Proposal 1003 - Preparation and use of an existing wind tunnel model for ducted propfan investigations

Fact Sheet

Project Information

DUPRIN
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Coordinated by Messerschmitt-Bölkow-Blohm GmbH (MBB) Germany

Objective

For improving the efficiency of new and existing transport aircraft for higher Mach numbers (M = 0.8+), the installation of ducted propfans can play a major role in the future. Preliminary limited investigations in national and international programmes have shown promising results. To maintain the European position in the future, more detailed investigations on a large complete model with powered engine simulation are necessary.

This project investigated the aerodynamic engine/airframe interference effects in the context of the new class of ducted propfan engines. The program makes use of an existing wind tunnel model and 2 model engine simulators one ducted propfan and one turbofan. The equipment was completed by designing and manufacturing a
second simulator for each engine type. In the wind tunnel program 2 configurations are investigated:
model without engines;
model with 2 turbofans.
The test program covers force distribution measurements and pressure distribution measurements for different Mach numbers, incidence and sideslip settings. Further on, the engine power setting was varied.

To get detailed information about the interference effects the flow field was analyzed using the wing pressure distribution in the vicinity of the engine. In all cases the installation of the engine leads to a significant reduction of the wing leading edge suction peak and to an increase in pressure over the whole span. On the lower surface, the interference effects for this type of engine are small.

The following theoretical calculations were performed:
use of an existing Euler code for investigations of interference effects of agreed test conditions;
coupling of the grid generation procedure and the Euler code with a viscous jet model;
application of a postprocessing technique on the existing experimental data and theoretical results.
In all cases the engine installation leads to a significant reduction in wing leading edge suction peak and increasing pressure on the wing upper surface. This result is in very good agreement with the experimental results. A direct comparison of experiment and calculation of the wing pressure distribution for the model with the turbofan engine is in good agreement for all sections. That means, the solution of the Euler equations accurately models the interference phenomena in this particular low speed case.

The project is based on an existing complete wind tunnel model owned by DLR. Together with the model 2 simulators plus instrumentation, cowlings and pylons exist, ie, one simulator for ducted propfans (DLR) and one simulator for conventional turbofan (DA). The model has a span of approximately 3.5 m and is equipped with a modern wing design for a transport aircraft. The wing has 9 sections of static pressure ports and is available in clean and high-lift configurations. The model will be completed with 2 further simulators (one ducted propfan, one turbofan), including instrumentation, cowlings and pylons.

With the complete model a first test series in DNW is planned. The investigations will lead to:
Analysis of installation effects of a ducted counter rotation propfan in relation to a conventional turbofan, concerning low speed interference in combination with unsymmetrical power settings and sideslip angles.
Experience concerning the behaviour of ducted propfans installed on an airframe.
Provision of test data for comparison with theoretical calculations, thus improving the
flow of information between theory and experiment as well as between industry and research institutes.

The theoretical work done in parallel will improve the calculation methods of the complex wing/pylon/nacelle structure covering the influence of a jet flowfield. Additionally, the results of the calculations will be used to support the test campaign and provide a deeper understanding of interference effects, while the test results will provide a validation basis for the calculations. In the test series, envisaged at the end of the project, effects of single rotation propfan and high performances are to be investigated.

Programme(s)

Funding Scheme

CSC - Cost-sharing contracts

Coordinator

Messerschmitt-Bölkow-Blohm GmbH (MBB)

Address

Haidgraben
81611 München
Germany

Participants (11)

ANALYSIS SYSTEMS RESEARCH HIGH-TECH LTD

Greece

Address

67,Argyroupoleos 86
16451 Argyroupolis -Athina

Alenia Aerospazio - Un'Azienda Finmeccanica SpA

Italy

Address

Viale Dell'aeronautica
80038 Pomigliano D'arco - Napoli
Dachauer Strasse, 665
Muenchen
Website

Stichting Nationaal Lucht- en Ruimtevaart Laboratorium
Netherlands
Address
8300 AD Emmeloord

TECHNISCHE UNIVERSITAET BERLIN
Germany
Address
Strasse Des 17. Juni 135
Berlin
Website

TECHNOFAN sa
France
Address
Place Marcel Dassault
31702 Blagnac

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