EROPS and Unscheduled Landings

Questions have arisen over the causes of unscheduled landings on long-range type aircraft. This study was undertaken to determine what the causes were for these unscheduled landings and to analyze what effect these causes might have on risk to Extended Range Operations (EROPS). Service difficulty reports (SDRs) were examined for 2000-2002 for the following aircraft Airbus 310 and 330, the Boeing 747, 757, 767, and 777, and the MD-11. All these aircraft are used to varying degrees in EROPS operations. Duplicate reports were removed and the remaining data was analyzed.

Disclaimer: Because of differing levels of participation of carriers in the SDR program no overall rates can be calculated from this data. Because of this the total numbers of these events can be misleading. The actual numbers must be at lease equal or greater than that indicated by SDRs. However, the rates calculated herein are an accurate assessment of the causes of unscheduled landings as expressed as a percentage instead of total numbers. It must also be noted that these rates are for the type of aircraft that are often used in EROPS, but the operation where the divert occurred was not necessarily during the EROPS portion of the flight.

EROPS flights typically operate over oceans, Polar Regions, or desolate areas for hours on end. So they have additional risk factors when the aircraft is not within a suitable range to an alternate field. This is different from most non-EROPS flights that have an alternate or emergency field readily available. So an EROPS flight must operate for extended periods of time with whatever condition that caused the crew to begin the divert.

1. The most common condition for unscheduled landings are “Warning Indications” and the most common defined cause was “Smoke”.
2. When looking only at cruise operations the percentage for “Smoke” conditions leading to an unscheduled landing was 20.3% of the events.
3. Most unscheduled landings initiating events occur during climb, but a large number, 39%, occur in cruise.
4. A majority of smoke related events occur during cruise. Fully 54% of all smoke events that cause an unscheduled landing occur during cruise.
5. During cruise operations “Smoke” is more than twice as likely to cause an unscheduled landing than an engine problem.

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A number of conditions will trigger a “Warning Indication” event. These numbers add up to more than 100% because of this. An example would be “Cargo Smoke”. This condition could be listed as both as “Warning Indication” and “Smoke”. An oil quantity loss could be indicated by “Fluid Loss”, “Engine Stoppage”, and “Warning Indication”. So “Warning Indication” does not by itself differentiate the actual cause of the unscheduled landing. Keeping this in mind the most common cause for unscheduled landings is “Smoke” with a 15% rate with “Fluid Loss” and “False Warning” following close behind at 12% and 11% respectively.

Total Condition Qualifications		
WARNING INDICATION	871	53%
SMOKE	238	15%
FLUID LOSS	195	12%
FALSE WARNING	180	11%
OTHER	153	9%
FLT CONT AFFECTED	99	6%
PARTIAL RPM/PWR LOSS	76	5%
VIBRATION/BUFFET	71	4%
ELECT. POWER LOSS-50 PC	40	2%
OVER TEMP	42	3%
MULTIPLE FAILURE	30	2%
ENGINE FLAMEOUT	26	2%
ENGINE STOPPAGE	28	2%
FLAME	20	1%
INFLIGHT SEPARATION	12	1%
F.O.D.	10	1%
INADEQUATE Q C	11	1%
NO WARNING INDICATION	6	0%
OTHER AFFECTED SYSTEMS	3	0%
SIGNIFICANT FAILURE REPORT	2	0%
FLT. ATTITUDE INST.	1	0%
AFFECT SYSTEMS	1	0%
ENGINE CASE PENETRATION	1	0%
SYSTEM TEST FAILURE	1	0%
Note: Adds up to greater than 100% do to multiple conditions		

It is only during cruise operations that the risk factors increase for EROPS because of their extended divert times.

When looking only at cruise operations the percentage for “Smoke” conditions leading to an unscheduled landing increases to 20.3% of the events.

Cruise Total Condition Qualifications		
WARNING INDICATION	313	48.9%
SMOKE	130	20.3%
FLUID LOSS	94	14.7%
FALSE WARNING	70	10.9%
OTHER	65	10.2%
VIBRATION/BUFFET	26	4.1%
PARTIAL RPM/PWR LOSS	26	4.1%
FLT CONT AFFECTED	28	4.4%
ELECT. POWER LOSS-50 PC	19	3.0%
MULTIPLE FAILURE	12	1.9%
ENGINE FLAMEOUT	14	2.2%
OVER TEMP	11	1.7%
ENGINE STOPPAGE	8	1.3%
INADEQUATE Q C	4	0.6%
FLAME	3	0.5%
INFLIGHT SEPARATION	2	0.3%
AFFECT SYSTEMS	1	0.2%
F.O.D.	1	0.2%
OTHER AFFECTED SYSTEMS	1	0.2%
FLT. ATTITUDE INST.	1	0.2%
AFFECT SYSTEMS	0	0.0%

Most unscheduled landings initiating events occur during climb, but a large number, 39%, occur in cruise

All Events Stage of Flight		
Stage of Flight	Count	
CLIMB	826	50%
CRUISE	640	39%
NOT REPORTED	99	6%
TAKEOFF	39	2%
UNKNOWN	13	1%
APPROACH	12	1%
DESCENT	9	1%
TAXI	1	0%
	1639	

A majority of smoke related events occur during cruise. Fully 54% of all smoke events that cause an unscheduled landing occur during cruise.

The following chart shows the phase of flight where the greatest chance to have a smoke related event that results in an unscheduled landing. Surprisingly most of these events occur in cruise.

Smoke Events with Unscheduled Landings During Cruise

Stage of Flight	Count	
CLIMB	89	38%
CRUISE	129	54%
DESCENT	2	1%
NOT REPORTED	14	6%
TAKEOFF	1	0%
UNKNOWN	2	1%
	237	

During cruise operations “Smoke” is more than twice as likely to cause an unscheduled landing than an engine problem.

Much time in risk mitigation for ETOPS (twin engine EROPS) operations have concentrated on engine failures. While this is an important issue this investigator has found that while looking at all engine related unscheduled landings versus smoke related unscheduled landings during cruise the results show that smoke is more than twice as likely to be the cause of an unscheduled landing as compared to engine problems.

Cruise Only Engine versus Smoke

SMOKE	130	20.3%
ENGINE	59	9.2%

What this suggests is that there is a real dilemma posed to crews by smoke. Current regulations only require that once the smoke generation stops that the air system be able to clear the cockpit of smoke within a preset time limit. AC25-9A admits that the regulations do not require this test to be performed. It then offers the suggestion that a continuous smoke test be employed, but caveats their suggestion with requirements that would require numerous additional performance criteria on a certifier if they were to do this test. Current regulations do not deal adequately with the problem of continuous smoke generation that often happens during the most serious of smoke and fire events such as the Swissair 111 and Valuejet accidents.

In summary, this investigator has found that the most common defined cause for unscheduled landing for EROPS type aircraft to be “Smoke” and occurs most frequently during cruise operations. “Smoke” also occurs twice as often in cruise than engine problems. With current smoke design criteria concentrating on the removal of smoke after the generation of the smoke ends, crews and passengers on EROPS aircraft are placed in the difficult position of trying to operate and survive for long periods of time in a smoke filled aircraft. Obviously the most important issue is to not allow events to occur that generate smoke, but as long

as electronic equipment and flammable materials are in our transport aircraft smoke will always be a real threat to all aircraft operations, but a more significant threat to EROPS because of the time required to stay airborne before reaching an alternate field.

To mitigate these risks there are several options. First is to reduce the risk of the fire or smoke generation through more rigorous wiring and flammability standards. Next is to get the fire or smoke generation stopped as soon as possible with improvements in fire detection and suppression in inaccessible areas such as the fuselage and cockpit overheads. And finally devices to improve instrument visibility, cockpit smoke procedures, and an adequate oxygen supply so the pilots have at least a chance of completing the divert when all else fails.

Captain Jim Shaw

Bio: Captain Shaw is a long time aviation safety volunteer and activist. He is type rated on the B-707, B-737, B-757, and B-767 aircraft. He has held numerous positions as an ALPA safety volunteer: Chief Accident Investigator, head of the ALPA Inflight Fire Team, participant on the ALPA ETOPS committee, and on Flight Operations Quality Assurance teams. He has also been honored to be the Vice-Chairman of the Aging Transport Rulemaking Advisory Committee, work for a long period of time on the SWR 111 accident and has received international recognition for his aviation safety work.