News from the European Wind tunnel Association NoE

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EWANEWS

Spotlight on ETW

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Update

Third Joint Workshop

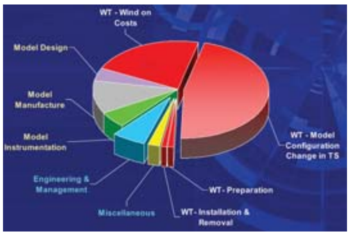
As part of the EWA progress, EWA Joint Workshops are organized at regular intervals. The Third Joint workshop was hosted by DNW in Göttingen, Germany on 17-19 September 2007

In addition to disseminating information on progress of joint developments and technology harmonization, a part of the workshop was dedicated to exploring the needs of the wider community of wind tunnel users, not only of EWA. Forty five delegates from the EWA partner organizations and fifteen invited guests from various European Aerospace Industries attended the meeting at the conference hotel and the facility tour to the DLR and DNW site at Göttingen.

On the first day distinguished speakers from Airbus, Alenia Aermacchi, BAE-Systems, Dassault, Diehl BGT Defence, EADS Military, and Eurocopter presented their industries' requirements for wind tunnel testing. These were derived from aspects like future projects, new technology trends, data validation processes, data accuracy, increasing integration of CFD and experiment, w/t role in design & development, and cost efficiency.

Much information was provided as input to the EWA community for the further development of simulation and measurement procedures within the partners' wind tunnels as well as for the future development of the EWA organization, in order to strengthen the European aerodynamic testing infrastructure.

For example, the cost break-down presented by EADS gives valuable information about the potential of optimizing testing procedures and



confirms the EWA effort for advanced design and manufacture of remote controlled models. Presentations on the second day were dedicated to the EWA work. In four sessions (Combining W/T Simulation and CFD, Benchmark Activities, Advanced Measurement Techniques, Models & Instrumentation, Networking) the progress of selected joint activities was demonstrated and supplemented by reports of non-EWA funded research in the same fields.

Besides the impressing results of the work itself, it was remarkable to see how much, in spite of the still existing competition, EWA has promoted trusting cooperation and communication between the partners.

The Polish Institute of Aviation took the opportunity of the Joint Workshop to present their organization with respect to aerodynamic research and expressed their interest to join EWA follow-up activities.

The third day of the workshop was used for an extended tour of facilities of DLR and DNW at Göttingen. Among others the 1m×1m Transonic Wind Tunnel, the High Enthalpy Shock Tunnel, the Institute of Aeroelasticity, and the Cabin Simulator (Do 728 prototype) were visited. The tour as well as the whole workshop took place in an atmosphere of intensive exchange with many fruitful discussions promoting relations between people and organizations.

Copies of the presentations given at the workshop are available in the EWA intranet. The next Joint Workshop will be organized by CIRA in the Naples area in September 2008.

Participants of the third joint workshop

Forthcoming events

VKI Lecture Series

18th -22th February 2008

Experimental Determination of Dynamic Stability Parameters

The objective of this lecture series is to provide a review of the experimental dynamic stability tools and to present a state-of-the-art survey of the analytical, wind-tunnel and flight-test techniques used for dynamic stability work. Experts from all around the world will present the fundamentals of dynamic stability testing, the detailed post processing methodologies, advances in experimental tools, etc.

Demonstrations on experimental facilities and examples from flight tests are also to be presented. Although the main concern is on experimental activities, there will also be some demonstrations on the usage of numerical CFD tools on the topic.

The lecture series is intended not only to provide suitable training and information to engineers and scientists who wish to enter the field, but also to provide a focal point for technical discussions and an opportunity to exchange views and ideas among engineers and scientists who already work in the field.

This activity is supported by EWA, European Windtunnel Association; a Network of Excellence for aeronautical applications and advanced measuring technologies funded by the European Commission.

For further details contact:
Lecture Series Secretary
von Karman Institute for Fluid Dynamics
72 Chaussée de Waterloo
B-1640 Rhode-St-Genèse
Belgium
www.vki.ac.be

EWA workshop

31st March- 2nd April 2008

Advanced Measurement Techniques in Aerodynamics

The Workshop intends to stimulate the links among leading European universities, research institutes and industry in the field of aeronautics and advanced measurement technologies in order to provide a transfer of new ideas from universities and research centres to wind tunnels operators.

Non-intrusive flow diagnostic techniques are nowadays continuing to grow in terms of capability and reliability for industrial wind-tunnel applications and for particular applications (unsteady flows, propeller rotors, helicopters, aero-acoustics) they can provide solutions that cannot be achieved with conventional techniques. This motivates to monitor the state-of-the-art of non-intrusive optical techniques such as PIV, PSP, DGV, BOS and related procedures, which now offer 3D and/or time-resolved flow diagnostic capabilities.

Main topics

Themes related to the application of optical diagnostic techniques in industrial wind tunnels:

- Requirements from applied aero dynamics research
- Pressure and forces determina tion by PSP and PIV
- Extended PIV methods, time-resolved, 3D
- Developments in PSP, DGV and other meas. tech.
- Diagnosis of complex aerodynam ic problems (rotors, vortical flows, aero-elasticity, aero-acoustics)

www.aero.lr.tudelft.nl/~conf08

EWA PSP course

14th -18th April 2008

Theory and Application of Pressure Sensitive Paint

Recently an increasing number of scientists and engineers have started to utilise the PSP technique to investigate pressure distributions in low speed up to hypersonic and cryogenic wind tunnels, as well as in turbo machines.

The PSP technique has also expanded from the measurement of steady state pressures to include both periodic and unsteady phenomena to study the instantaneous structure of pressure fields in various areas of fluid mechanics.

A number of different approaches for paint development, recording and evaluation of PSP images have been described in the literature.

This course, which is the second one on PSP organised at DLR Göttingen, Germany, will mainly concentrate on both industrial measurement techniques as well as aspects of the theory of PSP relevant to applications with special emphasis on unsteady PSP. In addition to lectures on the fundamental aspects of Pressure Sensitive Paint Systems, special emphasis is placed on the presentation of practical and reliable solutions for problems faced during the implementation of the technique in wind tunnels and other test facilities.

During practical sessions on the course, participants will have the opportunity to carry out experiments on paint characterisation, coating technique, and the recording and evaluation of PSP data in small groups.

Recent developments of the PSP technique such as PSP for unsteady applications and 360° PSP systems for calculation of forces and moments will be discussed and demonstrated.

pspcourse.dlr.de

EWA stand

15th -17th April 2008

Aerospace 08 Testing-Design -Manufacturing

EWA will have a stand at the Aerospace 08 Testing-Design-Manufacturing Expo, to establish the EWA brand-name as an EU Network of Excellence (NoE) working to strengthen European Aerospace.

This event is the only focused aerospace testing expo in Europe, and therefore offers an excellent opportunity to meet old and new customers. The Expo started in 2003 is now well established as an annual event, under new management.

The 36 sq. metre island stand (E201) will emphasis our diverse membership, and publicise our achievements. The stand (together with an EWA sponsored Workshop at Aerospace 08) will demonstrate to the worldwide testing community that EWA exists, and is helping to make European Aerospace more capable for the future. This is being achieved through networking, benchmark testing (model deformation measurements, balance calibration, pressure sensitive paint, and aeroacoustics) and the spreading of excellence (workshops and lectures).

The stand is being designed by members of the business relations working group (WP1.2), and staff for the stand will be drawn from all the EWA Partners. We look forward to meeting you on our stand.

www.aerospacetesting.com

Spotlight on ETW

Actual Flight Conditions in Wind-Tunnel Testing at ETW

The ETW Plant in Cologne, Germany

Aircraft model on the Twin Sting Rig in the Test Section

A Wind Tunnel for Flight Reynolds Numbers

Conventional wind tunnels simulate the flight of modern large aircraft inadequately because they cannot correctly represent the ratio of viscous to inertial forces in the flow, which is represented by the Reynolds number. Aerodynamic performance, flight envelope limits, aeroelastic stability in general are Reynolds number dependent. Therefore, the aerodynamic design of an aircraft based on tests in conventional wind tunnels is associated with risky uncertainties. This deficit in achieving full aerodynamic similarity in a wind tunnel has more than once resulted in extremely costly corrective actions required after the first flight of the large prototype causing long delays in bringing the aircraft into service. The European Transonic Windtunnel, ETW, the world's most advanced wind-tunnel facility developed and constructed in a joint effort by France, Germany, Great Britain and the Netherlands, located near the Cologne-Bonn airport in Germany, provides the capability to avoid this deficiency and to deliver test data of highest accuracy at the correct simulation conditions. ETW uses a very cold cryogenic flow down to 110 Kelvin (-163ºC/-261ºF). Combined with a high pressure of 4.5 bar, the physical properties of the wind-tunnel flow at high density and low viscosity exactly match the aerodynamic similarity laws (Mach and Reynolds numbers) with a medium size aircraft model (full span about 1.5m). Measurements at real flight Reynolds numbers in the wind tunnel allow aggressive aerodynamic optimization early in the development process and provide considerably more reliable predictions of many aerodynamic and performance characteristics of a new aircraft. Thus, ETW test results allow early confidence in meeting design requirements, and significantly reduce the risk of late design modifications and costly rework. In today's fiercely competitive international aerospace market, it is of vital importance to make use of this most advanced wind-tunnel technology. Future generations of aircraft will be developed applying "High Reynolds Number Design", using advanced computational aerodynamics and ETW in a cross-fertilization process.

Distinctive Features of ETW

The extraordinary good stability of the tunnel operation point (temperature, pressure and velocity) in ETW has demonstrated and guarantees perfect repeatability of test conditions regardless of the time between tests. In addition, the relevant control capabilities enable the independent variation of Reynolds number, Mach number and dynamic pressure. This unique feature to independently vary Reynolds number and structural loads allows clear distinction and separation of the various effects which act on an aircraft. Reynolds number effects, Mach number effects and flow/structure interaction can be investigated in detail. ETW is a closed circuit transonic wind tunnel which is internally insulated and can operate down to very low temperatures using pure nitrogen as the test gas. A two-stage fan generates the required speed of the nitrogen flow. It is driven by a 50 megawatt synchronous electric motor supplied with power at a variable frequency via a static converter. This enables very accurate control of the rotational speed and, therefore, precise adjustment of the flow velocity in the test section. The operational total temperature in the wind tunnel ranges from 313 to 110 Kelvin (+40 to -163 ºC) and the stagnation pressure can be varied between 1.15 to 4.5 bar. Mach numbers can be established from 0.15 to 1.35.
To generate the cold nitrogen flow, a special arrangement of spray nozzles is installed upstream of the fan. There, liquid nitrogen(minus196 ºC) is injected at high pressure into the flow. It vaporises immediately and thus forms the cold wind tunnel gas. During operation of the wind tunnel, a controlled amount of liquid nitrogen is continuously injected to compensate the heat generated by the drive as well as by the losses across the tunnel shell and thus constantly keep the temperature in the tunnel at the defined value. Gaseous nitrogen is blown off at the same mass flow rate to ensure a stable pressure level.
The dimensions of the slotted wall test section are: width 2.4 m, height 2 m, length 10 m. A typical transport aircraft model has a wing span of about 1.5 m. So called "full-span models", equipped with the necessary measurement systems, are mounted on a sting such that the flow around the model is affected as little as possible by the model support system. The sting with the model is then attached to one of two modular removable model carts carrying dedicated instrumentation systems. After the final check-out in a preparation room, the model and cart assembly is transported by remote control to the wind tunnel and lowered into the test section.
Various types of model supporting stings and adaptors are available including a twin sting rig system for sting interference assessment and tail flow investigations.
Additionally, a half model facility is in operation allowing larger more complex models to be tested at flight Reynolds numbers, both in cruising flight and in high lift configurations.

Half Model in High Lift Configuration in the Test Section

The first essentials for ETW's high data quality over the full operating range are the excellent flow quality and the precise tunnel control. The simultaneous and direct control of Mach number, stagnation pressure and total temperature is feasible by coordinated setting of the compressor speed, the injected liquid nitrogen mass flow and the blow off position. Further improvement of Mach number stability during a test run is achieved by activating a second throat control system downstream of the test section. This technique allows the Mach number to be kept constant within better than ±0.0005 when pitching the model continuously with a rate of up to 0.25 degrees per second.
The high quality of standard measurements in the low-temperature wind-tunnel environment is based on the optimized operation of three main instruments - the strain gauge balance, the inclinometer package and the pressure-measurement equipment.
For full-span models, internal unheated six-component strain gauge balances are used for the complete envelope with a calibration matrix established in a special automatic calibration machine over the complete temperature range.
For the half model set-up the balance is located above the top wall of the test section in a thermally controlled housing. Also for half models the full Mach number range from M = 0.15 up to M = 1.35 can be covered. High-lift half-model configurations tested at low speeds and correct flight Reynolds numbers present an area of particular interest for many clients. All balances provide accuracy of 0.01% of full range in the force components over the complete test envelope of the equipment. One of the most essential quantities to be measured in aerodynamic testing refers to the incidence of the model. In ETW, accuracy in incidence measurements of better than 0.01 degree is achieved and contributes to the repeatable high accuracy. Pressure measurements are performed with PSI scanners and carefully selected transducers providing measurement accuracy in the order of 10 Pascal.

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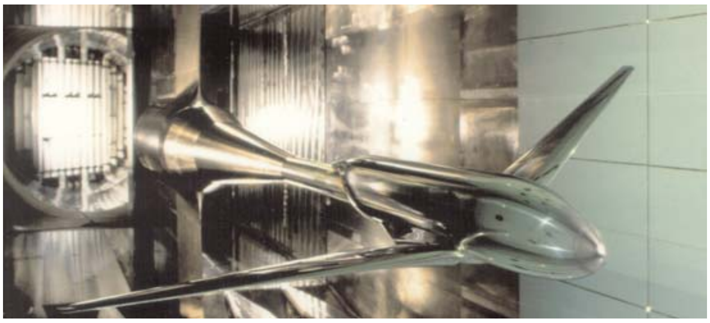
The scanner units are also installed inside insulated thermally controlled packages. For the investigation of dynamic flows, KULITE pressure transducers can be embedded in the wing surfaces.

Special Measurements Systems

For non-intrusive observation and assessment of the laminar-turbulent boundary-layer transition on the wing, infrared imaging technique has been adapted to low-temperature conditions.
In addition, a temperature sensitive paint is available covering the full temperature range of the facility, and pressure sensitive paint can be used down to cryogenic temperatures.
Wing-deformation assessment may be performed by two different concepts. One is based on a comparison of wing pressure distributions at different levels of dynamic pressure to identify deformation effects on full-span models and half models. The second one provides an online assessment of wing/flap/horizontal tail plane twist and bending using a photogrammetric system based on marker tracking using two CCD cameras.
The ability to independently control velocity, temperature and pressure generates the unique capability for investigations of pure Reynolds number dependencies by operating at constant levels of dynamic pressure. Additionally, pure aeroelastic effects can be analyzed at constant Reynolds and Mach numbers.

High Productivity and Cost Effectiveness

The modular model cart concept of ETW together with special arrangements of preparation rooms, ambient and dry air areas and remotely controlled transport devices for the model carts allow model rigging, check-out and configuration changes to be performed outside the test section in full confidentiality, and ensures economic operation with efficient, productive testing.
The manufacture of models for cryogenic wind-tunnel testing is no longer a major cost factor compared to conventional models. Material cost is only slightly higher and exacting surface finish can be confined to the first 20% of the wing cord. Altogether, the model design and manufacturing time has been significantly reduced, so that the model cost is just about 30% higher compared with conventional models.Operating in a cryogenic environment obviously requires more time than investigations in ambient temperature conditions due to the limited accessibility to the model and the periods devoted to thermal conditioning of equipment to ensure best data quality and high confidence in the aerodynamic results. Hence, the specific test requirements, such as configuration changes of the model, need special attention and are incorporated thoroughly into an optimized test schedule. Using the specially developed test techniques, like combined force/moment and pressure measurement, balance conditioning systems, modular concept of handling rooms with quick access to cold models, etc. the testing in cryogenic conditions has reached a high level of productivity. For new models to be built, ETW can advise on the design of remotely controlled components to minimize the time for configuration changes. The time-cost-quality benefit of ETW testing is significantly better compared with conventional facilities, taking into account the data quality and the real-time test-data analysis at flight Reynolds numbers. Since the facility offers absolute stable test conditions, testing at ambient temperatures can also be performed in a most efficient way, with high rates of incidence pitch and a minimum of polar repeats.
Of course, the technical complexity of ETW and its special energy consumption result in higher cost for a given test programme of about 30% compared with conventional wind tunnels. This cost increase, however, is more than balanced by the advantages gained from testing at flight Reynolds numbers and from the unique capability of ETW to uncouple the various flow effects on the aircraft.


Model of a Large Aircraft in the Test Section

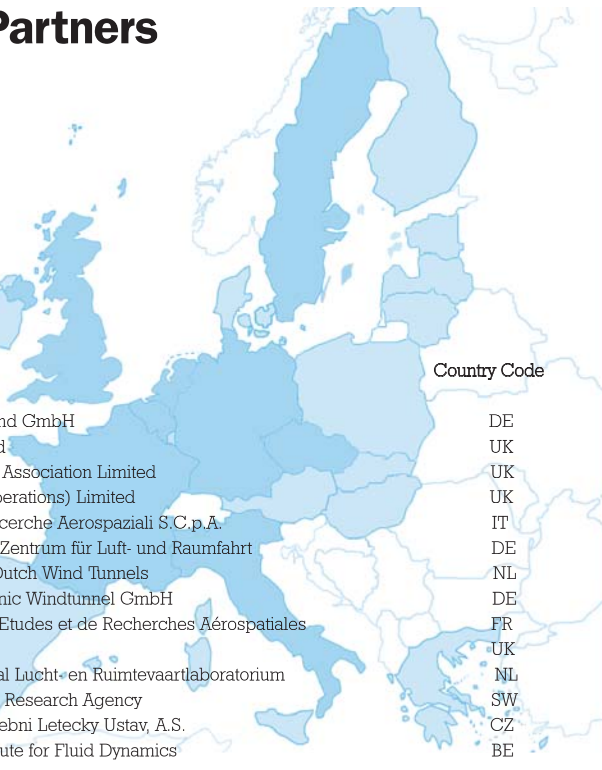
Moreover, ETW tests cost significantly less compared with flight tests and their results are available at a very early stage of the aircraft design process.

Guaranteed Security

The extremely high security requirements of the aerospace industry have been incorporated by ETW in the overall security concept of the facility and in all aspects of data security. Special restricted areas include three totally independent client suites comprising rooms for model rigging, test-systems check out and data evaluation and each are protected by uninterrupted access control. Test-data storage, processing and display are performed on individual client-dedicated computer systems. Strict clearance procedures for dealing with and handling client test project information are another part of ETW's consistent confidentiality philosophy.

For more information visit: www.etw.de

Other Partners



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BAE Systems (Operations) Limited	UK
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DNW - German Dutch Wind Tunnels	NL
European Transonic Windtunnel GmbH	DE
Office National d'Etudes et de Recherches Aérospatiales	FR
QinetiQ Limited	UK
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