Letters to the Editor

AIRCRAFT FUEL RESERVES

SIR,—In the discussion on Lieut.-Commander Satow's paper on Meteorology and Navigation (see Vol. V, p. 222), Mr. D. O. Fraser made several important points about aircraft fuel reserves. It is to be hoped that the Institute, perhaps through one of its working parties, will be able to devote some attention to this matter which is so important to air safety and economics.

I would agree with Mr. Fraser's statement of the problems of terminal forecasting, and of how operators provide against the uncertainties of these forecasts. However, here my agreement ceases, and Mr. Fraser (for whom I have the highest professional and personal regard) seeks, I think, to perpetuate an outmoded philosophy of fuel reserves which leads to bad transport economics. I would like, therefore, to put forward arguments for a more refined view of the whole matter.

At present what we say to our captains is in effect 'fly to destination and if you don't like the look of it, go to an alternate'. In other words, don't believe the landing forecast for destination but accept that for the designated alternate. This is in fact merely indulging in the old thimble and pea routine, and a short analysis of what it entails may be interesting.

At an intermediate point *en route*, say one hour's flight time from either destination or alternate, the captain has received, on request, a landing forecast for each airport. Let us suppose the forecast for destination to be 'on limits and deteriorating', and for alternate 'on limits and improving'. The captain, disbelieving the forecasts, starts the descent into destination; on arrival over the top, he finds the weather is on limits and fluctuating and so he commences an instrument let-down. He does not break through at the prescribed minima and therefore pulls up to initial-approach altitude, calls for terminal weather at alternate (for ETA) and receives '200 ft. and ½ mile above minima and steady'. The aircraft now starts on a one-hour diversion flight to alternate and eventually lands there, after holding for 15 minutes in the stack.

From the intermediate *en-route 'point of equal distance from alternative landings'* (*Pedal*) our captain took:

1^{h} descending from *Pedal* into destination
15^{m} on circuit, missed approach and pull-up
1^{h} on diversion to alternate
15^{m} in stack at alternate
10^{m} on approach and landing.

Total $2^{h}\ 40^{m}$ from *Pedal* to land at alternate.

Safety as it must, has been maintained, regularity is well busted and an economic millstone was carried along for good measure. At *Pedal* our captain renounced the forecaster and all his works, but, after his abortive approach on destination, his faith in landing forecasts one hour ahead was miraculously restored.

This is no plea for infallible landing forecasts, but only for a more logical use of such aid as the forecaster can give to flights in progress.

We can assume that a scheduled air transport flight will never deliberately enter an area from which there is no return, unless that area contains at least one airport which on all the evidence (terminal forecast, climatological data,

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landing aids, holding reserves, &c.) offers a 99·99% chance of a safe landing. (If the 00·01% chance is unacceptable, then the aircraft should be sent to Arizona and put in mothballs.) The terminal forecast on which entry is made into the no-return area will for long trans-oceanic operations often be more than one hour ahead. At this stage faith in forecasters is strong. We therefore ride over our PNR in good heart and full of running.

Let us suppose now that the captain disregards tradition and casts off the economic millstone of 'fuel for diversion from destination to alternate'. He will have retained his holding fuel, and at *Pedal* he will have received the same landing forecasts for destination and alternate. This time it will be assumed that the weather service knows more about the weather at the glide path than our captain riding 40,000 ft. above and 200 miles from it. On the evidence available at *Pedal*, the captain alters course towards his designated alternate. An hour later he arrives over the top, spends 15 minutes in the stack, 10 minutes for approach and landing, as before. The comparable times run from *Pedal* for the two flights are tabulated below.

Position	*Old Faithless* h m	*Riding High* h m
Pedal	0 00	0 00
Over destination	1 00	—
Depart destination	1 15	—
Over alternate	2 15	1 00
Land alternate	2 40	1 25

Other comparisons reveal:

Safety. Both flights diverted on a landing forecast one hour ahead.

Regularity. Both schedules are busted, but *Riding High* is 1¼ hours ahead of *Old Faithless* on landing at alternate and has a chance of getting his passengers to their destination that much sooner.

Economy. *Riding High* did not carry 'fuel from destination to alternate'; instead he put on that much additional payload (which for a modern jet liner would be several thousand pounds), with no decrease in safety. If *Old Faithless* had brought off his landing at destination, he would have gained in regularity, but still have lost on payload.

I make no claim that these arguments apply universally to air transport operations; and the analysis only considered reserve fuel for diversion to an alternate airport, and that conveniently orientated with respect to destination and the *en-route* track.

However, I believe that the whole question of fuel reserves needs a critical examination, taking into account considerations such as those I have tried to illustrate. Reserve fuel, like preventive maintenance, is an essential safety provision; but successful safety measures are built on quality not quantity. The advent of high-density tourist services and the introduction of jet liner operations demand a complete overhaul of present fuel policies.

A refinement of the principles of fuel control implies an examination of almost the entire field of air navigation, in its broadest sense, and there would therefore seem no body better fitted to undertake it than the Institute.

34 Warren Road,
Double Bay,
Sydney, N.S.W.

Yours faithfully,
A. J. MOLINE
(Member of the Australian Institute of Navigation)

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