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Turbojet Aircraft Performance Characteristics
and their Meteorological Implications for
Australian Air Route Conditions

by

H.R. PHILLPOT

Mr. Phillipot of the Bureau of Meteorology gave an account of his investigations of the physical principles on which the operation of civil turbojet aircraft is based, particularly as they concern the meteorologist.

He reviewed the advantages and characteristics of the turbojet engine and the performance characteristics of the turbojet aeroplane. From the latter he showed that the MACH number M , is a function of $N/\sqrt{\theta}$ and W/δ and that for an aeroplane cruising on a constant MACH number the pressure height must be continuously varied as W (the aircraft weight) changes with burn-up of fuel. Temperature effects (as shown in the term $\sqrt{\theta}$) must be compensated by changing the engine RPM (N) and it is this fact that is specially important for the BOEING 707-138 which is subject to power limitation, particularly with high all-up weights, when the ambient air temperature at cruising altitude is much higher than I.S.A. This means that the significance of the forecast error varies with the ambient temperature and aircraft weight, and the problem is more serious in the tropical regions where, on the whole, temperatures above I.S.A. are consistently greatest up to the probable cruising levels. From the meteorological point of view, the difficulty is offset to some degree by the much smaller temperature variability in the tropics and where, as a consequence, the forecasting problem is less difficult.

He said, the effect of the wind forecast errors on cruise is a direct one because the flight time is affected and therefore the period for which fuel is used. He furnished some statistical data for the Sydney-Darwin and Sydney-Nandi air routes showing that at cruising heights between 30,000 and 40,000 feet the temperatures through the tropics will average about ISA + 10 to ISA + 15°C.

From the results of about six months "paper operations" on both the Sydney-Darwin and Sydney-Nandi routes, while he stressed the reservations which must be attached to any conclusions drawn from

these operations, Mr. Phillipot found standard deviations of the wind and temperature errors of 10.5 to 12.5 knots and 3.5°C respectively, with a resultant standard deviation in the flight fuel consumption of very nearly 1000 lb. He said, the practical significance of this is that extreme meteorological errors are likely to result in a variation of the planned arrival time by some 30 minutes. This, he said, in turn emphasizes the significance of the terminal conditions (and terminal forecasting accuracy) as the great increase in fuel consumption at lower heights alone demands that a substantial fuel reserve be carried for every flight.

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A Theory of Fronts in Relation to Surface Stress

by

F.K. BALL

Mr. F.K. Ball, of the Division of Meteorological Physics, C.S.I.R.O., Melbourne gave the results of his mathematical investigations of the equations governing the motion of the cold air ahead of a warm front or behind a cold front into which he had introduced surface stress terms.

He stated that solutions for the steady state indicated that a kata-front inversion tends to become horizontal at increasing distances from the front, whereas an ana-front inversion may continue to slope upwards indefinitely. The depth of cold air will, when the upper flow is curved cyclonically, actually decrease with increasing distance from a cold kata-front. He also showed that the existence of a sharp surface warm front depends on the sudden breakdown of a trailing layer of cold air. The thickness of this layer increases with decrease in latitude and as a result sharp warm fronts are unlikely to occur at low latitudes. The conclusions concerning cold fronts, Mr. Ball said, are in broad agreement with Sansom's (1951) observations.