New Light on the Slush Problem

IN order to lay the slush bogy once and for all, the United States Federal Aviation Agency conducted a series of tests last autumn to determine the effects of slush and water on take-off and landing performance. In terms of manpower and equipment alone these tests must certainly have been the most extensive and most closely controlled ever undertaken in connection with measuring aircraft field performance. For this reason the results, now available, could form the basis for new wet-runway performance regulations and be a guide for future tests.

Using the Agency's own Convair 880M, the tests were made at the Atlantic City Airport of the National Aviation Facilities Experimental Centre. Eight ice-crushing vehicles capable of turning out 50 tons of slush per hour, and a team of 150 men, were on hand for preparing the close-tolerance slush conditions on the 50ft-wide by 1,000-3,000ft-long test strip placed roughly midway along the 10,000ft runway. Eleven cine cameras in the aircraft and up to 15 high-speed cine and still cameras on the airfield were used to record spray pattern and performance (by film measurements and instrument recording).

Slush Drag In 1960 NASA had investigated the drag on a single wheel by rolling it through a trough containing various depths of slush and water at speeds up to 104kt. Technical note D552 on these tests was used to prepare tentative field-length charts for various transport aircraft operating in comparable conditions. However, because of the relatively simple nature of the earlier tests, doubts were soon cast on the validity of the estimated airfield performance, complications being introduced by the inevitable effect of spray impingement on the aircraft, tyre hydroplaning, and their combined effects at high ground speeds.

One of the Convair 880M tests showed the importance of spray retardation. For this test, a narrow path was cleared through the slush for the nosewheel; the comparative decelerations are shown in Fig 1. These particular tests showed that nosewheel drag was 38 per cent of the total drag. From D552 data, slush drag on the nosewheel alone would be about 11 per cent; therefore spray impingement accounted for about 27 per cent of the total aircraft slush drag.

After a number of calibration runs on dry concrete, the 880M made repeated runs into the slush at speeds between 80kt and 160kt, and Fig 2 shows the total drag in various depths of slush. Gross weight on these runs was about 150,000lb. As the total thrust available from the four CJ805-3B engines of the 880M is 46,600lb and the take-off rotation speed roughly 125kt, it is apparent from Fig 2 that slush depths greater than 1.5in would make take-off marginal. This was dramatically demonstrated by two take-off runs made into the slush. On the first run, the 880M entered 1⅛in of slush at 100kt and took 2,800ft to accelerate to 125kt and rotate—nearly twice that predicted by the D552 formula. On the second run, 1.4in of slush was entered at rotation speed and the aircraft was immediately rotated and lifted off. This proved the possibility of a take-off in slush, and allayed certain fears that spray on the aft fuselage would create so much nosedown pitch as to prevent rotation. It may be advisable to note that these tests only indicate the possibility of a take-off from deep slush. The pilot

Fig 1

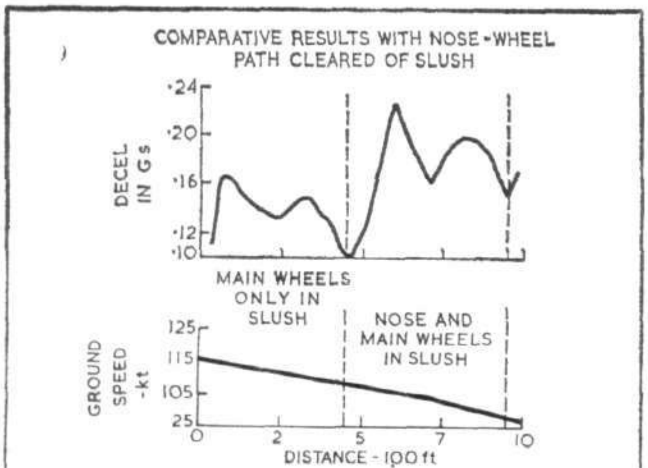

Fig 2