(1) to assess the quality of the pilot's flying controls in the hover and at low speed, (2) to check the functioning of the powerplant and its control system, (3) to maintain a close check on the stress levels in the main parts of the rotor system, and (4) to extend gradually the speed/height envelope.

"All this initial flying was confined to the helicopter regime until an indicated speed of 136 kt and an altitude of 6,800ft had been attained. The flying controls proved eminently satisfactory, particularly those of the rotor, an adequate degree of directional control being achieved by the differential propeller pitch scheme.

"Aerodynamic investigation had shown that the optimum speed for transition, based on a combination of performance and control factors, was likely to be around 100 kt, and thus sufficient speed margin above this was cleared for helicopter height. On the Boscombe Down rig development tests had proved, within the rig limits, that relighting of the tip-jets in the air could be relied upon from either of the duplicated tip-jet ignition systems.

"The stage was now set in which to begin the transition work. We were fortunate in that several hundred transitions had already been accomplished on the Jet Gyrodyne and thus the principles of the powerplant control during the process were well understood. The lifting wing, however, introduced a very important new feature which was thoroughly studied by the aerodynamic staff using theory and model tests. We decided to follow a gradual approach, reducing the maximum rotor power in discreet steps from the "all four jets lit" condition by extinguishing each pair of jets in turn, then declutching each half-rotor in turn, until finally no tip power was transmitted to the rotor. This phase threw up some further problems of relighting, and compressor air blow-off valves were introduced to facilitate the process at the higher altitudes where these initial transition tests were conducted. These blow-off valves showed to advantage in allowing a more rapid rate of descent than had hitherto been possible. This step-by-step approach allowed the pilots to assess the trim problems involved at each stage, until on the 71st flight on April 10, 1958, after a total of 20 hours' flying, the first full transitions were completed.

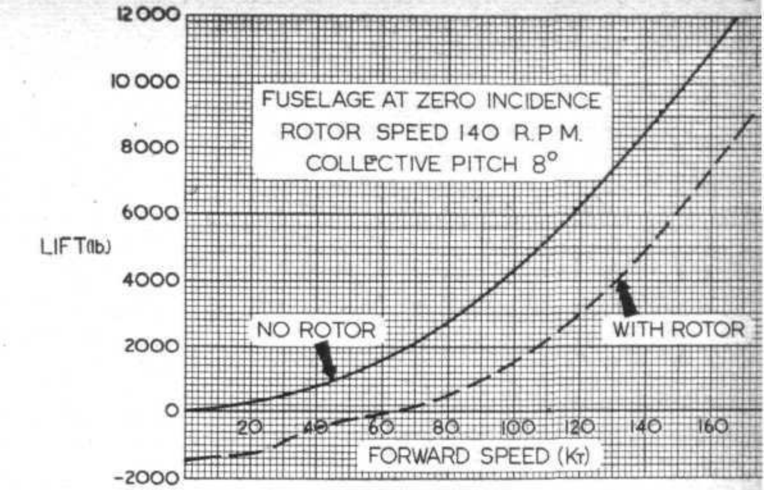
"Once the autogyro regime had been reached, more and more time was spent in this condition, extending the speed and height range, assessing the aircraft's flying characteristics and control qualities, and always keeping a careful watch on hub and blade stresses as well as on the powerplant and its control. The transition technique has been steadily perfected and now this is often conducted at very low altitudes and very shortly after take-off or before landing. The cruise speed of 160 kt on which the economics have been based has been exceeded, even at this relatively early development stage, at a power inside the cruise power rating of the engine, thus demonstrating beyond all shadow of doubt the soundness of the basic approach. The tip speed ratio so far reached in cruise is about 0.53, though ratios exceeding 0.6 have been attained. The climb performance is phenomenal for such a large aircraft as vertical rates of climb of over 1,900ft/min and forward rates of climb of over 2,400ft/min have been measured at full gross weight appropriate to the present engine ratings. I might emphasise here that virtually all flights have been done at full design take-off weight appropriate to these engines (the all-up weight was originally fixed as that at which 200ft/min rate of climb on one engine at one-hour power rating could be maintained) or slightly above.

"It would be wrong of me to suggest that no problems have shown themselves, and in any case no-one would believe me. I can say though that few, if any, serious problems have asserted themselves within the speed range originally fixed when design began about five years ago. The aircraft manœuvrability is very impressive for such a large, heavy aircraft, turns of 60 deg bank having been done in the course of such handling tests as we have covered to date. At the high speeds which have been attained, there is evidence of a reduction in the rolling control and an increase in the sensitivity of the fore-and-aft control.

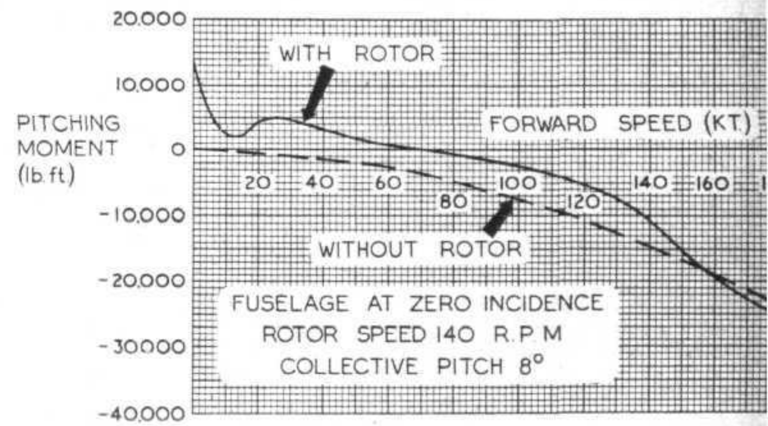
"The steps required to overcome these problems are clear to us and will be taken as soon as sufficient break in the flying programme offers itself. In the meantime, the emphasis will be on performance and handling assessment, especially in the engine-failed case which is of such vital importance to any civil air transport machine."

Further Development. "You may now ask what development possibilities there are with this configuration. Apart from increase in weight by a factor of 1½, which can be contemplated with equanimity, we were especially concerned with exploiting the speed potential as much as possible. We believe that cruising speeds of 220 kt are possible with this basic configuration by developments mainly aimed at maintaining good control for the pilot and reducing rotor drag.

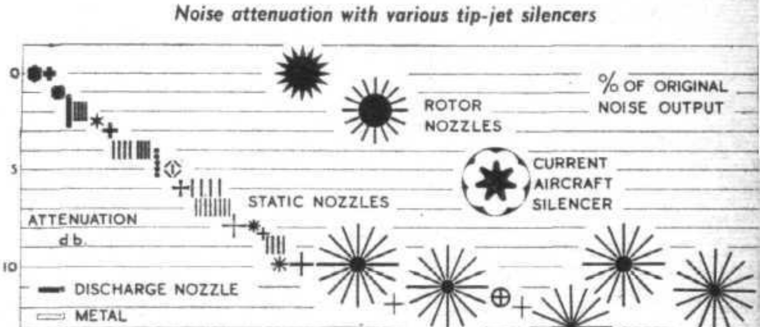
"At the moment, I would not care to say that higher speeds than 220 kt cruise could be achieved, though experience is a great teacher. In any case, an economic VTOL aircraft, with adequate performance standards with an engine failed, *and* a cruising speed of 220 kt, with all-weather capabilities is, I am certain, a vehicle which no operator, civil or military, scheduled or bush, can possibly afford to ignore."



Typical wind-tunnel results for the Fairey Rotodyne: (above) airframe lift and (below) airframe pitching moment



Noise attenuation with various tip-jet silencers



Estimated direct operating costs for Rotodyne