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Cost Efficiencies and Sustainability via

OXYGEN OFFSETS

Advancements in Oxygen Compensation

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The Relationship between Fuel and Oxygen

The relationship between an aircraft's fuel and oxygen systems is unique and interdependent in that they can be exchanged to enhance the aircraft's range. Unlike other onboard energy resources, their consumption rates are inversely proportional at higher altitudes. This balance is achieved by adjusting the aircraft altitude: as altitude increases, fuel consumption decreases and oxygen consumption increases.

Managing and comparing these resources can be conceptually challenging since they are measured using different criteria. To address this, a common metric is needed to assess both resources in a universally-understood way. Duration (time remaining) serves as such a metric, acting as a common denominator. By considering the aircraft's velocity, time can be translated into distance, which can be displayed in real-time on a geospatial mapping platform like Google Earth.

Using distance (range) as a management tool allows pilots to efficiently exchange these resources during flight by adjusting the aircraft's altitude. In simple terms, increasing the aircraft's altitude extends its fuel range (reducing fuel consumption) while reducing its oxygen range (increasing oxygen consumption).

An aircraft's fuel and oxygen ranges can be viewed using a geospatial mapping program as shown. *(Figure 1)*

Figure 1

By applying this concept, if one resource is running low, the range of the other resource can be extended by adjusting the aircraft's altitude—either climbing or descending—depending on which supply is critical.

It is important to note that fuel systems are extensively documented and well understood by pilots, dispatchers, ground handlers, air traffic controllers, and others involved in aviation operations. This is primarily because fuel consumption is measured using familiar units such as pounds (fuel weight) or gallons. However, the oxygen system does not share the same fortune. Oxygen supplies can be presented in various formats, such as PSI (pounds per square inch), percentage of full, liters per minute, or proprietary metrics based on the manufacturer's design. Currently, there is no universal standard for oxygen measurement, except for PSI used in aircraft servicing.

As mentioned, the conversion of fuel and oxygen consumption into a universal metric (i.e., time) and then further translating it into range (i.e., distance) serves as the common denominator for both resources. Altitude becomes the management tool for optimizing their utilization.

Fuel is the Driver

Throughout history, fuel has been the driving factor in determining oxygen requirements. In situations where a flight needs to descend due to an emergency depressurization or abnormal operation requiring supplemental oxygen, and there is sufficient fuel at 10,000 feet to safely reach a landing destination, the need for oxygen at or below 10,000 feet MSL is eliminated. This is because the presence of ample fuel on board overrides any requirement for oxygen during extended flight.

However, if there is insufficient fuel at 10,000 feet to continue the flight to a safe alternate or diversion airport, the aircraft can climb to a higher altitude that is more fuel-efficient, thereby extending the aircraft's range. However, for such a climb to be possible, the pilot must plan for an adequate supply of oxygen on board to meet the needs of both the crew and passengers. The specific amounts of oxygen required for these scenarios will be discussed in the following section.

Oxygen Management

Oxygen management is a critical aspect of flight operations. In situations where it is determined that there is insufficient fuel at 10,000 feet to safely divert, it becomes necessary to have an additional supply of oxygen on board prior to departure. This ensures that the aircraft can achieve a higher diversion altitude (above 10,000 feet) in order to extend its fuel range.

Determining the amount of oxygen available in a meaningful way (i.e., duration of use) can be challenging, as it involves complex calculations that are not readily provided by the Original Equipment Manufacturer (OEM). Advanced oxygen management programs like ERGO 360 GREEN provide a simple, visual solution.

Effective oxygen management must incorporate fuel management as well, enabling the exchange of onboard resources (i.e., fuel and oxygen) through adjustments in altitude if required.

The responsibility for ensuring an adequate supply of both fuel and oxygen lies with the pilot, as mandated by regulations. Typically, pilots assume that if the oxygen system is fully charged (e.g., 1850 psi), there is enough oxygen on board. However, this assumption is not always accurate and must be verified during the aircraft flight planning stages, just like fuel quantities.

ETOPS Regulations and Fuel/Oxygen Management

ETOPS (Extended Operations) regulations provide guidelines for pilots in the event of an engine failure followed by decompression during a flight. The creators of these regulations foresaw the possibility of such incidents and emphasized the importance of considering and planning for this scenario in all ETOPS flights. This includes ensuring an adequate amount of contingency fuel to mitigate the associated risks and hazards.

Figure 2

In the case of a domestic overland flight with multiple diversion airports available, oxygen planning is typically not required, except for situations where an emergency descent needs to be executed. *(Figure 2)*

During long flights over water or uninhabited terrain with limited diversion options, fuel management becomes a crucial concern. This becomes particularly critical if the aircraft must fly at a lower altitude unexpectedly, where fuel consumption increases and True Airspeed (TAS) decreases—especially in the event of an engine failure or decompression.

The requirements for such scenarios can be found in FAR 121.646 under the ETOPS critical fuel scenario. Essentially, the aircraft must plan to carry enough fuel at the Equal Time Point (ETP) to account for the loss of an engine, a decompression event, and safely descend to a designated "Safe Altitude." The specific Safe Altitude will depend on factors such as weather conditions and terrain clearance, but in this context, we are concerned with the low *fuel altitude* of 10,000 feet, where fuel consumption is high and fuel quantities are limited. *(Figure 3)*

Figure 3

While large commercial flights are legally mandated to comply with these regulations, virtually all long overwater flights, in one way or another, adhere to similar practices by incorporating equal time points and calculating decompression ETPs, akin to the principles of ETOPS.

It is widely understood by pilots that flying at higher altitudes significantly improves fuel efficiency due to lower fuel consumption and higher true airspeeds. This, in turn, extends the aircraft's fuel range. Regulations also allow flight above 10,000 feet as long as there is an adequate supply of oxygen. Thus, the concept of Oxygen Offsets™ comes into play -- leveraging oxygen availability to maximize fuel efficiency.

Maximizing Fuel Efficiency through Oxygen Offsets

It is customary for ETOPS flights and similar long overwater journeys to plan their diversion from the Equal Time Point (ETP) to the designated airport at the suboptimal altitude of 10,000 feet. This is primarily due to regulatory (oxygen) requirements and the previous complexity involved in oxygen planning.

However, there are **no restrictions** that prevent a flight from considering a higher altitude for their regulatory diversion airport. The industry recognizes that while decompressions are rare, they do occur, and as a risk mitigation measure, regulations and sound judgment provide the pilot with the option to fly at higher altitudes, albeit while being mindful of associated risks and planning accordingly.

This exceptional opportunity allows for the utilization of a more fuel-efficient altitude, enabling the exchange of one energy resource (fuel) for another onboard energy resource (oxygen). Oxygen consumption is typically limited to regulatory requirements, except in cases of oxygen contingencies such as decompression events. Although the concept of converting oxygen into fuel has existed for decades, the integration of this complex system with fuel management has only recently been achieved.

The fuel savings can be easily demonstrated by comparing flights from the Equal Time Point (ETP) to the diversion airport, with the higher altitude option (above 10,000 feet) showing significant reductions in fuel usage. Consequently, during flight planning, less fuel needs to be loaded, resulting in reduced total weight carried and minimizing the additional fuel required to sustain that weight (commonly known as a tankering penalty). Depending on the extent of weight reduction, further savings can be attained by enabling the aircraft to ascend to a higher performance altitude earlier in the flight, leading to additional fuel efficiency. The critical component that completes this puzzle is the effective management of the oxygen system.

These savings directly impact operating costs and can be easily tracked. The initial savings are evident in that the fuel doesn't need to be purchased. For instance, if the operator plans the required diversion altitude higher than 10,000 feet and saves 500 gallons of jet fuel at a rate of $3.40 per gallon, the immediate savings amount to $1,700 for that specific flight.

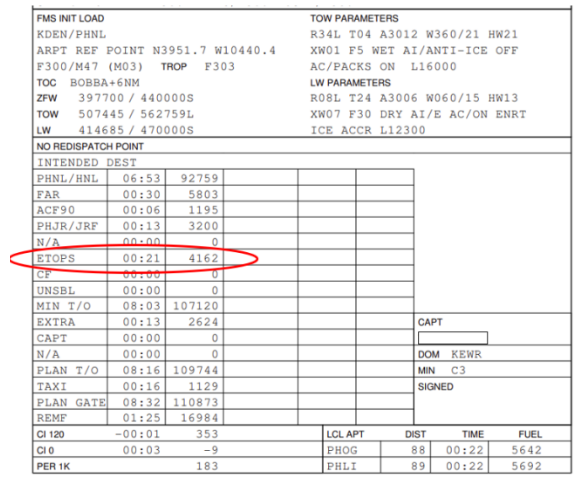
Moreover, there is an additional static savings that operators can realize through this fuel reduction—reductions in carbon footprint and potential carbon credits. These savings can be utilized in various ways, including future considerations and governmental tax reductions. This creates a double benefit, wherein the weight of an aircraft's oxygen supply (which is seldom expended except in emergency situations) becomes an instrumental source for achieving both fuel and carbon offset savings. The term "Oxygen Offset" aptly describes this catalyst-driven approach.

Figure 4

Applicable Flights

These savings are primarily observed on long overwater flights and flights traversing high terrain where a safe descent to 10,000 feet is limited by the elevation of the earth's surface below. *(Figure 4)* These savings are particularly relevant for flights that must adhere to ETOPS critical fuel scenario requirements or any flight that necessitates an Equal Time Point (ETP) calculation. Moreover, these considerations are significant for flights that need to maintain altitude above the terrain.

In general, flights which initiate over land and the final segment is over water (arriving at a coastal airport) or over uninhabited terrain are likely to require increased fuel load for these segments. Weather conditions, terrain clearance, availability of alternate airports, and other pertinent considerations contribute to the calculation of uploaded fuel (e.g., ETOPs fuel). *(Figure 5)*



FMS INIT LOAD
KDEN/PHNL
ARPT REF POINT N3951.7 W10440.4
F300/M47 (M03) TROP F303
TOC BOBBA+6NM
ZFW 397700 / 440000S
TOW 507445 / 562759L
LW 414685 / 470000S

TOW PARAMETERS
R34L T04 A3012 W360/21 HW21
XW01 F5 WET AI/ANTI-ICE OFF
AC/PACKS ON L16000
LW PARAMETERS
R08L T24 A3006 W060/15 HW13
XW07 F30 DRY AI/E AC/ON ENRT
ICE ACCR L12300

NO REDISPATCH POINT
INTENDED DEST

PHNL/HNL	06:53	92759
FAR	00:30	5803
ACF90	00:06	1195
PHJR/JRF	00:13	3200
N/A	00:00	0
ETOPS	00:21	4162
CF	00:00	0
UNSBL	00:00	0
MIN T/O	08:03	107120
EXTRA	00:13	2624
CAPT	00:00	0
N/A	00:00	0
PLAN T/O	08:16	109744
TAXI	00:16	1129
PLAN GATE	08:32	110873
REMF	01:25	16984
CI 120	-00:01	353
CI 0	00:03	-9
PER 1K		183

CAPT
DOM KEWR
MIN C3
SIGNED

LCL APT	DIST	TIME	FUEL
PHOG	88	00:22	5642
PHLI	89	00:22	5692

Figure 5

In certain circumstances, if there is insufficient reserve fuel for landing, the flight planning program may automatically select a higher diversion altitude (above 10,000 feet). However, this concept is selectively applied, understood by pilots and dispatchers in specific circumstances.

Diverse Implementation across Systems

It is important to emphasize that achieving this efficiency does not necessitate new regulations, as existing regulations already permit such practices. This efficiency has minimal impact on the flight crew, except for the requirement to acknowledge and plan for a minimum amount of dispatch oxygen to attain this efficiency.

Typically, if the aircraft's passenger oxygen system operates using a gaseous design, there is no need for additional weight upload specifically for oxygen purposes. This enables a substantial reduction in total fuel weight, with the potential for even greater savings as the diversion oxygen altitude may extend up to 25,000 feet.

In the case of passenger oxygen systems utilizing time-limited Chemical Oxygen Generators (COGs), there might be a need for small oxygen uploads to ensure compliance with regulatory standards. However, the impact on fuel weight savings remains significant.

In the past, understanding and management of fuel and oxygen systems was challenging. Fortunately, advancements in technology and robust software programs have simplified the management of these systems.

Fuel/Oxygen Management Software

While oxygen systems can be complex, use of time and distance metrics using mapping software like ERGO 360 GREEN provide user-friendly, standardized oxygen management regardless of aircraft type. Pilots can easily and accurately optimize their oxygen supplies when flight planning, paving the way for the utilization of Oxygen Offsets to reduce fuel consumption. *(Figure 6)*

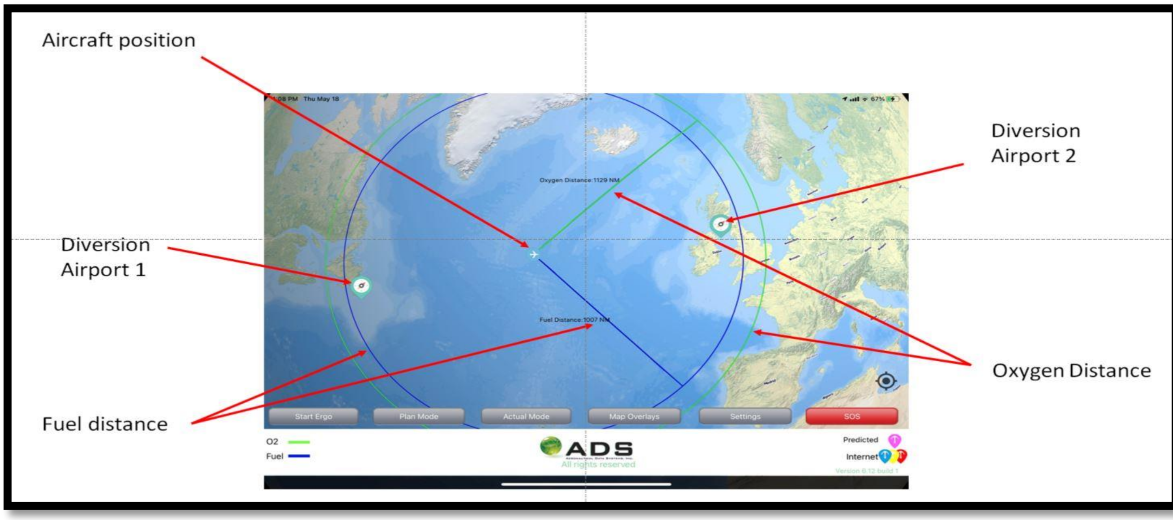


Figure 6

The simplified visual display of the program allows anyone -- including dispatchers who play a crucial role in the analysis -- to instantly understand the impact of altitude on the fuel and oxygen system. Dispatchers are already familiar with calculating fuel loads, and since fuel is the primary driver for oxygen requirements, determining oxygen needs only requires altitude, time, and the number of users.

Now, let's examine the implementation process using the comprehensive software systems developed by Aeronautical Data Systems (ADS), which are readily available.

Dispatch and Maintenance Implementation

Implementation requires collaboration between dispatch and maintenance. Dispatchers must be equipped with the necessary tools to match the minimum dispatch fuel with the corresponding minimum dispatch oxygen pressure for a specific aircraft.

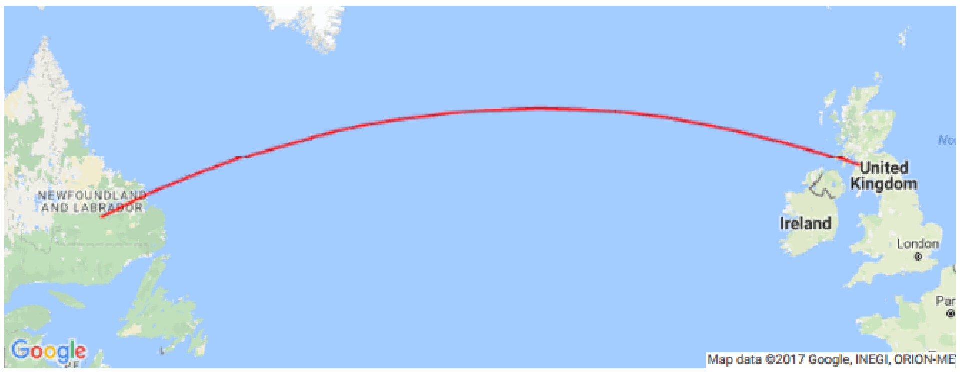
As previously discussed, fuel always determines oxygen requirements. The dispatcher will execute a standard flight plan and conduct an ETP analysis. Among the ETP options, the dispatcher will select the most restrictive one, considering the longest time to the diversion airport and the highest fuel consumption. Remaining fuel at the ETP, along with the calculated time from the ETP to the diversion airport, is input into the ADS E-OPS software.

The E-OPS program will then generate a "mini" flight plan from the ETP to the diversion airport, replicating a typical aircraft flight plan. It will calculate fuel and oxygen remaining at 15-minute intervals along the great circle path from the diversion point to the diversion airport. This enables the pilot to make periodic adjustments to either fuel consumption or oxygen consumption through changes in altitude.

The ADS EOPS program takes into account all oxygen consumption rates, including regulatory and therapeutic rates used prior to reaching the ETP, and applies them to calculate the total oxygen requirement. *(Figure 7)*

ADS Oxygen ETP

RC #Waleed-2	ETP 3	N125CH	Crew 2	Pax 4	ZFW 38000



Dispatch	Enroute	Landing
cyyr	**ETP 3**	**egpk**
Min O-2:737	Altitude:15000	Total Used:244
Actual O-2:1700	O-2 to ETP:119	Dest. O-2:1456

Fuel

High	Engine Inop	Actual	Delta
FL430	FL300		
12658			
11941	11800		
11224	11082		
10507	10364		
9790	9646		
9073	8928		
8356	8210		
7639	7492		
6922	6774		
6205	6056		
5488	5338		
4771	4620		
4054	3902		
3337	3184		
2620	2466		

Oxygen

O-2	TIME	% of Full	Liters	PSI	Actual	Delta
FL150	:15 Inverval					
11334	03:17	85	4811	1581		
10643	03:02	83	4698	1529		
9952	02:47	80	4528	1477		
9261	02:32	77	4358	1425		
8570	02:17	74	4188	1373		
7879	02:02	71	4019	1321		
7188	01:47	69	3905	1269		
6497	01:32	66	3736	1217		
5806	01:17	63	3566	1165		
5115	01:02	60	3396	1113		
4424	00:47	57	3226	1061		
3733	00:32	55	3113	1009		
3042	00:17	52	2943	957		

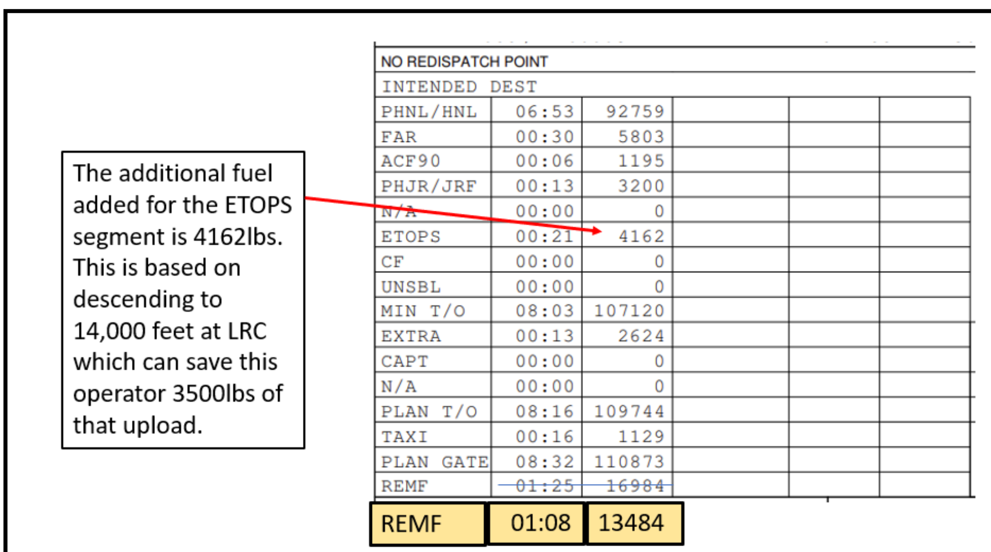
Figure 7

Once dispatch has determined the total oxygen requirement, it becomes a straightforward task to inform maintenance of the dispatch PSI. As all gaseous oxygen systems are serviced using the PSI metric, no further calculations are necessary. It is worth noting that this type of dispatch system already promotes efficiency, as it may eliminate the need for additional oxygen servicing. In the case of commercial aircraft utilizing Chemical Oxygen Generators (COGs), dispatch will specify any additional uploaded cylinders or COGs to meet the regulatory requirements for that specific flight based on passenger count and diversion times.

Dispatch and Flight Crew Implementation

Contrary to expectations, flight crews will require minimal additional training and procedure modifications. In reality, their operations will see little change. The crew's primary responsibility will be to approve the minimum dispatch oxygen PSI provided by dispatch and acknowledge the altitude designated for the depressurized equal time point (ETP). Aside from these considerations and their existing emergency procedures, there is little change to what pilots currently do.

The only noticeable difference for the pilot may be a reduction in landing fuel by approximately 3,500 pounds (a typical savings for the aircraft in this example) and a 13-minute decrease in remaining fuel time. As you can see, automation takes on the majority of the workload to implement this efficiency. *(Figure 8)*


NO REDISPATCH POINT

INTENDED DEST

PHNL/HNL	06:53	92759
FAR	00:30	5803
ACF90	00:06	1195
PHJR/JRF	00:13	3200
~~N/A~~	00:00	0
ETOPS	00:21	4162
CF	00:00	0
UNSBL	00:00	0
MIN T/O	08:03	107120
EXTRA	00:13	2624
CAPT	00:00	0
N/A	00:00	0
PLAN T/O	08:16	109744
TAXI	00:16	1129
PLAN GATE	08:32	110873
REMF	~~01:25~~	~~16984~~
REMF	01:08	13484

Figure 8

It's important to note that while this procedure does not require new approvals or regulations, it must comply with Safety Management System (SMS) requirements. To ensure SMS compliance, a robust program is necessary to address the extensive and complex threats and hazards associated with the oxygen system. The ADS program will identify such risks and provide a mitigation plan that satisfactorily addresses all identified issues.

Development Background

In 1983, two pilots realized the need for a standardized, universal oxygen planning program. Bill Mack and Jim Stabile, pilots from the National Distillers flight department in Teterboro, NJ, saw and began researching the issue. Over the course of the past four decades and countless hours of development, they have created the sole universal oxygen solution to date that can meet this requirement. This solution involves standardizing all oxygen systems using time and distance metrics. Below is an excerpt from an early article written 40 years ago by Stabile and Mack, which served as the catalyst for the creation of ADS' ERGO 360 GREEN.

"One of our first discoveries was that the GII had more installed oxygen aboard than the GIII. Why the difference? We found that the oxygen system design was predicated on a San Francisco to Honolulu flight with a 90-knot head wind component with full fuel aboard. This was considered the longest overwater flight requirement in the world. The 90-knot component was considered the maximum that might be encountered (using Boeing winds). The oxygen system was designed using this criterion. At the ETP (worst case) the aircraft had to have enough fuel and oxygen to either return to departure point or continue to destination. With more fuel aboard, a lower flight altitude could be tolerated and therefore, less oxygen was required. The GII had 23,000 pounds of fuel and 406 cubic feet of oxygen, the GIII had 28,000 pounds of fuel and 278 cubic feet of oxygen.

We then needed additional information to compute the oxygen used in the descent profile, the flow rate at the cardinal altitudes of 15,000, 20,000, 25,000 feet. Note: The continuous flow system used for the passenger system is only certified to 25,000 feet. John Dow, of Dow Aerospace was contacted to fill in some of the oxygen system blanks we still had. John had designed the GIII oxygen system when he was with the Page Avjet engineering department, San Antonio, TX. Pete Hellsten, the Gulfstream Aerospace preliminary design guru and aerodynamicist extraordinaire, was asked to help us in designing a range chart for the GIII. Don McKeown of FlightSafety provided us with the overwater planning essentials. With this group of interested individuals providing the expertise and we (Stabile and Mack) providing the 'donkey' power, we were off and running at last!

We then began the long, arduous task of planning for the worst case scenario, a flight from KSFO to PHNL against a 90-knot headwind. At the ETP we had an engine failure followed by a decompression. Could we make it to either our coast out airport or our coast in airport? We found that, using this scenario we would have had a 'wet' footprint. We would be short of KSFO by 75 miles. The immediate problem was to find the altitude that we would need to climb to in order to gain the 75 miles plus fuel reserves necessary. The next problem was to inventory the oxygen system, calculate the flow rates at the new cruise altitude, multiply the rate by the number of passengers and decide if the supply was adequate. After this exercise we realized that the appropriate time to do our planning was here, on the ground and not over the Pacific in an unpressurized Gulfstream.

That was the 'worst case' scenario for the GII. Don McKeown always played the Devil's advocate. I remember saying to Don that it was such a remote case that it would never happen to me in my lifetime. He presented me with another scenario: 'how about a GIII departing Denver en route to Honolulu direct?' As you pass overhead SFO you are now a GII in terms of range. However, you are in worse shape because you do not have the same oxygen duration as a GII. Remember, the GIII had more fuel and less oxygen *than the GII, and now you have consumed some of your fuel on the flight from Denver. This, of course, is an avoidable situation, Don's advice: 'never fly over a gas station.' If you do, you should have a plan and knowledge of your range and your oxygen duration. We always felt it a novel idea to have the ability to turn oxygen into range by having the capability of climbing to a higher altitude, thus extending your range."*

This passage describes the origins of the research and the key individuals who contributed to the foundation of this approach. Initially, the research relied on traditional charts and graphs, as it was the only available technology at the time. However, with the advent of computers and iPads, much of the complex work has been automated. Now, pilots simply need to input the remaining resources, such as fuel weight and oxygen pressure, into the system. The result is a universal and easily understood visual representation that allows pilots to make informed decisions during rare and complex situations.

ERGO 360 GREEN's patented approach was developed by pilots, for pilots, which has contributed to the establishment of a standard that is easily comprehensible to end users, who ultimately face critical in-flight decisions in real-time. The final design utilized a visual representation on a geospatial mapping program to standardize the fuel and oxygen systems. This design enables pilots, dispatchers, flight attendants, mechanics, and even passengers, to quickly and accurately assess the remaining reserves of these various systems. The values entered align with familiar aviation industry metrics, such as fuel weight (in pounds or kilograms) and oxygen pressure (in PSI, percentage of full, liters, etc.).

By simplifying the fuel and oxygen systems and standardizing those using common metrics such as time and distance, the foundation is laid for the development of an Oxygen Offset.

What is an Oxygen Offset?

An Oxygen Offset refers to the quantity of oxygen (liters or PSI) required to save a unit of fuel (pound or kg) by strategically flight planning at higher altitudes. The term "Oxygen Offset" serves as a means to facilitate these savings, which would not be possible without the presence of onboard oxygen and the developed management programs that enable such an exchange.

Flight planning at higher altitudes by optimizing oxygen resources can significantly reduce required fuel. Decreased fuel purchase and carriage on a specific flight decreases the onboard weight accordingly. Any reduction in fuel weight translates to fuel savings, with the magnitude of savings increasing with longer flight durations, leading to greater dollar savings.

While the Oxygen Offset is attained through weight savings, the primary metric to consider is the total fuel saved at the departure airport, measured in pounds. The pounds of fuel saved are then converted into gallons of fuel and multiplied by the fuel price at the departure airport. This dollar amount represents the initial savings achieved through the Oxygen Offset. Operators realize immediate cost savings as they no longer need to purchase the unnecessary fuel. This tangible cost reduction can be validated on each flight.

The second phase of savings is less direct but equally important, involving a reduction in carbon emissions and a decrease in the overall carbon footprint of the aircraft or flight department. The valuation of these carbon emission reductions can be explored in various ways, yet to be determined. The annual total of fuel weight saved is converted into carbon offsets, which can be utilized as additional savings. This aspect extends beyond the scope of this white paper but underscores the relationship between the amount of oxygen required to save each pound of fuel.

It is crucial to emphasize the connection between the fuel savings achieved and the oxygen system, as it promotes innovation and technological advancements in carrying and managing oxygen in the future. It must be recognized that without the utilization of oxygen duration in flight planning, these savings would never be realized. Eventually, the concept of Oxygen Offsets will evolve into carbon credits, and the industry must acknowledge the distinctiveness and efficiency of this approach.

Savings Validation

Verification of savings can be achieved by the flight planning provider through the analysis of two slightly different calculations for the flight plan ETP. The initial ETP calculation considers a fuel diversion altitude of 10,000 feet for the depressurized ETP, while the second flight plan evaluates the fuel requirement at an altitude higher than 10,000 feet for the depressurized ETP. The disparity between these calculations represents the expected fuel savings if the flight segment necessitates an additional Extended Operations (ETOPS) fuel upload. Dispatch utilizes this fuel savings calculation to determine the appropriate amount of oxygen required to offset the fuel upload. It is important to note that this exercise is solely conducted during the flight planning phase to ensure compliance with regulatory standards.

The revenue savings resulting from Oxygen Offsets are substantial, and progress has already been made in this area by certain flight planning companies collaborating with ETOPS operators. These companies will determine the extra fuel required to meet the regulatory critical fuel scenario as defined in FAR 121.646. This calculation, often referred to as "ETOPS Fuel" or "ADD ETOPS Fuel" in the flight plan fuel ladder, takes into account the necessary fuel for ETOPS flights and calculates any additional fuel needed from the equal time point (ETP) to the diversion airport at 10,000 feet. Essentially, it identifies the additional fuel that can be offset through the use of oxygen at higher altitudes, as outlined in regulations such as 121.329, 121.333, 135.89, 135.157, or 91.211.

It's important to note that not all flights will experience these savings, but those flights that have a value greater than zero in the "ADD ETOPS Fuel" column will be eligible to participate in the Oxygen Offset program for increased efficiency. I have personally witnessed cases where the "ADD ETOPS Fuel" exceeded 21,000 pounds, highlighting the significance of these savings.

To provide a perspective on these savings, let's consider flights to and from the US mainland to the Hawaiian Islands, where "ADD ETOPS Fuel" is common. The flight data is from the year 2022, assuming a standard Jet-A fuel price of $3.40 per gallon. The flight data was sourced from Flight Aware, and we will assume all equal time points are at 3:00.

Figure 9 compares the fuel difference on a B-737 800 between maximum continuous thrust at 10,000 feet and long-range cruise at 14,000 feet based on the distance flown between diversion airports (2,274 nm). The approximate fuel savings amount to around 3,400 lbs. (The distance 1137 is from the equal time/distance point to the diversion airport). This represents the individual aircraft savings on a typical 3:00 ETOPs flight.

ETOPS COMPARISON ANALYSIS: BOEING 737-800

ETOPS TIME	180
RADIUS	1137

10,000' MAX CONTINUOUS PWR

ACFT WT.	TAS	FF	SR	TIME	DIST	FUEL BURN
150,000	379	7031	0.0539	85	539	10,000
140,000	379	6962	0.0544	95	598	10,984
				180	1137	20,984

MI/MINUTE	FF/MIN
6.3	117.2
6.3	116.0

14,000' LONG RANGE CRUISE

ACFT WT.	TAS	FF	SR	TIME	DIST	FUEL BURN
150,000	342	5378	0.0636	112	636	10,000
140,000	330	4998	0.0660	91	501	7,589
				203	1137	17,589

MI/MINUTE	FF/MIN
5.7	89.6
5.5	83.3

Figure 9

Figure 10 represents the annual number of flights from the US to the Hawaiian Islands (127,296) and then from the Hawaiian Islands to 5 cities on the west coast (Seattle, Portland, San Francisco, Los Angeles and San Diego) which would utilize an equivalent upload of fuel for ETOPs compliance (96,902) for a total of 224,196 flights for the year 2022.

A	B	C	D	E	F
YEAR	**US-HAWAII FLIGHTS**		**HAWAII-WEST COAST FLIGHTS**		**TOTAL FLIGHTS**
2022	**127294**		**96902**		**224,196**
Fuel saved/Flt	LBS	CO2 reduction/metric tons	Fuel Savings $$@ $3.40/Gal	Carbon Credit Savings	Total O-2 Offset Savings
1000	224,196,000	354,230	$113,771,104.48	?	TBD
2000	448,392,000	708,459	$227,542,208.96	?	TBD
3000	672,588,000	1,062,689	$341,313,313.43	?	TBD
4000	896,784,000	1,416,919	$455,084,417.91	?	TBD
5000	1,120,980,000	1,771,148	$568,855,522.39	?	TBD

Flight Aware Data: In 2022 there were 127294 flights from the US mainland to the Hawaiian Islands and 96,902 flights from the Hawaiian Islands to the US West coast totaling 224,196 flights where ADD ETOP's fuel would be required.

The following analysis examines the potential fuel savings of 1000lbs for these flights, with a gradual increase up to 5000lbs. This information aims to help the reader comprehend the significance of utilizing **Oxygen Offsets** in order to achieve these savings.

The savings is categorized into pounds of fuel reduced, carbon emissions/Metric tons of CO2 reduced and a fuel savings in US dollars based on a fuel price of $3.40/gallon. Until there is a standard transparent value for the carbon credit savings, the total savings achieved through the use of **oxygen offsets** will only reflect the savings for not buying and transporting the additional weight of fuel.

Figure 10

- Column A represents an increasing scale of fuel presumably uploaded in 1000 of pounds.
- Column B total amount of fuel uploaded for ETOPs compliance (224,196 flights X 1000lbs of fuel)
- Column C is the total amount money spent/saved not buying fuel at $3.40/gallon
- Column D is the calculated Metric tons of carbon saved based on 1 gallon of fuel = 3.4 lbs of carbon

This is just one snapshot of the US market and the savings that can be reasonably validated through the implementation of an efficient Oxygen Offsets program.

Figure 11 presents actual flights in 2022 which calculated the extra fuel added to meet the ETOPS critical fuel scenario. Almost all of the total "ADD ETOPS Fuel" required, which amounted to 37,700 lbs., could have been eliminated from each of those ten flights.

The direct savings from not purchasing this fuel at $3.40/gallon amounted to $19,134. This does not include additional savings from not carrying the additional weight or performance improvements.

Additionally, the calculations do not account for the further savings in carbon emissions or the potential for carbon credits. These savings are achieved through more efficient and streamlined flight planning.

	A	B	C	D	E	F	G	H
1	**Date**	**Flt number**	**City Pair**	**AC type**	**ADD ETOPS fuel**	**ETP Time**	**IAS (Knots)**	**Fuel Price**
2	3/16/2022	[redacted]	DEN/HNL	777	4960	159	329	-1.77
3	3/20/2022	[redacted]	SFO/LIH	757	5077	178	299	-89
4	3/22/2022	[redacted]	DEN/HNL	777	4162	162	329	-242
5	3/22/2022	[redacted]	EWR/EDI	757	4096	201	299	-285
6	3/31/2022	[redacted]	IAD/LIS	757	1497	168	300	-144
7	4/1/2022	[redacted]	DEN/OGG	777	5342	166	329	-171
8	4/3/2022	[redacted]	IAH/HNL	777	4257	158	329	-203
9	4/3/2022	[redacted]	LAX/SYD	787	3397	190	329	-487
10	4/5/2022	[redacted]	SFO/OGG	777	3510	160	329	-110
11	4/7/2022	[redacted]	HNL/GUM	777	1407	106	329	-118
12					**37705**			
13					$19,134	savings based on $3.40/Gallon		

Figure 11

ERGO 360 GREEN: Cost-Efficiency & Sustainability

Here's a concise recap of how operators can lower costs while truly "flying green:" The first step is for the pilot/operator to utilize a method that enables the evaluation of the fuel and oxygen system based on the remaining time at the ETP and converts it into a distance. This approach simplifies the management of the intricate relationship between fuel and oxygen by providing a clear and easily manageable framework.

In addition to displaying the fuel and oxygen reserves on a geospatial mapping program, ERG0 360 GREEN has the capability to calculate an optimal oxygen altitude. Once the oxygen altitude is determined and it is confirmed that there is an adequate oxygen supply on board, the program evaluates the aircraft's fuel-specific range at both the optimal oxygen fuel altitude and 10,000 feet. By comparing the fuel consumption between these altitudes, taking into account tankering practices, the program determines the amount of fuel saved.

After analyzing the fuel weight, it is converted into gallons saved, and then multiplied by the fuel price at the departure airport. This calculation yields the dollar savings for that specific flight. ERGO 360 GREEN also tracks total savings annually or for the duration of its usage, providing the operator with a comprehensive record of the direct cost reductions. *(Figure 12)*

Viewing: Flight #1374 for

- **Tailnumber:** N1010P
- **Altitude:** 25000
- **# of Crew:** 3
- **# of Passengers:** 273
- **ETP Time:** 2:39
- **Date Created:** 2022-04-16 07:05:38
- **Dispatch Oxygen Pressure:** 708

Would you like to add a new flight?

Oxygen Offset Savings

This flight: $2,487 YTD: $18,909 All time: $18,909

Figure 12

Furthermore, ERG0 360 GREEN records the fuel weight savings and, utilizing advanced capabilities, calculates the corresponding carbon offsets resulting from the use of Oxygen Offsets. These carbon offsets can be incorporated into the operator's carbon-neutral plan, contributing to their overall efforts in reducing carbon emissions.

By implementing ERGO 360 GREEN technology, operators can optimize their flight planning process, resulting in significant fuel savings and direct cost reductions. Moreover, the system facilitates the operator's commitment to environmental sustainability by accurately measuring and leveraging carbon offsets for a more eco-friendly operation as well as providing a direct and transparent path to the monetization of carbon credits through the use of Oxygen Offsets.

Conclusion

In today's world, the pursuit of efficiency and cost-savings is a driving force across all industries. In the aviation industry, the oxygen system has long been an essential but overlooked component of every flight. However, through innovation, this once burdensome system can now become a revenue-generating asset, not by actively using oxygen on each flight, but by employing efficient flight planning practices to meet regulatory and safety standards.

The standardization of the oxygen system using time and distance metrics not only enhances flight efficiency but also improves flight safety through the implementation of new management programs. As Ben Franklin famously stated, "*Failing to plan is planning to fail."* In today's context, we can add, *"and also missing out on opportunities to protect our environment and save significant costs!"*

It is crucial to prioritize safety and regulatory compliance above any financial or economic benefits associated with this program. However, as we have articulated throughout this discussion, this approach achieves both objectives by simultaneously enhancing operational safety and realizing financial benefits.

Fly safely . . . and fly smart!

