European Transonic Windtunnel GmbH
Ernst-Mach-Strasse D-51147 Köln

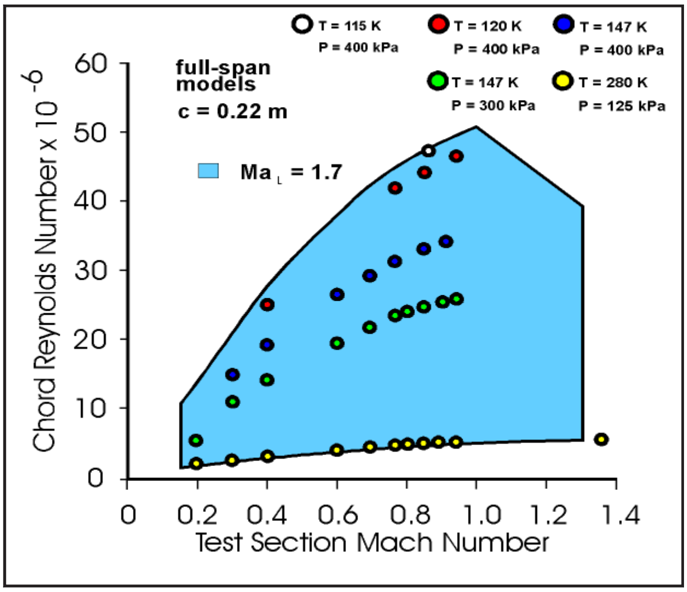
News

Issue No. 4, January 1996

Operation at High Reynolds Numbers

ETW has undertaken the successful final commissioning of the liquid nitrogen injection system. Except for a few excursions to low temperatures ETW was, up until October 1995, restricted to operations above 150K due to a malfunction of the injection nozzles. The PTFE piston rings in the 230 actuators which control the nozzles did not perform as expected. The redesign, manufacture and testing of the modified actuators took approximately 12 months and installation was completed during the 1995 annual maintenance period.

The restriction to 150K still allowed testing to be done at Reynolds numbers up to 30 million covering full scale cruise flight values of an Airbus A-320. In November tests were undertaken down to 105K. It can be seen in the figure below that todate a Reynolds number of 48 million, based upon a typical wing chord of 22 cm, has been achieved at a Mach number of 0.9 testing at 115K and a pressure of 4 bar.



Reynolds Number vs Mach Number Envelope Explored

The temperature stability attained at these high Reynolds numbers is ±0.08K. This is well within the original specification goal of ±0.25K.

The temperature distribution measured by a thermocouple array in the stilling chamber at a Reynolds number of 46 million is shown on the next figure. As can be seen the temperature

continued page 2

Alphajet TST in ETW

In collaboration with the Military Aircraft Division of Daimler-Benz Aerospace AG a test campaign was carried out with a 1/10th scale full span model of the Alphajet TST. The model has a fully pressure plotted wing which is also equipped with Kulite pressure transducers and wing root buffet gauges and is fitted with internally mounted thermocouples. The model was tested with a cryogenic balance owned by DLR and tested at temperatures down to 115K and pressures up to 3.5 bar to achieve full scale chord Reynolds numbers up to 30 x 10^6 at flight Mach numbers up to 0.9.

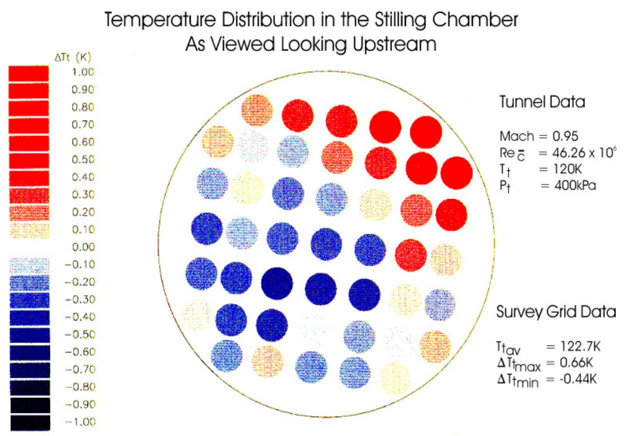
TST Model prepared for Test

In this issue

Issue No. 4, January 1996

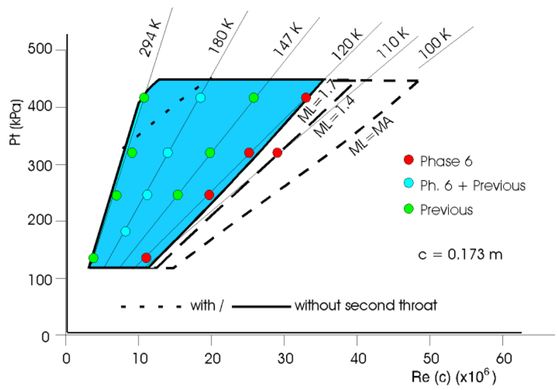
Operation at High Reynolds Number

continued from page 1



distribution is within ± 0.55 K which when extrapolated to the test section, based upon present experience, suggests that the specification of ±0.25K will be met in the test section. This will be confirmed in 1996 with a new test entry of the rotating rake equipped with thermocouples and PT100 sensors.

The envelope of a typical cruise Mach number of 0.78 is also presented which shows a Reynolds number of $34x10^6$ being achieved with the ETW reference model. It can be seen that the runs have been conducted to take polars along constant temperature lines so as to minimise the temperature stabilisation times of the tunnel. The tests however have been taken at set total pressures so that pure Reynolds number effects can be evaluated (horizontal sets of data) without the data being affected by aeroelastic distortion of the model. To evaluate pure aeroelastic effects the data can be analysed at constant Reynolds numbers (vertical sets of data).



M = 0.78 Envelope Explored with ETW Reference Model

Quality Assurance - ISO 9001 Certification

Concentrating on the need to provide the very best possible service to our International Clientele - accurate, cost effective and timely test data - ETW is investing heavily in the development of Quality Assurance systems which comply with ISO 9001. These efforts are now sufficiently advanced to invite an accredited body to carry out an independent preliminary assessment; the Köln office of "Lloyds Register Quality Assurance Ltd" has been commissioned to do so in the near future.

It is anticipated that a full assessment will follow in due course, leading to internationally recognised certification, thereby giving our Clients the confidence that ETW offers a quality of service of the highest order and which has been independently assessed by an accredited agency of worldwide repute. A further progress report will be included in a later issue of this Newsletter.

News in Brief

The ETW half model cart system being manufactured by NFM, France, and the associated balance and turntable being manufactured by ARA, UK, are on schedule for validation in July 1997.

The ETW Materials Guide has been published. It will be made available to prospective clients at the start of model design.

ETW presented the paper "Testing at Flight Reynolds Numbers" at the 34th AIAA Aerospace Sciences Meeting in Reno, NV, USA, in January, 1996.

Visitors to ETW

Recent visitors to ETW included:

Mr. Akira Murakami of NAL, Japan.

Mr. W. Sonnleitner, DARA, Dr. Heinemann, and Dr. Krebs of BMBF.

Mr. H. P. Balzerowiak, BMVG and Mr. Stellisch, BWB.

Mr. P.G. Vermeulen and Mr. E. J. Bos, NIVR and Mr. P. Kluit, NLR, NL.

Delegates of the Defense Committee and the Technological and Aerospace Committee of the Western European Union.

IGA J. Y. Chaumeton, Mr. B. F. Jaeggy and Prof. P. Smigielski of ISL.

Mr. C. Honvault, Director ESA, MSF Dept., Mr. P. Moskwa, Dep. Director, and Dr. D. Vennemann.

Issue No. 4, January 1996

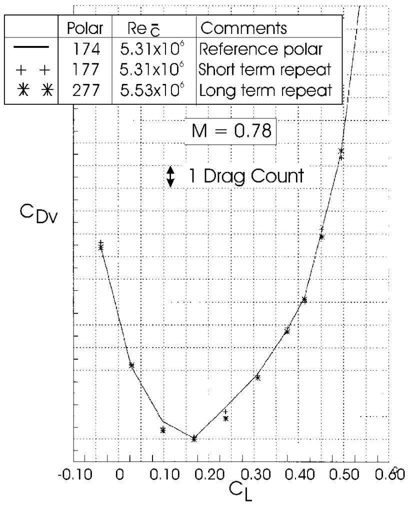
Operational Experiences with Client Models

A series of cooperative tests have been undertaken on models provided by a number of companies for which suitable data can be traced back to flight test for validation of ETW results at flight Reynolds numbers. Direct comparisons against high quality but low ReN wind tunnels are also being made.

The data quality obtained typically during these early tests is summarised in the table below.

Drag repeatability		
	short term:	<0.5 count
	long term:	<1 count
Mach number stability		
	low Re:	±0.0005
	high Re:	±0.001 (M = 0.78)
Temperature stability		
	low Re:	±0.3 K
	high Re:	±0.08 K

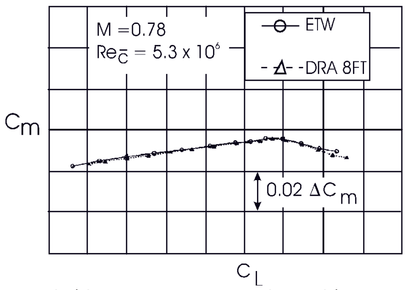
The drag repeatability for a British Aerospace model of the Airbus A-320 aircraft is illustrated. The model has a fully pressure plotted wing with a total of 277 tappings and the repeatability shown here was with all the pressure instrumentation connected. For the long term repeatability case the model was removed from the tunnel after the first polar which was then repeated some hundred polars later. The drag repeatability was matched by the quality of other parameters including pitching moment.



Repeatability in Validation Test Models

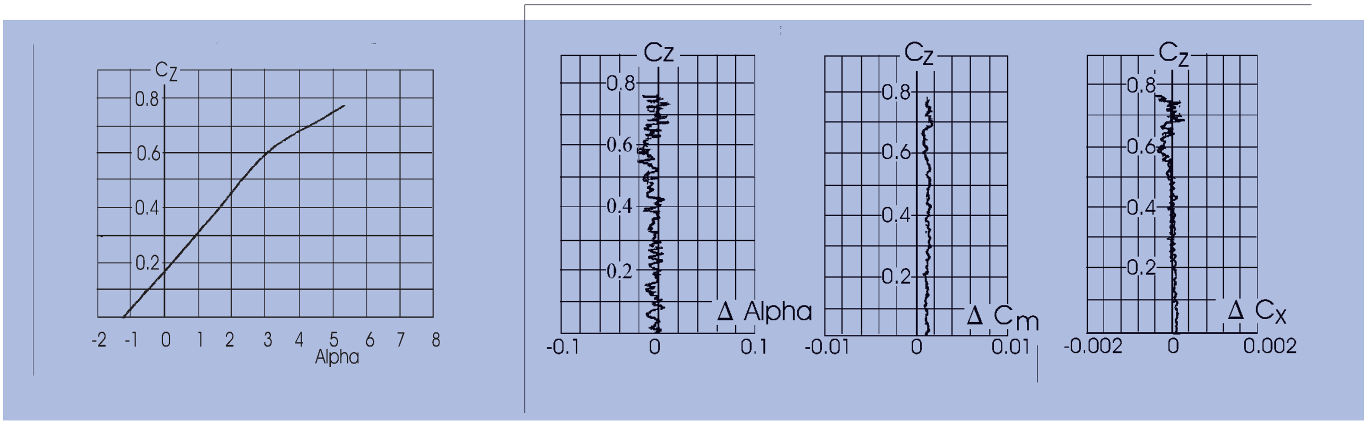
The flow angularity determined by comparing the lift coefficients with the model erect and inverted was found to be constant over a variety of military and civil configuration models tested over a wide range of conditions up to and beyond the buffet boundary. A typical example of forces and moments from erect and inverted measurements corrected by the constant value of 0.02 degrees is shown in the figure below for an Aérospatiale model of the Airbus A-340 tested to beyond the buffet boundary (complete model, tails on). In view of the range of spanwise distributions of flow characteristics that is represented this gives some confidence that the upwash will prove to be constant across the test section (longitudinal and lateral) when a detailed survey is carried out in the near future.

During the tests of the A-320 model runs were made at 5.3 million Reynolds number so that direct comparison could be made with results for a different model tested in the 8 foot tunnel at DRA, Bedford, England. The DRA results had been fully corrected and validated against flight test. The comparison proved to be almost exact, for instance the pitching moment curve shown here shows no significant difference between the two sets of results.



Pitching Moment Comparison with DRA

These initial validation tests with clients' models have proved invaluable for developing the use of ETW and have borne out the encouraging indications of excellent flow quality and instrumentation accuracy suggested by the calibrations.



Difference between Inverted and Erect Results with 0.02 degree Correction Applied

Issue No.4, January 1996

Experimental Services Available at ETW

Much has been written about the tunnel testing services offered by ETW. The equipment and expertise needed to produce this service can also be employed in the provision of other services, some of which are outlined here.

Balance Calibration

The balance calibration machine installed at ETW is state of the art and, as stated in the ETW Newsletter No.3, produces excellent results. Although designed for calibrating balances of cryogenic models, the machine can be used for the calibration of conventional internal balances used in atmospheric and pressurised facilities.

A full six component calibration can be provided comprising six single load components and fifteen dual load combinations carried out at different temperatures over the range from 313K down to 120K. The calibration data can be reduced via a matrix computation to produce a linear, a quadratic and a cubic order calibration matrix and the respective balance matrix. Each cubic order matrix contains 198 sensitivity coefficients composed of 36 first order, 126 second order and 36 third order coefficients. Verification errors are also calculated for each of the matrix combinations.

ETW Internal Balance

Cryogenic Test Chambers

ETW is equipped with a variety of pressure vessels and temperature test capabilities designed to evaluate and calibrate pieces of equipment over the complete pressure and temperature range of the tunnel. The most versatile of the test chambers are given below.

Test chamber TRA-10/H

- variable temperature 93K - 473K
- temperature stability 1K or better
- cool down time up to 80K/ minute
- test volume 300 x 300 x 250 mm
- test gas: nitrogen

Test Chamber TRA-10/H

Pressurised Test Chamber

- temperature range 83K - 313K
- temperature stability: 0.1K
- pressure range 50kPa - 500kPa
- test volume: Ø500 x 600 mm
- test mounting plate: 330 x 550mm
- maximum specimen weight: 20kg
- test gas: nitrogen or instrument air

Further details regarding these facilities and the services offered by ETW can be obtained by contacting Hans van Ditshuizen at ETW.

Personnel

Test Engineer

Dieter Schimanski joined the ETW Project in 1981 as a Model Design Engineer seconded from DASA Munich. Dieter managed the Cryogenic Technology Programme, this concentrated on studies for Model Design, Model Handling, Test Techniques, Strain Gauge Balances, Instrumentation, Optical Systems for the cryogenic application in ETW.

In January 1994 Dieter joined the ETW GmbH as a Test Engineer . Since that time he performed the first test programmes with the ETW Reference Model and several early cooperative test campaigns with first ETW clients.

Dieter will handle Clients Projects in future operations and will be the direct contact for his clients during the early planning of the test campaigns.

ETW News

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