European Transonic Windtunnel GmbH
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News

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Airbus A380 in Test at ETW

The European Transonic Windtunnel, ETW, after some five years of operation, continues to prove that low temperature (cryogenic) flow conditions resulting in true flight Reynolds numbers can successfully be combined with high flow quality and productivity as good or better than modern conventional wind tunnels.

ETW provides an additional advantage in that flow velocity, pressure and temperature can be very accurately controlled individually, thereby allowing the Mach number or the Reynolds number or the dynamic pressure to be varied while keeping the other two parameters constant. Thus, the aerodynamic effects of these essential parameters can be clearly separated and distinguished (e.g. Re number effects and model deformation effects) which is not possible in other wind tunnels.

Also an absolutely accurate repeatability of test conditions is possible regardless of the time between tests.

ETW is being used by major aircraft companies as a development and/or check-out facility for their current projects (e.g. Airbus, Fairchild Dornier, Dassault).

Being open for clients world-wide, ETW is in the position to still accommodate further test entries by extending established shift work schemes.

The extraordinary features of ETW have induced the Airbus partners to issue the statement quoted on the next page.

If clients wish, ETW is able to offer the complete package of model design, model manufacture and wind tunnel testing in the form of well co-ordinated contracts.

By this means, the lead time for tests making use of the outstanding performance and quality of ETW can be considerably shortened.

For this purpose, ETW has established close links with E2CM, a co-operative organisation of some major European aerospace research establishments for cryogenic model design and manufacture, as well as with two German manufacturing companies, DEHARDE GmbH in Bremen, Northern Germany, and EUBEL GmbH in Troisdorf, close to the ETW site.

Both have very successfully been involved in preparation of various test assemblies for cryogenic environment.

The Airbus Partners Praise ETW, the World's Most Advanced Wind Tunnel.

Drawing on their experiences gained with testing in ETW the Airbus Partners, Airbus UK and EADS Airbus (formerly BAE SYSTEMS Airbus, Aerospatiale Matra Airbus and DaimlerChrysler Airbus) last year have released the following statement:

ETW, A Unique European Facility: An Industrial View

The Union of four key European aerospace research institutes has, in the view of industry, produced the best wind tunnel facility in the world; a facility that provides the following unique capabilities:

- The potential to capture aerodynamic data for flight performance of new aircraft without the need to refer back to a reference aircraft possibly allowing the underwriting of flight performance guarantees for new, innovative designs.
- The provisions to undertake complete balance calibration, within one work cycle, to an incredibly high standard.
- The only tunnel in the world that allows the user to always get an exact tunnel setting, irrespective of time between tests and external factors.
- The ability to measure near flight Reynolds number flight loads, allowing the early right sizing of key structures and the avoidance of expensive component retrofits.
- The only tool to allow the investigation of the effect of wing twist upon aerodynamic characteristics, independently of all other flow parameters.
- The ability to test at high speeds, under moderate cryogenic conditions (–30°C), with a conventional 4 bar wing at a Reynolds number of about 15 Millions (based upon AMC).

Overall Comments of the Facility: A User's View

- **Customers:** All of the Airbus Industrie partners who have tested at ETW have found the customer focus of the ETW staff to be exemplary. ETW's attention to detail, plans & time scales meant that as users of the facility we always felt in the driving seat.
- **Performance:** The modern, purpose made facility proves to be very productive in comparison with comparable existing facilities.
- **Quality:** In terms of both force and surface pressures, we have found the repeatability and quality of the data to be excellent. Similarly, the quality of flow, both in terms of stability and homogeneity, has proven to be very impressive. In addition, the facility's existing quality control procedures and post-test reviews underline the commitment to the customer in delivering a quality service.
- **Innovation & Technology:** Much of the productivity is derived from modern working practises and technology. Of particular note is the on-line data analysis suite, providing the user with immediate access to corrected data as the test is progressing. All partners found this a very powerful tool in assisting the reactive management of the various test programmes.
- **People:** Our experience is that problems, when they occur, are quickly and effectively addressed, reflecting the understanding and knowledge base of the facility's staff. The knowledge base of the ETW staff is seen as a key strength of the facility and in our experience underwrites the quality and productivity of the service provided.

ETW's Quality Management System Appreciated.

After the first certification of ETW's Quality Management System following the thorough audit and the respective recommendation by Lloyd's Register Quality Assurance Ltd. (LRQA) in March 1997, the triannual reassessment by LRQA in March 2000 again resulted in the unqualified award of the approval certificates of the official QA accreditation bodies of France, Germany, Great Britain and The Netherlands.

LRQA continues to monitor the QA management system through yearly surveillance visits, the most recent took place on 29th March 2001.

ETW is progressively amending its system to comply in due time with the recently issued revision of the standard EN ISO 9001:2000.

Determination of the Wing Twist by Comparison of Wing Pressure Data

High Reynolds number testing of aircraft models at ETW requires, in addition to cryogenic flow temperature, an elevated tunnel pressure with a corresponding increase in the aerodynamic loads. For distinguishing between true Reynolds number effects and those caused by the elastic deformation of the wing, the determination of the wing twist is very important.

ETW's unique ability to test models at the same Mach and Reynolds number, but different combinations of tunnel pressure and temperature, allows the determination of the effective aerodynamic twist by comparing the pressure coefficients measured at certain wing sections. The assumptions made are:

- At a given Mach and Reynolds number, the variation of the pressure coefficient versus the local angle of attack is identical for each individual measuring point, irrespective of temperature and dynamic pressure.
- The local effective wing twist is a linear function of the lift coefficient and the dynamic pressure.

The computation of the effective aerodynamic twist is accomplished by a computer program which processes the pressure coefficients of one individual wing section that have been acquired at different levels of tunnel pressure and temperature.

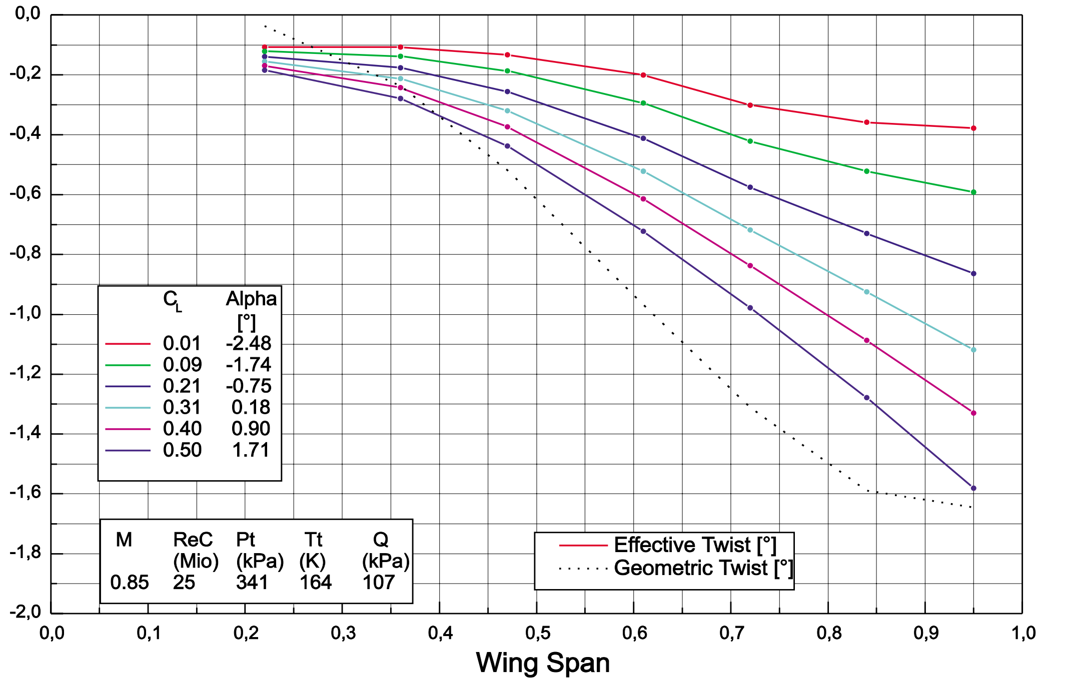
The software performs an extensive selection and evaluation of the measured data, including a correction algorithm for scanner offset drifts.

Since the true (effective) angle of attack is the difference between the geometric and the induced angle of incidence, the obtained result does not represent the geometric, but the effective local wing twist, which is reduced by the difference of the induced local downwash. The geometric twist of the examined wing section can be esti-mated by computing the induced downwash angle which originates from the effective wing twist alone (see figure below).

The uncertainty in the determination of the effective aerodynamic twist, i.e. the change of the local effective angle of attack due to torsion and bending, is estimated to be less than ±0.1° at a dynamic pressure of 100 kPa, good data quality provided. Concerning the geometric twist, the additional uncertainty in the computation of the induced downwash angle has to be considered.

The main advantages of the described method are the applicability over the full operating range of ETW, low susceptibility to vibrations, turbulence, temperature gradients, etc., and the independence from model attitude and mounting.

Results of a Wing Twist Analysis - Effective Twist vs. Wing Span
Estimated geometric twist (C_L=0.5) shown as dashed line

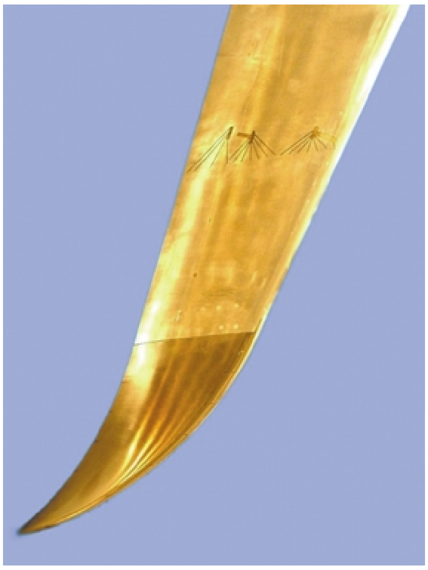


FAIRCHILD DORNIER 728JET TESTING

In April 2001, Fairchild Dornier has successfully completed tests of several winglet configurations with a test assembly of the 728JET wing in the ETW. These tests were carried out in addition to the first test series with the complete half model of the 9.24 scaled 728JET aircraft, which covered the high Mach number range at low and medium Reynolds numbers. In the first test campaign in January/February 2001, Reynolds number effects were investigated in detail. In the second campaign, different winglets were tested at high Mach numbers and one fixed Reynolds number.

The incremental data comparison of the test results for the different configurations was used for aerodynamic performance analysis.

The test result was achieved due to the unique cababilities of ETW by always providing an excellent repeatability of test conditions. Both tests also included checks to assess the influences of wing deformation on the test results. Since it is possible in ETW to control all tunnel parameters individually, this can be achieved by variation of the dynamic pressure at constant Mach and Reynolds numbers. In both campaigns, the ETW method of using the measurements of the wing pressure ports for wing deformation analysis was successfully applied. The verification of the effectiveness of the different transition tripping bands was done with thermographic images from the AGEMA infrared camera system at different Reynolds numbers.



Personnel

Eric GERMAIN

Eric Germain from France joined ETW as Test Engineer in Nov. 2000. His prime responsibility is to co-ordinate and supervise Client and ETW test campaigns.

Eric graduated from the French national engineering school ENSIMEV in Valenciennes having been enrolled at ENSMA in Poitiers for part of his last year.

During the last six months of his study, he prepared a diploma thesis on evaluation of wind tunnel test data for a wing with boundary layer suction at EADS Airbus in Bremen, Germany.

In addition to his mother language, Eric is fluent in English and German and is familiar with a variety of important computer software.

He enjoys travelling abroad, is interested in astronomy and is in advanced state of training for a private pilot licence.

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