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

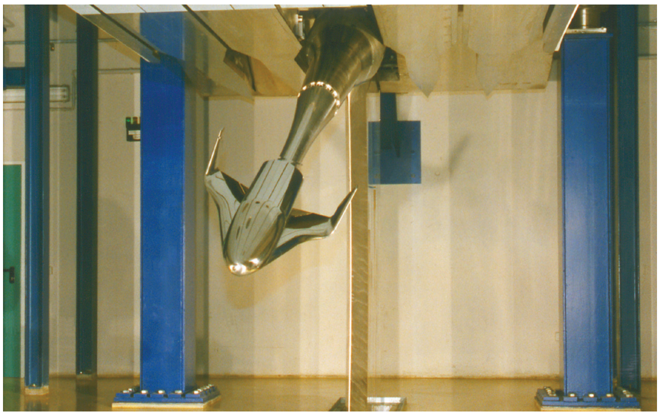
News

Issue No. 7, Feb. 1998

HOPE - X Space Shuttle Test

During the period from 11th to 18th July 1997 extensive wind tunnel tests were carried out on a 1:20 scale cryogenic model of the HOPE-X space shuttle. The test was performed by order of Nissho Iwai Corporation acting on behalf of Kawasaki Heavy Industries (KHI) as contractor for the National Aerospace Laboratory and the National Space Development Agency, both of Japan.

HOPE-X, an acronym for "H-2 Orbiting Plane Experimental", is an experimental vehicle designed to be an engineering demonstrator of an unmanned space shuttle and is scheduled to be launched by a single stage H-2 launch vehicle from the Tanegashima Space Center in the south of Japan in the year 2000. The test at ETW was carried out as the final stage of the preliminary design phase in the overall project and comprised both subsonic and supersonic Mach numbers ranging from 0.4 to 1.3 at low and near flight Reynolds numbers.



The KHI HOPE-X Model on Model Cart 2

The test was performed, using Model Cart 2, at temperatures between 120 K and 305 K and pressures up to 4.5 bar and included incidences up to 15^0 at sideslip angles of 0^0 and 5^0. These conditions represented launch as well as re-entry simulations. The maximum chord Reynolds number achieved during the test was 81.2×10^6 at a Mach number of 0.8. The model was mounted on the new ETW internal balance B004 and was equipped with pressure orifices along the fuselage and at several wing sections (see also page 2).

Visit by NASA Administrator Mr. Daniel Goldin

Mr. Daniel Goldin, Administrator of NASA, visited ETW on 21st January 1998 in the company of Prof. Dr. Walter Kröll, Chairman of DLR and Associate of ETW.

10th ANNIVERSARY in 1998

On 28th April 1998 it will be 10 years ago that ETW was founded as a company following four meetings at government level between February 1984 and June 1985. The signing of the Memorandum of Understanding for final design, construction and operation of ETW by the governments of France, Germany, The Netherlands and the United Kingdom was completed on 27th April 1988 and ETW GmbH was established one day later. In addition, a Cooperation Agreement was signed between the four Associates as shareholders of ETW. The associates are, for France: ONERA, for Germany: DLR, for the Netherlands: NLR, and for the United Kingdom: the Ministry of Defence.

Twin Sting Rig Delivered by NLR

On 29th September 1997, the Twin Sting Rig (TSR) - a dual sting support system for sting free afterbody flow studies- was delivered at the premises of ETW. The TSR was designed and manufactured by NLR, the Dutch associate of ETW, and forms the newest asset of ETW. The rig will be used to study sting support interference effects on model data and will also be used for accurate measurements of afterbody drag contributions and tailplane effectiveness. The TSR is designed to cope with the cryogenic and pressurized environment of ETW's test section flow conditions (see also page 4).

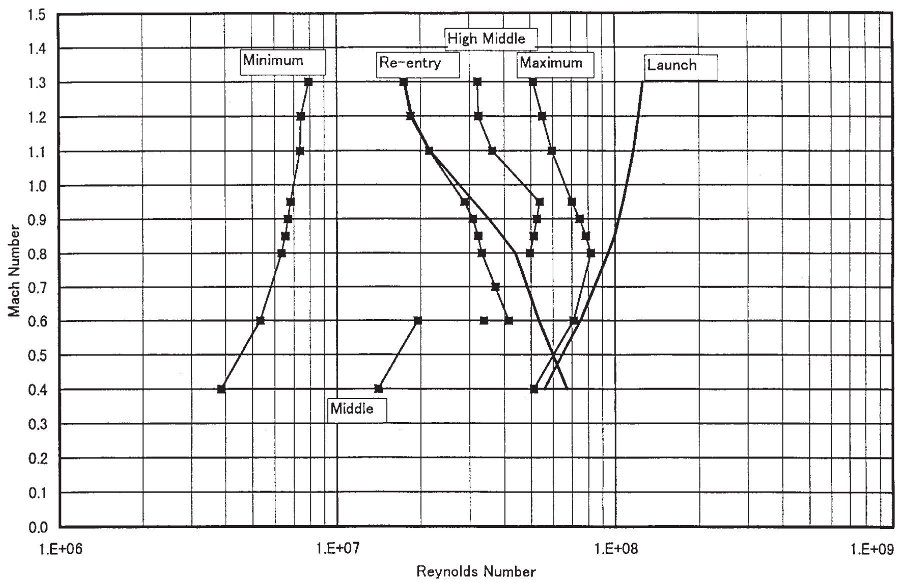
Issue No. 7, Feb. 1998

HOPE - X Space Shuttle Tests

By commission of Nissho Iwai Corporation (NIC) a test campaign was carried out with a 1:20 scale cryogenic model of the HOPE-X space shuttle in ETW on Model Cart 2. The model was designed and constructed by KHI and manufactured from stainless steel SUS304L by Tokuda Model and Mould Co. in Kakamigahara, Gifu, Japan. For correlation with theoretical aero-dynamic calculations the model was equipped with a number of pressure orifices along the fuselage and on several wing sections. ETW's new high capacity (30 kN) internal balance B004 was used for determination of the overall integral force and moment coefficients. The model was further provided with winglets and a body flap.

The test programme contained both pitch-pause and continuous angle of incidence polars at rates varying from 0.5^0 to 0.15^0 angle of incidence per second. In addition, a number of sideslip measurements were made in pitch-pause mode by combination of angles of incidence and roll of the sting. Three temperature levels, i.e. 293 K, 200 K and 120 K, were selected, which in combination with pressures between 125 and 450 kPa provided a Reynolds number range from 8 to 80 million for Mach numbers between 0.4 and 1.3. This range allowed simulation of conditions in conventional wind tunnels for correlation purposes as well as covering re-entry flight and approximate flight launch conditions.

The test with the HOPE-X model was characterized by a number of "firsts". It was the first time that the full envelope of ETW was used for a commercial test including supersonic operation at cryogenic temperatures. It was also the first time that the new tapered balance B004 and the matching sting were used, and last but not least, it was the first time that the drive power limit was explored with a model in the test section. Despite these new aspects the wind tunnel and equipment behaved according to expectations and practically all test objectives were realized as scheduled due to the excellent cooperation with the staff of NIC and Kawasaki Heavy Industries.



News in Brief

ETW has now a mailbox address in Internet through our service provider EUNET. The address is:

etw.k.eunet.de

Individual staff members can be addressed directly by using the proper initials as in use at ETW. A list with initials is available on request. Please contact Dorothee Reintjes at:

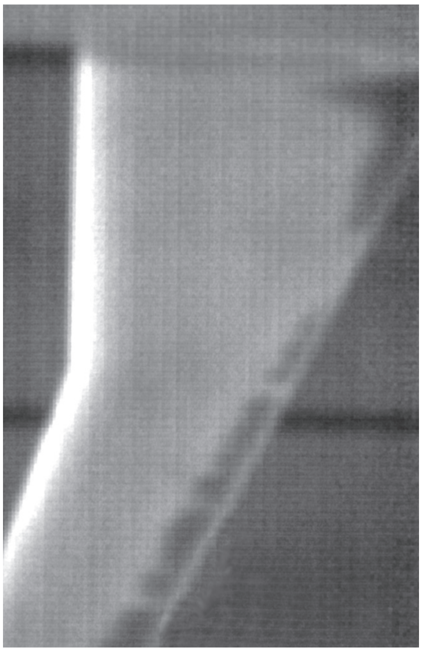
dr@etw.k.eunet.de

On 5th November 1997, ETW accomplished the 1,000th run since the start of operation of the facility in 1993. During these runs many polars have been completed, typically over 3,000 annually.

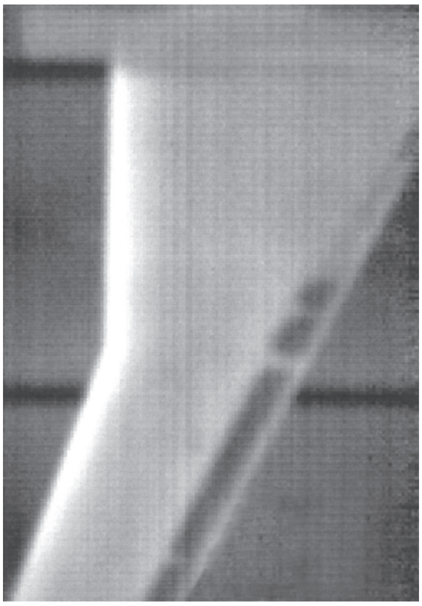
Visitors to ETW

- Mr. D. Rondeau, Chief Exp. Aero., Dassault Aviation, France.
- Mr. M. Scheller, President of ONERA, Mr. Ph. Duranthon, DPAC, France.
- Mr. F.T. Lynch, Program Manager, MDC, U.S.A.
- Mr. A. Masyuk, Deputy Director of TsAGI, Russia.
- Dr.-Ing. I.A. Habibie, Exec.Vice President of IPTN, Indonesia.
- Mr. S. Nogueira, Project Manager, Centro Técnico Aeroespacial, Brasil.
- Prof. He Yijin, Exec.VP, Ms. Cui Zhihua, Director, Mr. Zhou Jun, Ass.Dir., CAE, China
- Mr. R. Nelson, Chief Aero., Mr. J. Felter, Proj. Manager, CESSNA, USA.
- Mr. R. Foster, Director Aerospace and Defense Industries, DTI, U.K.

Transition Detection by Infrared Thermography



Re = 10 x 10^6
CL = 0.0
M = 0.75
T = 120 K



Re = 10 x 10^6
CL = 0.5
M = 0.75
T = 120 K

Images of ETW's Reference Model made with the CRYSTAL Camera at 120K

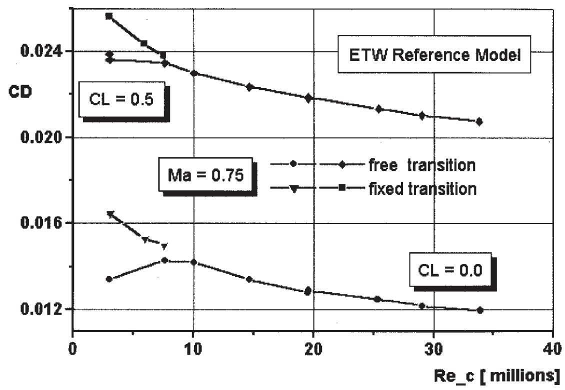
For transition detection ETW currently operates two different camera systems. The older system is a conventional infrared camera, the AGEMA Thermovision 1000, which operates with a detector in the waveband between 8 to 12 µm , and is cooled by means of liquid nitrogen. The camera is installed in a pressure ventilated heated housing behind a test section wall window made of Germanium. The camera allows for image recording down to 200 K with video signals, and images can be stored directly on a PC system through a digital interface. A second camera can be provided optionally for extra views.

The second concept is being developed by ONERA and is known as the Crystal Camera. This system will allow for transition detection down to 100 K. In this case the camera system consists of a pressure shell which contains the optical part with a Si:Ga detector for the waveband above 15 µm , cooled down to below 15 K. Cooling is achieved by a Joule-Thomson closed cycle Helium system precooled by a Gifford-Mac Mahon cryomachine. The optical lens system which has selectable rotating diaphragms for focussing, will be below 80 K.

Images are taken during a quickly induced transient temperature step in the flow. It enhances the temperature at the surface by different amounts due to the different heat transfer rates through the laminar and the turbulent part of the boundary layer. Reference images are taken prior to the temperature step at the correct tunnel conditions to help improve the quality of the images by eliminating any spurious optical effects.

A condition for infrared imaging is that the models should be coated with a suitable paint which is compatible with the high standards in surface quality (0.4 µm) and has the required thermal, optical and mechanical characteristics for cryogenic operation. A typical paint thickness is about 100 µm.

Both systems were checked out during a number of tests with varying success. Typically, quick temperature steps in the order of 4 degrees are required to get the best images, which are normally obtained just before the peak of the step is reached. Current efforts at ETW and ONERA are now focussed on achieving reliable operation with the Crystal camera which has proven to be functioning with good success at temperatures as low as 120 K.



The transition pictures obtained with the ONERA Crystal camera still show considerable portions of laminar boundary layer flow at a chord Reynolds number of 10 million indicating that the cross-over point in the drag curve lies at an even higher value.This in itself is a proof of the excellent flow quality of the tunnel for laminar flow research.

Issue No. 7, Feb. 1998

Test Technique Development

Twin Sting Rig System

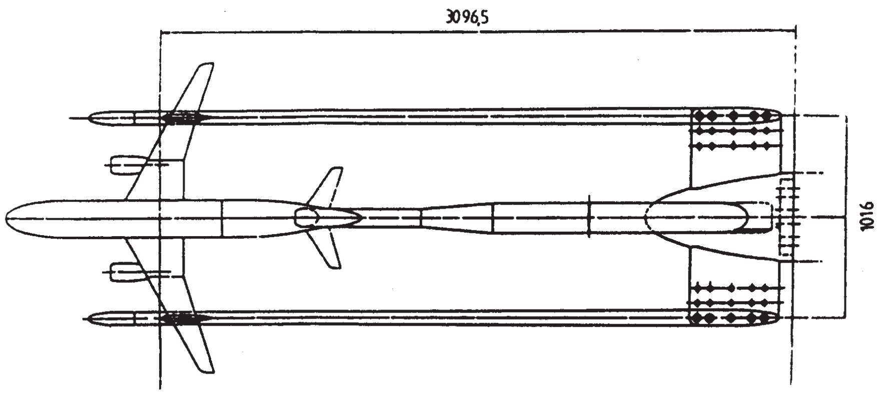
The ETW Twin Sting Rig (TSR) enables full span models to be tested at ETW by supporting the model by means of two stings at the wings at one of three different spanwise locations. This has the advantage that rear sting interference for standard support systems can be obtained by measuring the loads and pressures acting on the rear fuselage with and without a dummy rear sting by means of a special internal balance. For this purpose TSR supported models are typically split across the rear fuselage. The TSR can also be used for afterbody and empennage development tests.

A typical model would incorporate wing attachment points for connection to gauged flexures to the twin booms. These flexures are essentially 3-component low accuracy balances to monitor the overall forces generated by the model. The booms are in turn supported by a yoke plate and a sting boss adapter attached to Model Cart 2 which provides an adequate incidence range for obtaining sting correction terms and empennage effects. A TSR supported model can be traversed over a pitch range from nominally -18^0 to $+10^0$ when the model is tested "Fin up". The rig includes a remotely controlled actuator which is able to support and position a dummy sting relative to the model rear fuselage.

The TSR is designed to enable operation over the full pressure and temperature test envelope of ETW for the following model generated loads:

Axial Force:	± 1,800 N	Rolling Moment:	± 720 Nm
Side Force:	± 3,000 N	Pitching Moment:	± 2,160 Nm
Normal Force:	± 21,600 N	Yawing Moment:	± 720 Nm

It is planned to calibrate the TSR with a static pressure probe followed by a commissioning test with an aircraft model in mid 1998. It will then be available for clients use.



Personnel

Martin Wright

Martin Wright joined ETW as Aerodynamicist in 1994. His prime responsibility is to coordinate the aerodynamic integration of new model support systems such as the Twin Sting Rig and the Half Model Support. He has also supervised a number of Client and ETW test campaigns. As such, Martin was in charge of the HOPE-X test for NIC, KHI and NASDA/NAL.

Martin previously worked at British Aerospace and latterly at ARA Bedford as a Project Supervisor actively involved in many aspects of experimental aerodynamics. He holds a degree in Mechanical Engineering from Newcastle University and a Masters degree in Aerodynamics from the College of Aeronautics, Cranfield, and is a Member of the Royal Aeronautical Society.

ETW News is issued by
ETW GmbH,
Ernst-Mach-Strasse,
D-51147 Cologne.

Editor: U. Walter,
Tel.: +49 (0) 2203 609 115
Fax.: +49 (0) 2203 609 270
uw@etw.k.eunet.de

Print: Druckerei Thierbach,
Mülheim an der Ruhr.