CoA Memo. No. 64

February, 1965

THE COLLEGE OF AERONAUTICS

DEPARTMENT OF AIRCRAFT DESIGN

Design study for noise tests on laminar flow fin

SUMMARY

The study deals mainly with engineering problems associated with the introduction of a noise generating facility on 'Lincoln' aircraft R.F.342 for the purpose of studying the effect of high intensity sound pressure levels at both random and discrete frequencies on the laminar flow fin currently being tested in this aircraft.

The frequencies selected as representative of both turbulent boundary layer and propulsion system disturbances lie within the band 200 to 2000 c.p.s. with an upper limit of 1200 c.p.s. for discrete work. Required sound pressure level at the fin surface is estimated to be 130 db.

Conclusions are that the project is feasible but with the reservation that certain estimated figures and effects will require to be confirmed by a test programme prior to mounting the full-scale experiment.

(Prepared under Ministry of Aviation Agreement No. PD/28/024).

Contents

1. Introduction

It has been established that acoustic disturbances radiated from the turbulent boundary layer on unsucked areas of a laminar flow aircraft, together with noise generated by the propulsion system, may have sufficient effect on the laminar flow surfaces to cause transition.

Dr. Pfenninger[1] of the Norair Group, Northrop Corporation, has investigated the effect of noise on the behaviour of a swept laminar suction wing in the Norair 7' x 10' tunnel. These tests were, however, conducted in a sound field of a rather complex nature due mainly to reflections from the tunnel walls, therefore they are not really representative of the free field conditions which would occur with an aircraft in flight.

Dr. Pfenninger visited this country in July 1962 in order to discuss specifically, the possibility of carrying out acoustic experiments in flight using the Handley Page laminar flow test wing. J.B. Edwards[2] of Handley Page Ltd., has reported on these discussions and, subsequent to Dr. Pfenninger's visit, a decision was taken to measure the ambient external noise level at the test wing on 'Lancaster' P.A. 474 (the test vehicle at that time) in flight.

This work was carried out during the autumn of 1962 and the report[3] published in February 1963. A further report[4], published in April 1963, summarised results and clarified the general proposal to subject the test wing to fairly high sound pressure levels in flight.

The current design study carries the work a stage further and deals, on a feasibility basis, with design and engineering problems associated with the provision of an acoustic test facility on 'Lincoln' RF.342 (the present test vehicle) for the purpose of achieving the required SPL's at the test wing surface.

Note: Ambient levels on 'Lincoln' RF.342 will not be identical to the measured levels on 'Lancaster' P.A.474 since the engine/propeller combination is different. (Lanc. - Merlin 38 - 3 bladed prop.: Lincoln - Merlin 68 - 4 bladed prop.). The order of both SPL and frequency however will be similar and it is considered that the existing report[3] would still be valid.

2. General requirements

Due to the limitations of Pfenninger's experiments an assessment of the required S.P.L's can only be approximate. This is highlighted by Hyde[4] in his note and, when ambient levels[3] are considered also, the resulting generated S.P.L. will require to be of the order of 130 db at the test wing surface.

After discussion within the College, it was established that realistic limits of frequency would lie within the band 200 to 2000 c.p.s. with an upper limit of 1200 c.p.s. for discrete frequency work, the most useful range being centred on 600 c.p.s. approximately.

The noise sources are required to be located such that effects of propagation spanwise, chordwise and normal to the test wing surface can be studied. It is clear, however, that the latter condition would be extremely