

SPECIAL OBJECTIVE CHECK ON AIR OPERATORS' FUEL PLANNING POLICIES - SUMMER 2000

1 Introduction

- 1.1 A Special Objective Check (SOC) on UK air operators' fuel planning policies was carried out in the Summer of 2000. The aim was to determine how operators had based their policies upon the requirements prescribed in Joint Aviation Requirements - Operations 1 (JAR-OPS 1) and how they had presented the information in company computer-generated pilot navigation logs. Fourteen operators' policies were reviewed and compared against the same aeroplane types. The SOC also asked questions which reflected concerns raised in letters to the Confidential Human Factors Incident Reporting Programme (CHIRP).

2 JAR-OPS 1

- 2.1 The text of JAR-OPS 1.255 prescribes the basic elements of an operator's fuel planning policy. Further guidance for use by operators in drafting their policies is contained in related Acceptable Means of Compliance (AMC) and Interpretative and Explanatory Material (IEM). Together, these documents reflect the text of ICAO Annex 6 Part I paragraph 4.3.6.1, which is:

“All aeroplanes. A flight shall not be commenced unless, taking into account both the meteorological conditions and any delays that are expected in flight, the aeroplane carries sufficient fuel and oil to ensure that it can safely complete the flight. In addition, a reserve shall be carried to provide for contingencies.”

- 2.2 The Civil Aviation Authority (CAA) expects operators to apply JAR-OPS AMC and IEM guidelines unless alternative procedures intended to provide an equivalent level of safety are acceptable to the Authority. This is no different from when Civil Air Publication (CAP) 360 Part 1 was used by the Flight Operations Department (FOD) as the standard by which all operators' fuel policies were to be specified. In practice, very few operators have sought to differ from implementing first CAP 360 and then AMC/IEM guidelines in their operations manuals.

- 2.3 The basic elements of a fuel planning policy published in JAR-OPS 1 for normal flights are:

A Taxi Fuel This is the total amount of fuel expected to be used prior to take off. Local conditions at the departure airfield and APU consumption should be taken into account.

B Trip Fuel This should include:

Fuel for take-off and climb from aerodrome elevation to the initial cruising level/altitude, taking into account the expected departure routing;

Fuel from top of climb to top of descent, including any step climb/descent;

Fuel from top of descent to the point where the approach is initiated, taking into account the expected arrival procedure; and,

Fuel for approach and landing at the destination aerodrome.

C Reserve Fuel This should include:

Contingency Fuel Because at the planning stage, not all factors which could have an influence on the fuel consumption to the destination aerodrome can be foreseen, Contingency Fuel is carried to compensate for items such as:

Deviations of an individual aeroplane from the expected fuel consumption data;

Deviations from forecast meteorological conditions; and,

Deviations from planned routings and/or cruising levels/altitudes.

Alternate Fuel This should be carried only if a destination alternate is required;

Final Reserve Fuel For aeroplanes with turbine power units, fuel to fly for 30 minutes at holding speed at 1500 ft above the aerodrome elevation in normal conditions; and,

Additional Fuel This should be carried only if required by the type of operations, (eg ETOPS);

D Extra Fuel This should be carried only if required by the aircraft commander.

2.4 In summary:

Contingency Fuel is the greater of (a) or (b), where:

(a) is 5% of the planned Trip Fuel, *or* 3% of the planned Trip Fuel where an en-route alternate (ERA) is available, *or* fuel for 20 minutes' flying time based on an operator's fuel consumption monitoring programme, *or* (with the approval of the Authority) an amount of fuel to fly for 15 minutes above the destination; and,

(b) is an amount to fly for 5 minutes at 1500 ft above the destination aerodrome.

Alternate Fuel should be sufficient for a missed approach from the Decision Altitude (or equivalent) at the destination aerodrome, followed by climb, cruise, descent, approach and landing at the destination alternate aerodrome.

Final Reserve Fuel should, for turbine engine aeroplanes, be sufficient to fly for 30 minutes at 1500 ft above the aerodrome, which could be the destination alternate or else it could be the intended destination (when no destination alternate is required).

Additional Fuel should be carried when the type of operation planned to be undertaken requires fuel over and above that required for normal operations.

3 Results

- 3.1 Data from the questionnaires was entered into four Tables, each of which matched the four aspects described above. Arranged vertically, each pair of types surveyed (four in the case of the B737s) were placed adjacent to one another to facilitate visual inspection of the results. One 'block' of aeroplane types contained the short- and medium-haul types (B757, A320, B737, and BAe 146), the other the long-haul types (B747-400, B747-200 and A330).

4 Analysis

4.1 Horizontal and Vertical Climb Profiles, and Contingency Fuel Amounts

- 4.1.1 The results of this SOC showed that all computer-generated pligs but one failed to take full account of the actual departure and arrival routings in Trip Fuel calculations. This begs the question as to whether these inaccuracies could be significant in terms of fuel burn not accounted for, and whether provision is made to ensure that corrections to Trip Fuel amounts will be made before the total fuel required is determined.
- 4.1.2 At the planning stage, although possible, it is unlikely that on many occasions an aircraft commander will be able to ascertain which runway and associated STAR will be in use when the aircraft arrives at its destination. Therefore, unless the computer program either reflects which STAR is expected to be used (as three did) or contains a default that assumes that the longest STAR will be used (as six did), the Trip Fuel may be inaccurate. Where such inaccuracies are known to be inherent in the computer program and no adjustment is made by the aircraft commander or dispatcher to adjust the amount of Trip Fuel required, then Reserve Fuel may - but should not - have to be relied upon to make up for any deficiency.
- 4.1.3 However, it is reasonable to expect an aircraft commander or dispatcher to know at the planning stage which runway and associated SID are likely to be used on departure and - if the computer program does not include this in its calculations - he should be at liberty to increase (or, possibly, to reduce) the Trip Fuel accordingly. (Seven of the pligs reflected the expected or 'longest' departure routings, and three reflected the 'most used'.)
- 4.1.4 The significance of failure to make adequate provision for extended routings can be illustrated by comparing the amount of Contingency Fuel carried by a typical short-haul operator, based upon the greater of 5% of Trip Fuel or a specified minimum, (and which equates to about 5 minutes), with the additional time spent in the cruise following departure from a runway orientated in the opposite direction to that of the flight plan routing (about 4 minutes). Of course, both times can vary considerably, but unless the commander increases the Trip Fuel required by the equivalent of 4 minutes, his aircraft will have burnt 80% of the Contingency Fuel by the time it passes abeam the departure runway on the SID routing. Reliance should not be placed upon the use of Contingency Fuel for this purpose since the additional track miles to be flown/time in the air and the associated fuel burn are almost certainly foreseeable. Contingency Fuel should be carried only for unforeseen circumstances.
- 4.1.5 *Recommendation 1* Operators should review their fuel policies to ensure that, if their computer fuel planning programs do not take proper account of the runways and their associated SIDs and STARs which are likely to be used 'on the day', commanders or dispatchers are required to consider adjusting Trip Fuel amounts so as to rectify any deficiencies. Preferably, operators should change their computer fuel planning programs to remove or to reduce to negligible proportions all such inaccuracies where these might lead to inadequate amounts of Trip Fuel being calculated.**

4.2 Unusable and Unavailable Fuel, and the Declaration of an Emergency

- 4.2.1 In researching the extent to which fuel quantity indicating systems might mislead flight crews by including unusable and unavailable fuel in the amounts displayed, the SOC revealed that for most aeroplane types surveyed this concern was unfounded. These systems displayed either only the fuel that could be used or fuel that was less than actually remained. 'Unusable' in this context should be taken to mean fuel that cannot reach the engine due to tank and fuel line design, and 'unavailable' means that the fuel indicating system over-reads.
- 4.2.2 However, for two B737 operators, unusable fuel amounts of 68 and 72 kg were recorded, equating to less than two minutes time in the air. This, it is suggested, would not be significant when compared with the associated fuel levels at which the aircraft should have landed (Final Reserve Fuel - about 1200 kg) preceded by the declaration of an emergency.
- 4.2.3 No unavailable fuel amounts were declared - for the reasons stated above.
- 4.3 **Requests for a Priority Approach, Declaration of an Emergency, and Typical Holding/Final Reserve Fuel Amounts**
- 4.3.1 All operators except two (B757 and A330) used Final Reserve Fuel (30 minutes at 1500 ft) as a value associated with the declaration of an emergency. One of the two who did not conform with this formula used a value that equated to about 37 minutes and the other a value that equated to about 25 minutes. One operator of B747-400 and B747-200 aeroplanes specified that a Priority Approach was to be requested when it seemed likely that the aeroplane would land with less than Final Reserve Fuel remaining, declare a PAN call when it seemed certain that this would be so, and a MAYDAY when (if) the fuel on board reduced to 20 minutes-worth.
- 4.3.2 Eight other operators specified that the commander should request a Priority Approach when it appeared likely that the amount remaining on landing would be less than Final Reserve Fuel. Whilst there is some merit in having a 'caution' area before entering a 'warning' zone, it rests with the operator to specify clearly at what point a Priority Approach should be requested and the manner in which the request should be made according to the air traffic environment or region in which the aerodrome is situated. The UK, for example, does not recognise the term 'Fuel Emergency' and notified flight crews by means of an Aeronautical Information Circular (AIC 36/1998 (Pink 170) dated the 24th of March) that air traffic control cannot give priority to an aircraft with a shortage of fuel unless an emergency is declared.
- 4.3.3 AIC 36/1998 recommends that adequate reserves of fuel should be carried when intending to land in the UK at certain airfields where delays should be expected at times when the associated terminal areas will be busy. This AIC had been re-issued because it again became apparent that too many aeroplanes continued to arrive in the vicinity of their planned destination with little more than Alternate and Final Reserve Fuel remaining. Concern remains that this message has still not been acted upon to the extent envisaged: in late September 2000 one controller dealt with three fuel shortage PAN calls in one shift.
- 4.3.4 **Recommendation 2 Operators should review their fuel policies to ensure that adequate provision is made either through their computer programs or by adjustments made by aircraft commanders or dispatchers (acting in accordance with guidance or instructions specified in operations manuals) for the Trip Fuel to include, where appropriate, fuel for use in holding prior to commencing the approach when there is reason to believe that this will occur. An example of such circumstances can be found in AIC 36/1998 (Pink 170).**
- 4.3.5 It should be noted, in the context described above, that having arrived overhead his intended (flight plan) destination, there is, according to JAR-OPS 1, no obligation on the commander to

set off for his planned destination alternate the very moment that the fuel remaining on board his aircraft reduces to the sum of Alternate Fuel and Final Reserve Fuel. Rather, the commander can decide - as may be permitted by the operator's fuel management policy - either to divert or else to remain overhead his destination aerodrome. This choice exists because it may well be preferable to land at the intended destination with less than the sum of Alternate Fuel and Final Reserve Fuel as opposed to setting course for the destination alternate when upon arrival Final Reserve Fuel could (but not necessarily will) be all that remains. If deciding not to divert, the commander can use Alternate Fuel together with any unused portion of Contingency Fuel to extend the length of time he may be required to hold before commencing his approach at his planned destination.

4.4 Miscellaneous Information Displayed on the PLOG

4.4.1 Most computer-generated plogs displayed important parameters such as ERA, cruise profiles, etc, used in fuel plan calculations, and where default programs were employed this information was generally to be found also or instead in manuals available to flight crews (the operations manual, flight crew orders, aircraft or flight crew operating manual).

5 Discussion

5.1 Adjustments to Computer-Generated Fuel Plan Calculations

5.1.1 Because Contingency Fuel is carried for events that cannot be foreseen, its use should not be planned before departure to compensate for needs that can reasonably be identified as likely to result in an increased fuel burn. Thus, for example, if an operator makes known his intention to the commander of an aircraft whose departure is likely to be delayed that, once airborne, he should adopt a high-speed cruise profile, then the proper course is that the commander should adjust the Trip Fuel sufficient to cover what can now be foreseen as a change to the manner in which the aeroplane will be operated.

5.1.2 In other circumstances where, possibly, fog has resulted in persistent delays to incoming aircraft and it is known that arriving aircraft are being held, prudence would suggest that the commander adjusts the Trip Fuel so that he is assured of having an excess on arrival sufficient to enable the aircraft to hold prior to its commencing an approach.

5.1.3 Less clear-cut circumstances are where it is known that at certain times of the day arriving aircraft might - but not necessarily will - experience delays before being permitted to begin their approach. In these circumstances, which cannot be foreseen accurately, it is not unreasonable for operators to give guidance to their aircraft commanders on the policy they should adopt. Thus any decision by the aircraft commander to uplift Extra Fuel might reasonably be made subject to such guidance. This, it is expected, should take due account of all circumstances affecting or likely to affect the flight (accuracy of computer program, proper account taken of routings and flight profile, pragmatic values of Taxi, Contingency, Alternate, Final Reserve and Additional Fuel, etc.), together with the rider that it still remains the commander's prerogative to uplift Extra Fuel if in his judgement this is needed. It would not be unreasonable for the operator to require the commander to make a note on a suitable document to record the reason or reasons why Extra Fuel was considered necessary, so that lessons learnt can be reflected in improved fuel programs of benefit to all crews.

5.2 Company Cultures on Fuel Planning and Usage

5.2.1 Company fuel planning policies varied between operators but nothing was seen that did not accord with the requirements of JAR-OPS 1 and its associated guidance material. Less easy

to measure was the 'company culture', instructions by the operator on the priorities he expected his aircraft commanders to apply such as whether or not to uplift Extra Fuel, to accept enforced delays or to make up for lost time, or to accept additional payload in place of slightly more generous calculations of Alternate or Contingency Fuel. Some operators were reported to have in place 'league tables' that 'ranked' commanders according to the amount of fuel they took on departure exceeding that calculated by the computer program.

- 5.2.2 The effect of keeping a league table as described exerts a form of pressure on each individual not to be shown up as being different from his colleagues in the fleet and vulnerable to attract attention from his fleet manager. Such perceived pressure is known to have resulted in pilots departing with less than that calculated by the computer-generated fuel plan so that their position in the table could be 'improved'. To depart on a public transport flight with less than the flight plan fuel calculated in accordance with a program accepted by the Regulator as sound - and without good reason - is likely to be in breach of the terms and conditions under which the Air Operator Certificate was granted. In short, such practice places the continuance of the Certificate at risk.
- 5.2.3 It has been pointed out by the JAA's Human Factors Steering Group that it is shortcomings such as low experience, inadequate training and lack of effective planning that increase risk. Another risk element identified through evaluation of accident reports - poor decision-making - is known to result from pressure perceived in the mind. It is conceivable that the application of excessively tight fuel policies will add to such a perception.
- 5.2.4 There are times when there can be little or no choice open to the commander to uplift any Extra Fuel he considers is needed. This occurs when the capacity of the tanks has been reached or when the contracted payload and regulated take-off weight place a constraint upon the mass of fuel that can be carried. When all other options have been discounted, an en-route (technical) stop may be the only solution. Yet in other circumstances, when the possibility of departing with Extra Fuel to address a perceived need exists, there should never be any undue pressure not to take it. (In many cases it is probable that it is the Trip Fuel that should be adjusted to reflect what can be foreseen and to correct inaccuracies in the computer plan, rather than the carriage of Extra Fuel.)
- 5.2.5 Although none of the operators whose policies were reviewed in the SOC were reported to have specified unreasonable guidelines on the amount of fuel with which commanders might depart, this was difficult to reconcile with some reports that had been received from flight crews. It would seem advisable that some operators should do more to gauge the impact their policies have upon the flight crews they employ and that they should be prepared to address the issue if it appears likely to prejudice safe operations.
- 5.2.6 **Recommendation 3** Operators should review their fuel policies to ensure that, as interpreted by fleet managers, training and line pilots, these do not result in a perception that aircraft may be permitted to depart with fuel amounts less than must be calculated in accordance with formulae specified in the operations manual (or equivalent document). Where such formulae are known not to address all circumstances that can reasonably be foreseen, pragmatic guidance should be specified to ensure that appropriate adjustments are made. This review might be managed through a schedule applied by the Operations Quality Manager so as to ensure that company policy endures with time.

6 Conclusion

- 6.1 The Special Objective Check on Fuel Planning addressed policies applied by UK air operators who were representative of those who had chosen to base their operating standards upon

JAR-OPS 1. The SOC took note also of issues raised in correspondence with the Flight Operations Department and with the Confidential Human Factors Incidents Reporting Programme.

- 6.2 The results showed that all operators who were surveyed applied their fuel planning policies in general accordance with the JAR-OPS 1 requirements and associated guidance material, and that such variations as existed between them reflected the nature of their work and the capabilities of their aircraft. However, there were some issues to which it appeared all operators could address their attention, comprising: inaccuracies inherent in many computer-generated pilot navigation logs; inadequate account taken of foreseeable events; and the manner in which flight crews interpret their company culture on fuel planning.

SPECIAL OBJECTIVE CHECK - OPERATORS' FUEL POLICIES

TABLE A

To show the extent to which computer-generated pligs accurately reflect fuel expected to be consumed flying SIDs and STARs, and how this compares with the amount of Contingency Fuel likely to be carried.

Operator	Type	SID Track	SID Levels	STAR Track	STAR Levels	Contingency Fuel	Four Minute Cruise Amount	Comments on Extra Fuel Uplift
		1	2	3	4	8	13	5
A	B757	No	No	No	No	500 / 9 mins	200	Commander can uplift Extra Fuel stating reason
B	B757	No +	No +	No +	No +	630 / 11 mins	240	Commander can uplift Extra Fuel but discouraged
C	A320	No	No	No	No	260 / 7 mins	160	Commander can uplift Extra Fuel without question
D	A320	Yes *	No	No	No	200 / 5 mins	180	Commander takes what he wishes within reason
E	B737-300	Yes	No	Yes	No	200 / 5 mins	150	Commander can uplift Extra Fuel stating reason
F	B737-300	No +	No +	Yes *	Yes *	500 / 15 mins	180	Commander can uplift Extra Fuel but discouraged
G	B737-300	No	No	No	No	200 / 5 mins	200	Commander takes what he wishes (extra for LHR)
H	B737-300	No	No	No	No	194 / 5 mins	150	Commander takes what he wishes within reason
I	B737-300	Yes *	No	No	No	200 / 5 mins	150	Commander takes what he wishes within reason
I	BAe 146	Yes *	Yes	Yes	Yes	175 / 5 mins	160	Commander can uplift Extra Fuel stating reason
J	BAe 146	Yes *	No	Yes *	No	190 / 5 mins	140	Commander can uplift Extra Fuel without question
W	B747-400	Yes	No	Yes	Yes	2300 (ERA)	850	Commander can uplift Extra Fuel stating reason
X	B747-400	Yes	No	Yes	No	2200 (ERA)	700	Commander takes what he wishes within reason
W	B747-Classic	No +	No +	Yes *	Yes *	2500	800	Commander takes what he wishes within reason
X	B747-Classic	Yes	No	Yes	No	2400	800	Commander takes what he wishes within reason
Y	A330	No +	No ^	No +	No +	2750 (5%)	400	Commander takes what he wishes within reason
Z	A330	Yes	No	Yes	No	2500 (5%)	500	Commander takes what he wishes within reason

* means the 'longest' routing

+ means the 'most used' departure or arrival routing

^ means 'continuous climb assumed'

SPECIAL OBJECTIVE CHECK - OPERATORS' FUEL POLICIES

TABLE B

To show the extent to which computer-generated pligs take account of unusable and unavailable fuel (and whether this is a problem).

Operator	Type	Unusable	Unavailable	Unusable + Unavailable	Emergency Declaration	Unusable + Unavailable v Emerg Declaration	Comments (on Operator's policy on taking due account of unusable and unavailable fuel when fuel quantities are low)
		6.1	6.2		14.2		
A	B757	-----	-----		2000		Fuel indicating system calibrated to show usable fuel only
B	B757	-----	-----		1770		Fuel indicating system calibrated to show usable fuel only
C	A320	-----	-----		900		Fuel indicating system calibrated to show usable fuel only
D	A320	-----	-----		<FR		Fuel indicating system calibrated to show usable fuel only
E	B737-300	-----	-----		1272		Fuel indicating system calibrated to show usable fuel only
F	B737-300	-----	-----		1165		Fuel gauges generally show less than there really is
G	B737-300	68	-----		1200		Fuel gauges are inaccurate to the extent shown
H	B737-300	72	-----		1240		Fuel gauges are inaccurate to the extent shown
I	BAe 146	-----	-----		890		Fuel indicating system calibrated to show usable fuel only
J	BAe 146	52	-----		930		Fuel indicating system calibrated to show usable fuel only
W	B747-400	-----	-----		4410		-
X	B747-400	-----	-----		4300		-
W	B747-Classic	-----	-----		<FR		Fuel indicating system calibrated to show usable fuel only
X	B747-Classic	-----	-----		<FR		Fuel indicating system calibrated to show usable fuel only
Y	A330	-----	-----		2400		Fuel indicating system calibrated to show usable fuel only
Z	A330	-----	-----		1900		Fuel indicating system calibrated to show usable fuel only

FR means Final Reserve Fuel, typically the amount burnt holding for 30 minutes at 1500 ft above the destination at the expected landing weight/mass

SPECIAL OBJECTIVE CHECK - OPERATORS' FUEL POLICIES

TABLE C

To show the relationship between the points at which (1) a Priority Approach must be requested and (2) an Emergency must be declared, compared with the amount of Holding Fuel likely to be on board.

Operator	Type	Priority Approach	Emergency Declaration	Holding or Final Reserve Fuel	Em Dec v Holding	Comments on Operator's Policy on Reserve Fuel
		14.1	14.2	7		
A	B757	<2000 likely	<2000 certain	1600	125 %	
B	B757	None spec	1770	1770	100 %	
C	A320	<FR likely	1100	1100	100 %	
D	A320	None spec	1200	1200	100 %	
E	B737-300	None spec	1272	1272	100 %	
F	B737-300	None spec	1165	1165	100 %	
G	B737-300	<FR likely	1200	1200	100 %	
H	B737-300	1240	1240	1240	100 %	
I	BAe 146	990	890	890	100 %	
J	BAe 146	None spec	930	930	100 %	
W	B747-400	<4410 likely	<4410 certain	4410	100 %	
X	B747-400	<4300 likely	<4300 certain	4300	100 %	Pan call when 4300 (30 mins) remain, Mayday when 20 mins (2870)
W	B747-Classic	<FR likely	<FR certain	30 mins	-----	
X	B747-Classic	<FR likely	<FR certain	4700	-----	Pan call when 30 mins remain, Mayday when 20 mins
Y	A330	<2400 likely	<2400 certain	2400	100 %	
Z	A330	None spec	<1900 certain	2300	85 %	

FR means Final Reserve Fuel, typically the amount burnt holding for 30 minutes at 1500 ft above the destination at the expected landing weight/mass

SPECIAL OBJECTIVE CHECK - OPERATORS' FUEL POLICIES

TABLE D

To record miscellaneous information on computer-generated plog accuracy.

Operator	Type	Contingency Fuel Formula	En-Route Alternate Identified	Cruise Profile Identified on plog	Alternate Routes Accurate	Step Climb Profiles Accurate	Comment
		9	10	11	12.1	12.2	
A	B757	5% of Trip or 500 minimum	Yes	Yes	Yes	-----	
B	B757	5% of Trip, ERA or 630 minimum	No	No +	Yes	-----	
C	A320	5% of Trip or 260 minimum	No	Yes	Yes	-----	
D	A320	5% of Trip	No	No +	Yes	-----	
E	B737-300	5% of Trip	No	Yes	Yes	-----	
F	B737-300	5% of Trip	No	Yes	Yes	-----	
G	B737-300	5% or 150 minimum	No	No *	Yes	-----	
H	B737-300	5% of Trip	No	Yes	Yes	-----	
I	BAe 146	5% of Trip or 100 minimum	Never used	Yes	Yes	-----	
J	BAe 146	5% of Trip or 5 mins at 1500 ft	Never used	Yes	Yes	-----	
W	B747-400	5% from abeam ERA	Yes	Yes	Yes	No #	
X	B747-400	5% of Trip or 15 mins at 1500 ft	Yes	Yes	Yes	Yes	
W	B747-Classic	5% from abeam ERA	Yes	Yes	Yes	Yes	
X	B747-Classic	5% of Trip or 15 mins at 1500 ft	Yes	Yes	Yes	Yes	
Y	A330	5% of Trip or 5 mins at 1500 ft	No ^	No *	Yes	No #	
Z	A330	5% of Trip	Yes	Yes	Yes	Yes	

No * means that the information is in the Operations Manual
 No + means that pilots know that 'ECON' is standard

No ^ means ERA at commander's discretion
 No # means the climb profile reflects the filed flight plan