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THE INFLUENCE OF HELICOPTER OPERATING CONDITIONS ON ROTOR NOISE CHARACTERISTICS AND MEASUREMENT REPEATABILITY

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INTRODUCTION

The RAE flight research programme on helicopter external noise is intended to help satisfy demands for minimisation of observed noise levels in respect of civil annoyance and of acoustic detectability, commensurate with operational safety and efficiency requirements, and for acoustic diagnosis of helicopter rotor noise leading to improvement of prediction methods. Some essential developments in flight-testing techniques and preliminary results on helicopter flight-path and acoustic-signal repeatability for noise diagnosis and noise certification were obtained mainly using Lynx (XZ-234 and XZ-233), as reported[1,2] in 1978. Exploratory analysis also then confirmed that the external noise characteristics of helicopters are complex not only as regards spectral content and levels, but can also change markedly with the flight conditions and design/performance restraints. Such variations are particularly associated with the complicated aerodynamic operating conditions of both the main-rotor and tail-rotor and with possible flow interactions, since the rotors are mounted in close proximity to one-another and to the large fuselage or tail-cone/fin.

During the past two years, extensive measurements of noise characteristics and associated flight-path data have been made by RAE on other Lynx variants, a Gazelle and a WG 30 in various operational modes, all with repeated flight trajectories over longitudinal/lateral arrays of ground-based microphones under quiet airfield conditions. Some tail-rotor near-field noise signatures have also been obtained for correlation purposes on a Lynx, using a microphone with a forward-facing noise-cone just outside the fuselage skin on the tail-boom. In the flight trials at RAE Bedford airfield, precise kine-tracking of the aircraft and time-coordination with the registered acoustic signals has been provided, but for other trials at RNAS Merryfield site cruder spatial/time information has had to be tolerated.

This present analysis provides RAE experimental results for the Lynx helicopters (XZ-234, XX-910 and XW-837) with standard rotor configurations, being concerned primarily with the influence of different operating procedures on main-rotor and tail-rotor noise characteristics and on measurement repeatability. In steady level flight, indicated airspeed was varied between 70 kn and 150 kn with appropriate collective-pitch changes of the rotor at normal rpm, and rotor speed was varied between -5% and +5% of the normal operating rpm at 120 kn airspeed.

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SUMMARY

Following on exploratory developments in flight-testing techniques and data-analysis procedures for helicopter external noise, extensive measurements of noise characteristics and associated flight-path data have been made by RAE on several helicopters in various operational modes, with repeated flight trajectories over longitudinal and lateral arrays of ground-based microphones under quiet airfield conditions. This analysis presents some experimental results from Lynx aircraft with standard rotor configurations, being concerned primarily with the influence of different operating procedures on both main-rotor and tail-rotor noise characteristics and on measurement repeatability, during level-flight, oblique landing-approach, and oblique take-off. Some tail-rotor near-field noise signatures have also been derived for correlation purposes, using a microphone mounted with a forward-facing nose-cone just outside the fuselage skin on the tail-boom. The scope of other noise measurements to be reported later by RAE, on a Lynx with a quieter tail-rotor, a Gazelle and a WG 30, is also outlined for completeness.

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* It is regretted that unexpected substantial delays in the data-reduction programme earlier this year precluded completion of analysis and interpretation of these RAE experimental results in sufficient time for current publication of the intended text. This should now be issued as RAE TM Aero 1876 by the end of 1980.

Oblique landing approaches were completed at approach angles of 6°, 9° and 12° (on XX-910) using the RAE portable approach aid (PPAPI). Oblique take-off trials have already been reported[1,2] on Lynx (XZ-255) and Sea-King (XV-371), so only brief reference to the implications of the results need be made here for completeness.

This paper explains the flight-path and noise measurement techniques, the scope of the flight-trials, and the acoustic analysis techniques. After consideration of flight-path repeatability, Lynx detailed noise results are illustrated primarily from extensive third-octave analysis for the far-field ground microphones, but also from narrow-band analysis for the near-field tail-boom microphone. Finally, our plans for further data-reduction and analysis are summarised.

REFERENCES

1 J Williams, MRP Law — Helicopter flight-path and acoustic-signal repeatability for noise diagnosis and noise certification. 4th European Rotorcraft Forum, Paper 54 RAE TM Aero 1773 (1978).

2 MRP Law, J Williams — Exploratory studies on helicopter take-off repeatability for noise certification procedures. RAE TM Aero 1750 (1978).