How many people are using the system.
- How much fuel is remaining.
- What is my oxygen bottle pressure?

All of this information is tailored to each specific aircraft performance and oxygen design. In addition, therapeutic consumption, regulatory consumption, emergency descent profile consumption and one engine inoperative variables are available, depending on the situation.

This program is not only a preplanning tool but can be used dynamically in flight as well.

And so you see by having this type of information available achieves many things. I'd briefly like to touch on the importance of oxygen management and discuss the benefits of utilizing some form of oxygen planning. Safety is always paramount, so in addition to what is always foremost in a flight here are other advantages:

- Increase oxygen ceiling restriction from 10,000' to 25,000'.
- Less fuel required for the flight plan.
- More fuel available for other considerations (weather, decompression sickness, etc)
- FAR compliance.
- Increase ETOP's coverage.
- More routing flexibility (Utilize 180 minute ETOP instead of 120 minutes due to less req. fuel at the ETP).
- Prevents unnecessary fuel stop.
- Resolves fuel oxygen/conflicts progressively, quickly and accurately.
- Provides for increased payload.
- Reduces over weight landings.



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- Permits departure with less than full oxygen.
- Allows maximum utilization of on board oxygen supply.
- Provides data for partial loss of cabin pressurization.
- Reduces number of alternate airports required.
- Provides consumption data for regulatory, therapeutic and emergency descent requirements.

And so you can see the advantages of having this information available is priceless. Today's aircraft can fly to almost any place in the world and so fuel for a normal flight is not an issue. However, without having some type of oxygen management system in place you could be oxygen restricted.

The ability to know before you go removes the guess work and in doing so essentially does away with the worst case scenario, thereby reducing the exposure to a wet foot print. As the pilot you are tasked with safe passage for crew and passenger, employing some type of oxygen management system will certainly assist you in doing so.

I hope that you have found this concept to be technologically enlightening to a point where you will now begin to consider the importance of some type of oxygen management program for your flight department. Thank you for your time and interest in our product. I hope to hear from you soon.

Sincerely,

Jim Stabile

VP Aeronautical Data Systems Inc.

# GULFSTREAM G-IV-SP

# R.R. TAY611-8 ENGINES

TWIN ENGINE 25,000 FEET I.S.A.

SPECIFIC RANGE vs. WIND COMPONENT						
WT LBS	TAS KTS	FUEL FLOW	100KT HW	50KT HW	ZERO WIND	50KT TW
70K	411	3620	.0859	.0997	.1134	.1273
68K	406	3530	.0867	.1008	.1149	.1292
66K	400	3440	.0872	.1017	.1164	.1308
64K	395	3350	.0881	.1030	.1180	.1328
62K	390	3260	.0890	.1043	.1197	.1350
60K	383	3160	.0896	.1054	.1213	.1370
58K	378	3070	.0906	.1068	.1231	.1394
56K	372	2980	.0913	.1081	.1249	.1418
54K	365	2880	.0920	.1094	.1268	.1441
52K	358	2780	.0928	.1108	.1288	.1468
50K	352	2690	.0937	.1123	.1309	.1494
48K	344	2590	.0942	.1135	.1330	.1521
46K	336	2500	.0952	.1152	.1352	.1552
44K	331	2410	.0959	.1166	.1375	.1581

\*INT'L B.O.W. = 45,000

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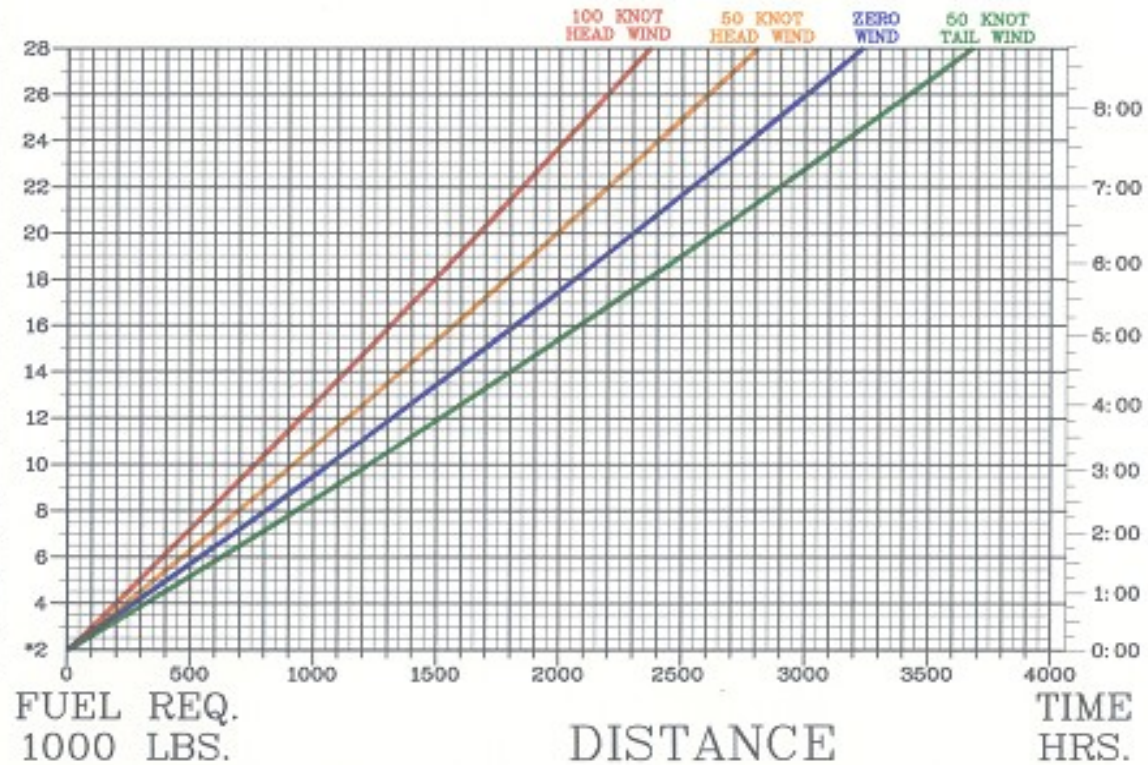


Fig. 1

# Oxygen Duration

Flight Level: 250

GULFSTREAM 200  
N0000  
S/N 000

PASSENGERS AND CREW  
1 x 115 Cu. Ft. Bottle

NTPD	LTRS	PASSENGERS AND CREW												
		1	2	3	4	5	6	7	8	9	10	11	12	13
1850	4882	13:47	10:59	9:08	7:49	6:50	6:04	5:27	4:57	4:32	4:11	3:53	3:37	3:24
1800	4750	13:25	10:41	8:53	7:36	6:39	5:54	5:18	4:49	4:25	4:04	3:47	3:32	3:18
1700	4486	12:40	10:06	8:24	7:11	6:16	5:34	5:01	4:33	4:10	3:51	3:34	3:20	3:07
1600	4222	11:55	9:30	7:54	6:45	5:54	5:15	4:43	4:17	3:55	3:37	3:22	3:08	2:56
1500	3958	11:10	8:54	7:24	6:20	5:32	4:55	4:25	4:01	3:41	3:24	3:09	2:56	2:45
1400	3694	10:26	8:19	6:55	5:55	5:10	4:35	4:07	3:45	3:26	3:10	2:56	2:44	2:34
1300	3430	9:41	7:43	6:25	5:29	4:48	4:15	3:50	3:29	3:11	2:56	2:44	2:33	2:23
1200	3167	8:56	7:07	5:55	5:04	4:26	3:56	3:32	3:13	2:56	2:43	2:31	2:21	2:12
1100	2903	8:12	6:32	5:26	4:39	4:03	3:36	3:14	2:57	2:42	2:29	2:18	2:09	2:01
1000	2639	7:27	5:56	4:56	4:13	3:41	3:16	2:57	2:40	2:27	2:16	2:06	1:57	1:50
900	2375	6:42	5:20	4:26	3:48	3:19	2:57	2:39	2:24	2:12	2:02	1:53	1:46	1:39
800	2111	5:57	4:45	3:57	3:22	2:57	2:37	2:21	2:08	1:57	1:48	1:41	1:34	1:28
700	1847	5:13	4:09	3:27	2:57	2:35	2:17	2:03	1:52	1:43	1:35	1:28	1:22	1:17
600	1583	4:28	3:33	2:57	2:32	2:13	1:58	1:46	1:36	1:28	1:21	1:15	1:10	1:06
500	1319	3:43	2:58	2:28	2:06	1:50	1:38	1:28	1:20	1:13	1:07	1:03	0:58	0:55
400	1056	2:58	2:22	1:58	1:41	1:28	1:18	1:10	1:04	0:58	0:54	0:50	0:47	0:44
300	792	2:14	1:47	1:28	1:16	1:06	0:59	0:53	0:48	0:44	0:40	0:37	0:35	0:33
200	528	1:29	1:11	0:59	0:50	0:44	0:39	0:35	0:32	0:29	0:27	0:25	0:23	0:22
Passengers		1	2	3	4	5	6	7	8	9	10	11	12	13

## REDUCTION TO O2 INVENTORY

EMERGENCY DESCENT TO FL 100

CLIMB TO FL 150

MINUS OXYGEN BELOW 200 PSI

Reduction	761	819	876	934	1043	1108	1163	1221	1278	1335	1393	1450	1508
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Fig.2

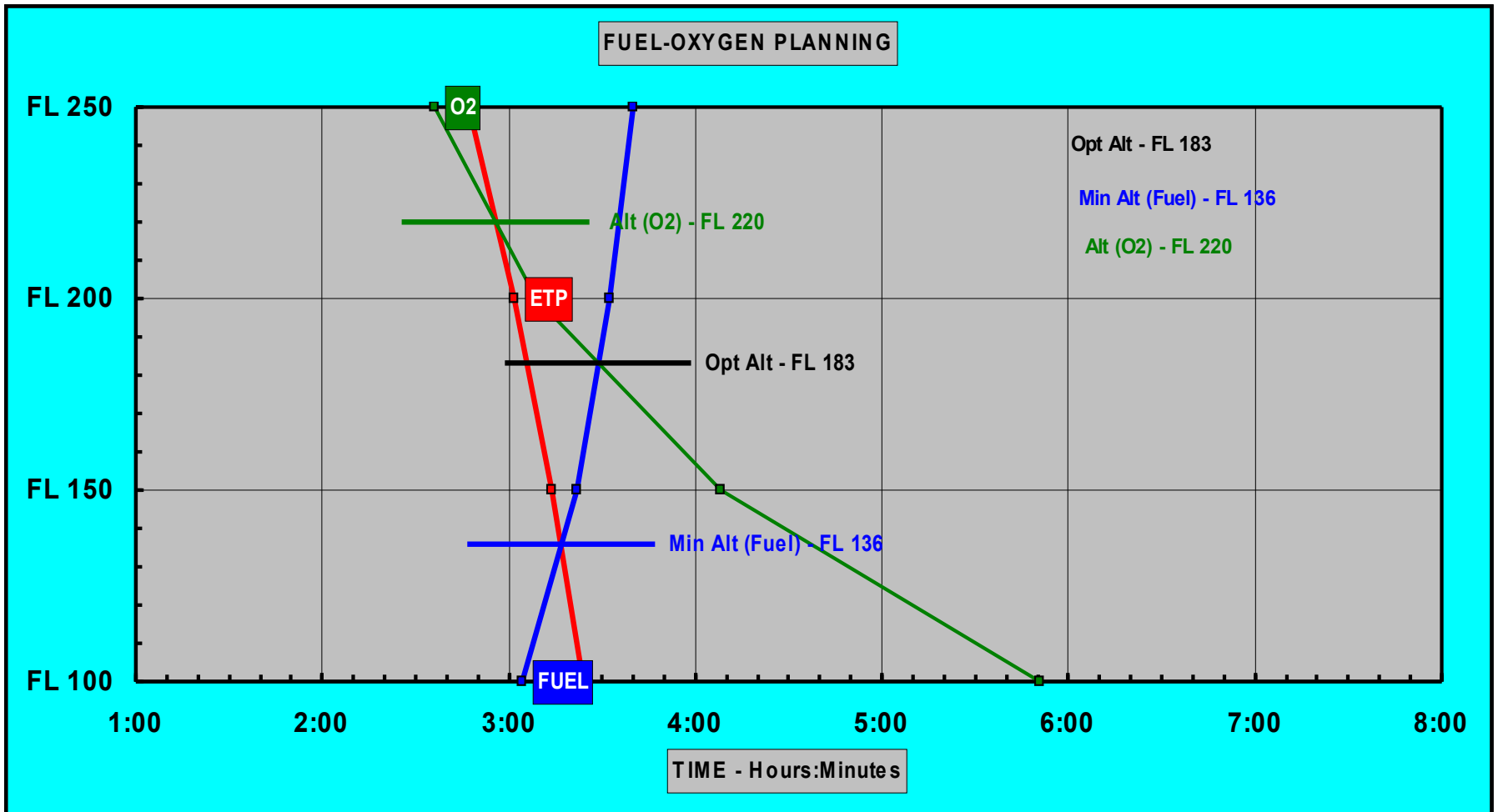


Fig.3