1

REPORT OF THE DIRECTOR

It gives me great pleasure to present the annual report for the year 2004-2005.

HIGHLIGHTS

The inaugural flight of SARAS took place at 8.20 a.m. on Sunday, 22 August 2004. All worries about a wet morning disrupting the flying display evaporated as the aircraft soared stylishly into the skies to a thunderous ovation. Joining the applause to hail this remarkable step forward in Indian civil aviation were Mr Kapil Sibal, Minister of State for Science & Technology and Ocean Development (*Figure 1*) and CSIR's Vice President, Dr R A Mashelkar, DG-CSIR, Dr V S Ramamurthy, Secretary, DST, Mr N R Mohanty, then Chairman, HAL, and Directors of 35 CSIR establishments.

NAL is grateful to all the institutions, groups and individuals whose support and involvement has made SARAS a reality.

⇩ Fig. 1 Mr Kapil Sibal, Minister of State for Science and Technology and Ocean Development, and Dr R A Mashelkar, DG-CSIR, greet Sqn Ldr K K Venugopal after the SARAS inaugural flight on 22 August 2004. SARAS was test flown by Sqn Ldr Venugopal and Wg Cdr R S Makker, IAF test pilots at ASTE.

SARAS was subsequently grounded for about four months to address some of the snags reported during its first block of seven flights. SARAS flew again at the Bangalore air show in February 2005 and has now completed 26 test flights. The SARAS flight test programme will continue right through 2005. The second (PT-2) SARAS prototype, with a more powerful engine, is also slated to fly by March 2006 (*Box 1*).

NAL continues to be intimately associated with the Tejas development programme. The fabrication and delivery of critical composite components such as CFC co-cured fins and rudders and centre fuselage parts, for the PV and LSP series of Tejas aircraft, continued. The process of transferring the fabrication know-how to HAL has begun. The development and validation of Tejas flight control laws is progressing smoothly. There were 185 Tejas flights in 2004-05 in the scheduled gain mode of the control laws and these have provided extremely valuable data and assessments.

The major exercise, started in October 2000 to augment the infrastructure at the National Trisonic Test Facilities, will end soon (*Box 2*). This exercise will increase the wind tunnels' productivity and improve data quality.

NAL is a major player in three of CSIR's 55 network programmes during the Tenth Five Year Plan period: (a) spearheading small civilian aircraft design, development and manu-

1. SARAS: The inaugural flight and after

SARAS had its maiden flight on 29 May 2004, and its inaugural (seventh) flight on 22 August 2004. Seeing the SARAS aircraft flying in the skies was a matter of great joy to everyone at NAL.

After the first block of seven flights, SARAS was grounded to correct certain deficiencies reported by the flight crew. The crew, for instance, reported that engine oil temperature was reaching the limit of 104 deg. C during take-off and climb. To correct this, modifications were made in the oil cooler duct geometry to reduce pressure losses by cleaning the duct geometry. This effectively solved the problem because engine oil temperatures dropped to an acceptable range of 68-76 deg C during subsequent flights.

The flight crew also reported stiffness in the rudder control circuit and low sensitivity of pedal movement to nose wheel steering. SARAS engineers decided to replace bare cables by nylon jacketed ones in the rudder control circuit to reduce the stiffness. An interface box was introduced upstream of the nose wheel steering controller to modulate the signal level thereby controlling the steering sensitivity. Two different sensitivities (mode 1 and mode 2) were also provided to the pilots to make a selection. The pilots chose mode 2 that provided a crisp response to pedal movement.

The vertical tail-fuselage attachment was also strengthened to cater to the higher vertical and lateral gust loads.

SARAS flew at Aero India 2005 in February 2005 with Wg Cdr R S Makker and Wg Cdr Vivek Kumar as test pilots, and received a very enthusiastic reception.

The test flight programme is now proceeding smoothly, with only monsoon rains causing the occasional disruption. 26 test flights have been completed, and the aircraft has logged in over 12 hours of flying. The flight tests are being carried out within a restricted flight envelope so far, but it is observed that the aircraft's controllability, functioning of the systems and basic handling is satisfactory.

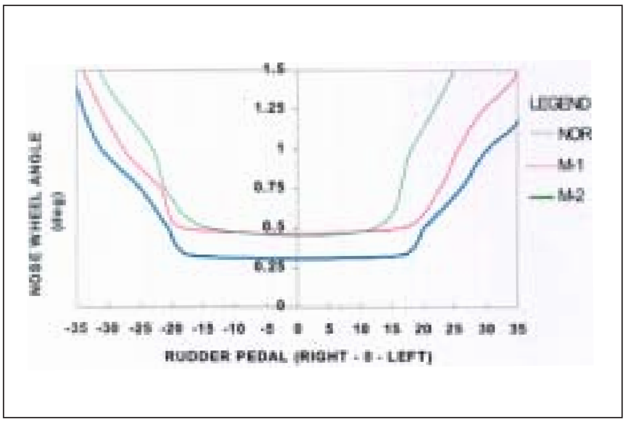
Test flights will continue right through 2005; the plan is to attempt to complete 100 flights by the end of 2005.

Work on the second SARAS prototype aircraft (PT2) is in progress. New (higher power) PT6A-67 engines are to be installed on the PT2 aircraft. A new 5-bladed propeller to match this new engine is under development. The nacelle, stub wing and yoke assembly are being redesigned to suit the new engine and propeller. The wing, fuselage and empennage are already available for equipping. A number of design changes, required to be incorporated due to a variety of reasons, in fuselage, ECS, hydraulic system, electrical system and pneumatic system are under progress.

IAF have shown considerable interest in the SARAS aircraft for an initial acquisition of six aircraft. An air staff requirement (ASR) has been issued in this regard and the final DPR was submitted to IAF in January this year.

Oil cooler duct geometry before and after modification. After this modification the engine oil temperature dropped to between 68-76 deg. C.

Two different sensitivities (mode 1 and mode 2) were also provided to the pilots to make a selection. The pilots chose mode 2 that provided a crisper response.



⇧ *Fig. 2 The Advanced Composites Division has developed composite control surfaces (elevators, ailerons, rudder and flaps) for the SARAS aircraft. The photograph shows the cyclic load test being carried out on the SARAS outboard flap.*

⇧ *Fig. 3 GSAT-3 (FM) spacecraft getting ready for acoustic test in the 1100 cu m reverberation chamber.*

⇧ *Fig. 4 SARAS, with a fresh coat of white paint, flew at the Bangalore air show in February 2005. The SARAS and HANSA flying displays attracted a lot of attention.*

facture (b) developing and sustaining high science and technology for national aerospace programmes and (c) developing specialized aerospace materials. I am happy to report that all these three programmes are progressing very well.

IN THE DIVISIONS

The *Advanced Composites Division* has played a stellar role in the design, development and fabrication of composite parts for both the Tejas and SARAS aircraft. For Tejas, two sets of CFC co-cured fins and rudders, centre fuselage components, wing spars, fairing skins, fairing blocks and undercarriage doors were delivered to HAL in 2004-05. For SARAS, the Division is developing and testing composite parts for the control surfaces, floor boards, wall assemblies, fuselage belly fairing, top skin and flap bottom fairing (*Figure 2)*. The AR&DB Centre for Excellence for Composite Structures Technology (ACECOST) offers the Division the opportunity to develop innovative technologies. I am happy to note the excellent work done in the design, fabrication and analysis of wing test boxes, fabrication and testing of T-joints, stitching technology and in structural health monitoring of composite structures using smart concepts.

The SARAS avionics and electrical system, successfully installed and integrated on the aircraft by the *Aerospace Electronics and Systems Division,* was extensively tested and eventually cleared for flight trials by DGCA. The Division also developed a flight test instrumentation system to monitor SARAS flights from the telemetry station at ASTE. Other major initiatives of the Division include the development of a modern digital autopilot for civil aircraft, design and development of an active control system in an aircraft environment, software development for flight operations and quality assurance and the electromagnetic design and development of radomes. Two facilities were recently created at the Division: a microwave anechoic chamber, and an acoustically treated laboratory for active noise control studies. Both the facilities are performing well.

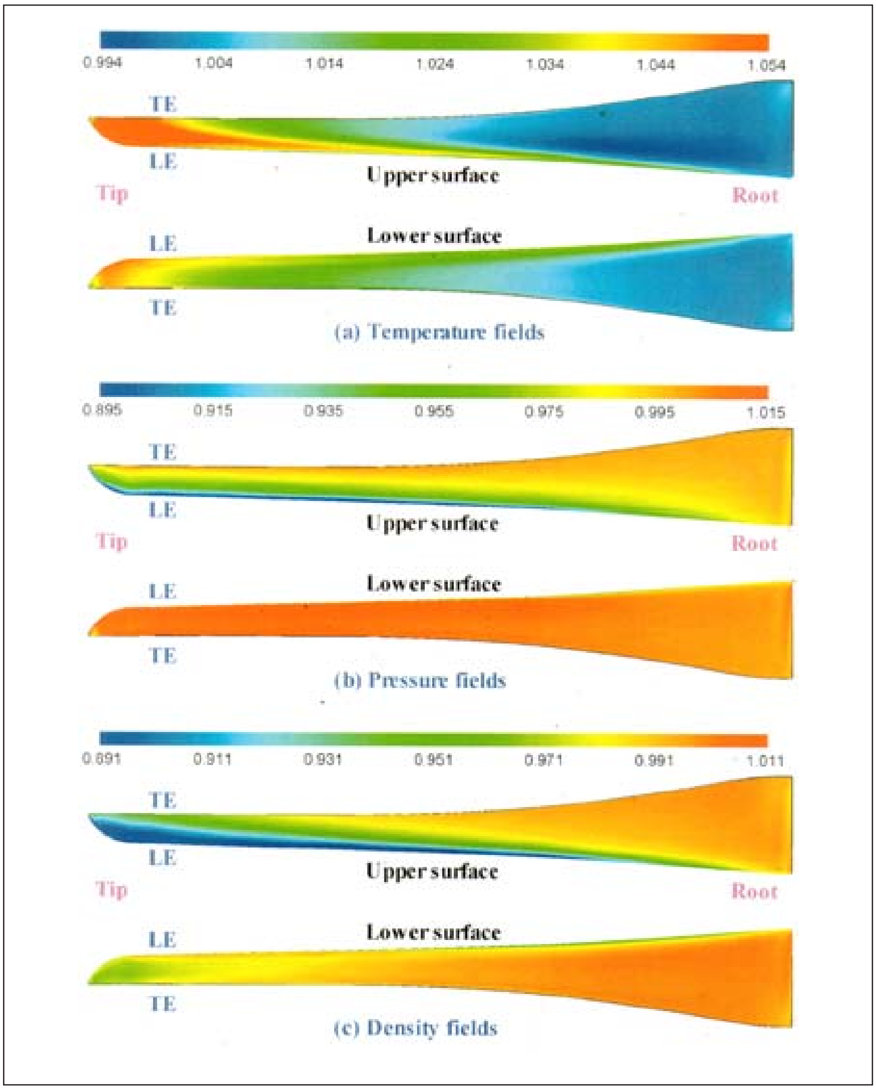
Two major satellites, their subsystems and a launch vehicle subsystem (*Figure 3)* were qualified in 2004-05 at the *Acoustic Test Facility* (ATF). The development and fabrication of the high intensity acoustic calibrator is progressing well. The ATF also offers calibration services to ISRO centres and certifies petrol and diesel generators.

The *Centre for Civil Aircraft Design and Development* (C-CADD) was largely pre-occupied with the SARAS test flights, and the modifications on the aircraft based on the pilot feedback after the first block of seven flights. Two HANSA aircraft (VT-HNY and VT-HNZ) were built and handed over to DGCA; they will soon be ferried to flying clubs identified by DGCA. Work on the development of the lighter-than-air Blimp is progressing well. Both the SARAS and HANSA aircraft flew at Aero India 2005 (*Figure 4*) in February 2005, and evoked widespread appreciation.

The *Computational and Theoretical Fluid Dynamics Division* continues to make valuable contributions to several national aerospace programmes. Two important application projects – CFD analysis for the development of a 500 kW low cost horizontal axis wind turbine *(Figure 5)* and aerodynamic analysis of a reusable launch vehicle technology demonstrator – were initiated in 2004-05. The Division's Reynolds-averaged Navier-Stokes code JUMBO3D was used to improve the aerodynamic performance of the modified HANSA aerofoil-flap configuration. The implicit multi-block RANS solver, MB-EURANIUM-R has been successfully validated to study hypersonic flows past a cone and a cylinder. The time-accurate implicit RANS solver IMPRANS was used to solve several practical aerospace problems.

The *Experimental Aerodynamics Division* works in the areas of flow structure and management, flow diagnostics and aircraft and spacecraft aerodynamics. In an interesting investigation on boundary layer separation control, the Division found that direct manipulation of shear layer reattachment offers an alternate strategy for separation control. NAL's pressure sensitive paint (PSP) measurement capability, already used for transonic flow studies, was successfully extended to low supersonic Mach numbers (*Figure 6*). The Division also carried out experimental studies on a high speed intake configuration.

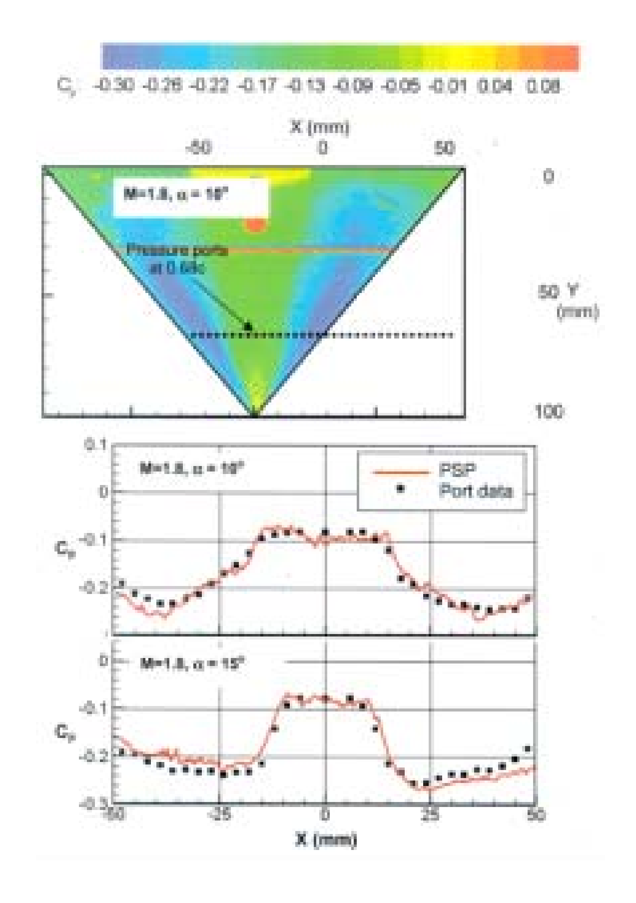
The *Flight Mechanics and Control Division's* technological pursuits are in the areas of modelling and parameter estimation, flight simulation, flight control, multi-sensor data fusion, air traffic management and simulation. The Division has been actively involved in the validation and future development of the Tejas flight control laws. The aircraft's flight envelope, in terms of Mach number, altitude, angle of attack and load factor, is being continually expanded. Other projects undertaken during the year were to estimate and study the inherent local pitch up behaviour using large and small amplitude manoeuvres (*Figure 7*) and moving the Division's engineer-in-the-loop (ELS) research simulator from a SGI-based platform to a PC-based platform.

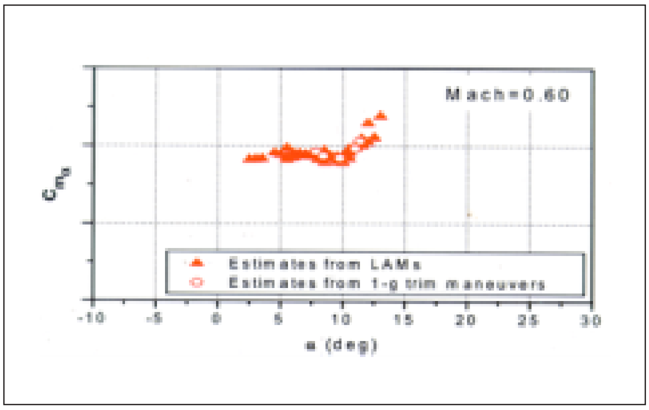


⇧ ***Fig. 5** A detailed CFD analysis is being undertaken for the development of a 500kW low cost horizontal axis wind turbine. The figure shows typical fields of temperature, pressure and density on the upper and lower surfaces of the blade.*

The *Flosolver Unit* is in the thick of its New Millennium Indian Technology Leadership Initiative (NMITLI) project on mesoscale modelling for monsoon-related predictions. This project involves the development of a customized hardware- software platform for weather prediction, especially in the Tropics (*Box 2*). NAL's involvement in this project is likely to trigger off valuable spin-offs: the opportunity to offer the Flosolver-NMITLI platform to a dozen Indian research centres involved in meteorological computing, and a tie-up with TCS to market commercial CFD software on the Flosolver hardware platform.

The *Fibre Reinforced Plastics Division* offers a very attractive mix: on the one hand it fabricates valuable composite products, such as radomes, for the aerospace sector using inno-





⇧ *Fig. 7 Typical results from a study at the Flight Mechanics and Control Division to estimate the local pitch-up tendency of an aircraft.*

⇦ *Fig. 6 Comparison of pressure sensitive paint (PSP) and pressure port data on a delta wing model. NAL is now extending its PSP measurement capability to low supersonic Mach numbers.*

vative techniques, and, on the other, it offers technical services and opportunities to do theoretical studies in polymer science and composites. In 2004-05, the Division completed its supply of eleven nose radomes for the Jaguar maritime aircraft and started work on the fabrication of a large (300 kW) wind turbine blade.

The major programme to develop an integrated facility for carbon fibres and prepregs (IFCAP) at the *Materials Science Division* has made rapid progress. The process for synthesis of PAN-copolymers, required for preparation of precursor fibres, has been optimized; the current emphasis is to optimize the process leading to improved properties of carbon fibres. The Division's failure analysis group undertook 72 investigations in 2004-05 (*Figure 8*), including 56 for the aerospace sector. The orders for the Division's automatic visual range assessor (AVRA) are multiplying; a multi-field site dual base line AVRA was installed at the naval station INS HANSA in Goa. The installation of a chemical vapour infiltration reactor facility, to be used in the Division's projects in ceramics, is nearing completion. Two new facilities – for failure analysis and accident investigation (*Box 3*), and for shape memory alloys, were inaugurated in January 2005.

I have already talked of the augmentation programme (*Box 4*) at *National Trisonic Aerodynamic Facilities* (NTAF). During 2004-05, NTAF carried out 840 blowdowns in the 1.2m trisonic wind tunnel and 272 blowdowns in the 0.6m transonic wind tunnel. Wind tunnel tests for ADA focused on airbrake performance studies (*Figure 9*) and aerodynamic data generation for the naval and trainer versions of Tejas; tests for VSSC were on scaled models of GSLVM3 and the reusable launch vehicle configuration. Wind tunnel tests were also carried out on a vari-

⇧ *Fig. 8 A progressive (fatigue) crack propagation in a low pressure turbine blade of an aero engine was just one of the 56 failures in the aerospace sector investigated by the Materials Science Division in 2004-05.*

ety of missile and bomb configurations, respectively for DRDL and ADE.

The *Propulsion Division* undertakes applied research in turbo-machinery, combustion and heat transfer, mechanical aspects of turbomachinery and propulsion and energy systems. In 2004-05, the development of a transonic axial compressor with high stability margin was a major thrust activity. Development

2. Cyclone track simulation

NAL's Flosolver Unit, together with other partners, is currently involved in developing an Indian computing platform for weather prediction under the NMITLI scheme of the Government of India.

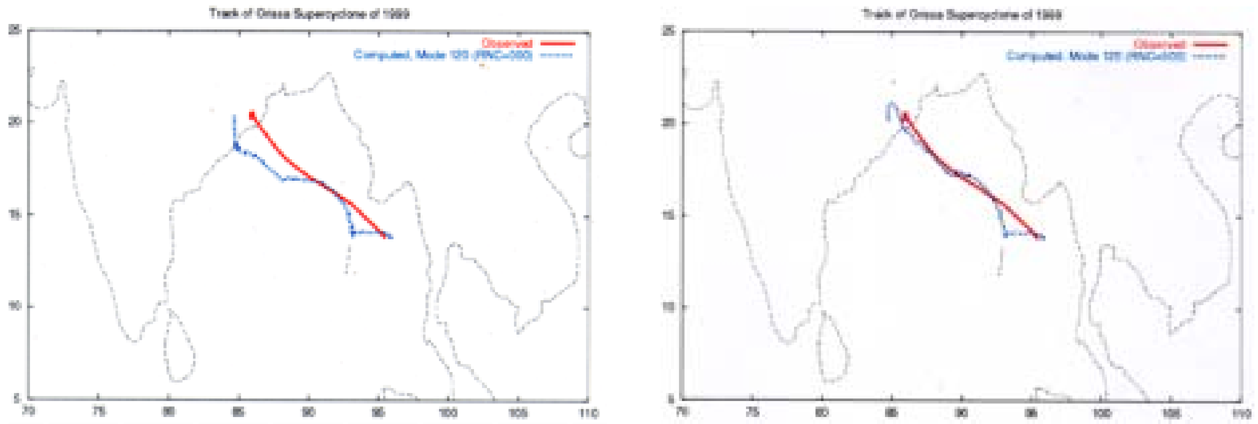
India has never built a dedicated computing platform for weather prediction: either the hardware, or the software, or, very often, both, are imported. This is a considerable disadvantage: embargos can be clamped at will on hardware imports and most of the weather prediction software technologies currently used for India fail to do a reasonable job (largely because the software is optimized for geographical regions very different from the tropics).

Under the NMITLI scheme, NAL has undertaken to write new software (based on Indian models for the boundary layer and radiation) for tropical weather prediction and then build hardware customized to most efficiently run this software (using, for example, the innovative FloSwitch).

At the mid-term project review a critical requirement was to 'calibrate' the performance of the software by simulating two events: the Orissa supercyclone of 1999 and the heavy rainfall over Bengal in 2000.

While comparing the 'predicted' 1999 Orissa cyclone track with the actual track, the prediction was found to improve significantly by incorporating, for the first time, a boundary layer (BL) model proposed for the tropics. The figure, below, on the left shows the prediction without the new BL model; the figure on the right uses the new BL model.

This seems to confirm what one would normally guess anyway: to predict Indian weather, we need Indian software incorporating Indian models, and ideally on Indian-built hardware.

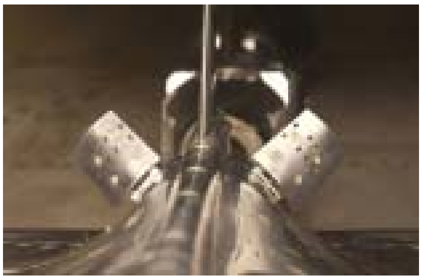


studies on cavity-based kersosene-fuelled ramjet/scramjet combustors was another thrust area; the large-scale high-speed combustor test facility for VSSC is nearing completion. The Division's design and development exercises on Wankel engines are also progressing well (*Figure 10*).

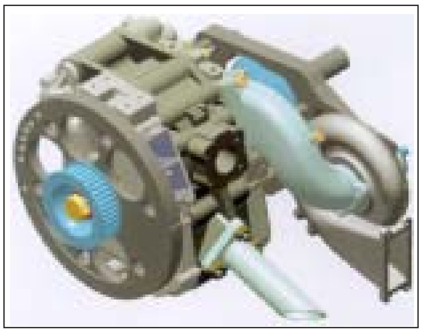
The structural testing of the SARAS airframe continued to be the major pre-occupation of the *Structural Integrity Division*. While carrying out structural tests on the SARAS wing, an attempt was made to identify possible locations of fatigue criticality in the wing using the analysis with the general finite element model. The other major activity at the Division was the total technical life enhancement (TTLE) through full scale fatigue testing (FSFT). The TTLE of the MiG-21 bis fleet will end soon; subsequently, FSFT studies on the MiG 29 aircraft will be taken up.

The *Structures Division* offers very strong support to the SARAS development programme. Strategies to reduce the structural weight of major components like the wing and fuselage have been worked out (*Figure 11*); work is also on to enable further opening of the SARAS flight envelope. The Division is also developing smart concepts for active control of aerospace structures. A spherical 600 m^3 air storage vessel was designed and fabricated for NTAF to augment the existing storage facility. The spherical vessel has now been integrated with the existing system and successfully tested. Several interesting results have been obtained from research teams working in structural mechanics.

The *Surface Engineering Division* has always been very strong in surface



⇧ *Fig. 9 Wind tunnel tests were undertaken at NTAF on Tejas airbrake performance studies. NAL's wind tunnels continue to be very valuable for all national aerospace programmes; the tunnel's performance and efficiency will improve even more after the current augmentation exercise ends.*



⇧ *Fig. 10 NAL's Propulsion Division, jointly with VRDE, is designing and developing a 55 hp Wankel rotary engine for unmanned aerial vehicles. The solid model of the core engine is shown in the figure.*

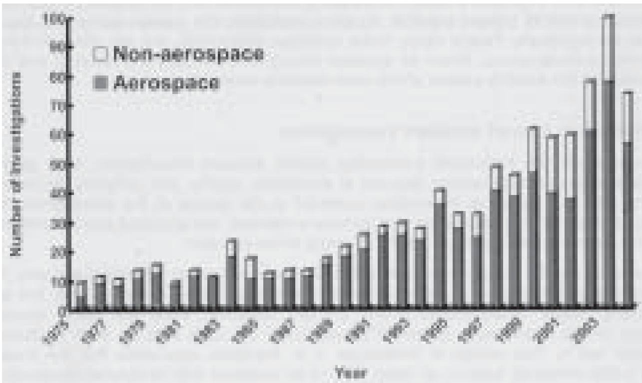
3. Failure analysis and accident investigation

Aircraft accident investigation has always been a daunting task. An accident investigator needs to face the most significant challenges, which require considerable breadth of knowledge in materials science as well as engineering. A key issue in any accident investigation is the status and impartiality of the organization carrying out the investigation. The primary objective of the investigation is to identify the shortcomings in the existing system and/or man-machine interface, and make recommendations so that corrective actions can be initiated to prevent recurrence of similar accidents.

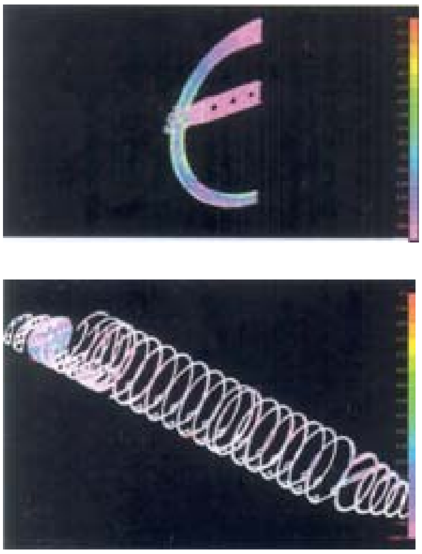
NAL has been the Indian pioneer in failure analysis and accident investigations, having investigated more than 900 cases over the past 30 years (see chart), and activity is continually rising (half of the 900 cases have been investigated in the last six years).

The Air India Kanishka explosion in June 1985 was investigated by NAL. During the last five years a sample of cases investigated by NAL include: failure of planet pinions, failure of connecting rod of piston engines, failure of rotary slide valves and failure of labyrinth pins.

A book titled "Failure Analysis of Engineering Structures: Methodology and Case Histories" compiling NAL's major investigations will be published later in 2005 by ASM International.



modification technologies for both the aerospace and energy sectors. In 2004-05, it recorded good progress in the development of sunshield mirrors for the INSAT-3D satellites; the ongoing trials are looking at the possibility of depositing a nano crystalline nickel coating directly on diamond turned aluminium panels. The Division is also closer to finding the optimal pressure sensitive paint for wind tunnel applications. The other promising initiatives include technology development of fuel cells and the development of nano-sized ceramic powders, nano composites and nano crystalline metals and alloys.



⇦ *Fig. 11 The Structures Division is looking at strategies to reduce the SARAS structural weight. The photographs show the new proposed engine attachment region on the fuselage, and the new fuselage layout for weight reduction.*

The emphasis at the *Wind Energy Division* is now on wind turbine development. The Division is now developing a 300 kW, low cost, indigenous, horizontal axis wind turbine (*Figure 12*); this will be followed by the development of a 500 kW wind turbine. All these wind turbines will be specially suited to the Indian wind conditions of relatively low wind speeds and dusty environment. The Division is scaling down its wind resource assessment activity.

TECHNICAL SERVICES

The *Computer Support and Services Division* provides infrastructure support in the areas of networking and network security, Internet and e-mail services and procurement of computer and UPS systems. A new version of the software solution for intellectual property governance is now ready. The *Electrical Sections*, on both the Belur and Kodihalli campuses, continued to give a good account; in particular, their support to major aerospace programmes was commendable. The SARAS teams use the well-established manufacturing and quality control facilities of the *Engineering Services Division* extensively. The Division's metrology lab also undertook some innovative reverse engineering exercises for certain critical aerospace studies.

The *Information Centre for Aerospace Science and Technology* (ICAST) has further expanded its suite of web-based services. The access to e-journals is continually improving. ICAST's initiative to create a digital repository of NAL's reports has made a good beginning. The *Information Management Division* (IMD) is now in the middle of a major project to imple-

⇨ ***Fig. 12** NAL is developing the 300kW wind turbine in partnership with the Sangeeth Group of Companies, and the new wind turbines will first be positioned at the Group's Kethanur site. The figure shows the wind speed and the energy available at the Kethanur site.*

4. NTAF augmentation programme

Wind tunnels play a crucial role in the development of aerospace vehicles. Experimental data generated in the wind tunnels can be utilized to determine and refine the shape of an aerospace vehicle.

Model mounted on twin roll model support system in the 1.2m tunnel.

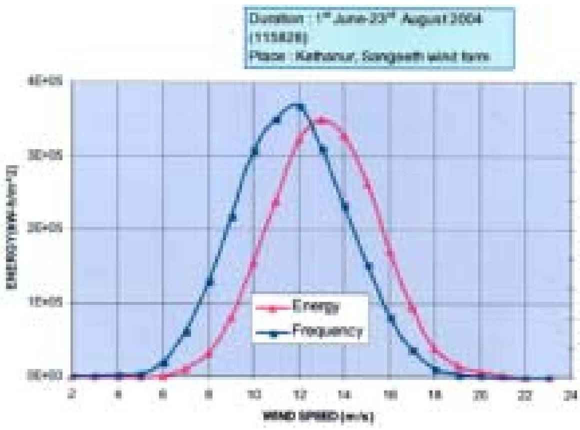
NAL's 1.2m x 1.2m trisonic wind tunnel, commissioned in 1967, has been extensively used for studies relating to the development of every Indian rocket, launch vehicle, missile or aircraft.

NAL started a major augmentation programme of the trisonic wind tunnel in October 2000 to include eight new and different constituents. This programme will increase the productivity of the tunnel and improve data accuracy.

The first three of these eight constituents: (1) automatic balance calibration system (Israel Aircraft Industry), (2) half-model support system (Hi-Tech Engineers, Bangalore) and (3) new transonic insert with slotted walls (HMT, Bangalore), were inaugurated in 2004.

The next three constituents: (4) additional air storage system (BOC, Kolkata), (5) new compressed air facility (BOC, Kolkata) and (6) twin roll model support systems (PARI, Pune) were inaugurated on 1 June 2005 at NAL's National Trisonic Aerodynamic Facilities (NTAF) complex.

NAL's capability to meet high speed aerodynamic test requirements will be enhanced even further when the last two constituents: (7) additional model cart (MECON, Ranchi) and (8) variable Mach number flexible nozzle (L&T, Mumbai) are commissioned by end-2005 and late 2006 respectively.



⇧ *Fig. 13 Dr G Madhavan Nair delivering the eighteenth NAL Foundation Day lecture on "Future space transportation systems" on 25 August 2004 at the S R Valluri Auditorium.*

⇧ *Fig. 14 Prof B N Raghunandan's CSIR Foundation Day lecture on "Rural technology development – issues and experiences", delivered on 26 September 2004.*

ment an ERP-like implementation at NAL. As our project responsibilities multiply, and our budgets grow, the need for an integrated workflow-based solution is being acutely felt. Using the Khoj software, developed by IMD for online recruitment, both NAL and NCL could significantly speed up new appointments. The Viman Vikas project, to automate the information workflows in the fabrication and inspection of composite airworthy components, is now ready for initial trials. IMD also played a major supporting role in acquiring extensive digital footage of the SARAS flight-testing.

The *Project Management and Evaluation Division* (PMED) plays an important management role, especially in supporting NAL's sponsored projects and monitoring its external cash flow (ECF); once again NAL achieved the largest ECF among all CSIR establishments. PMED also plays a key role in managing NAL's Tenth Five Year Plan network programmes and projects. The *Technical Secretariat* (TS) had a busy year: ten MoU's were signed, three patents (including one foreign patent) were granted, and three more patents were finalized and sent for filing to CSIR. TS supported NAL's participation in five exhibitions and received almost 300 batches of project students in 2004-05.

OTHER EVENTS

The eighteenth NAL Foundation Day Lecture was delivered by Dr G Madhavan Nair, Chairman ISRO and Secretary DOS on 25 August 2004 (*Figure 13*). Dr Nair's remarkable narrative on *Future space transportation systems* lucidly lined up ISRO's roadmap up to the year 2025. Dr K Yegna Narayan delivered the accompanying seventh NAL Technol-

⇩ *Fig. 15 Prof Javed Iqbal in the course of his National Science Day lecture on "Joys of drug design and discovery in the era of information technology" at NAL on 28 February 2005.*

⇩ *Fig. 16 Mr A Krishnappa delivered the Dr B R Ambedkar Birthday Lecture on "Education and social justice laid by Dr B R Ambedkar" at an impressive function held at NAL on 20 April 2005.*

ogy Lecture on *SARAS: From an idea to flight flight*. The CSIR Foundation Day lecture on 26 September 2004 was delivered by Prof B N Raghunandan, Chairman, Department of Aerospace Engineering, IISc. on *Rural technology development – issues and experiences*. Prof Raghunandan explained how rural technologies posed a very different set of challenges that many of us cannot easily relate to (*Figure 14*). Dr P R Viswanath's accompanying NAL Business Lecture, on *Advanced flow diagnostics and applications* described NAL's many initiatives in pressure sensitive paints, particle image velocimetry and laser Doppler velocimetry.

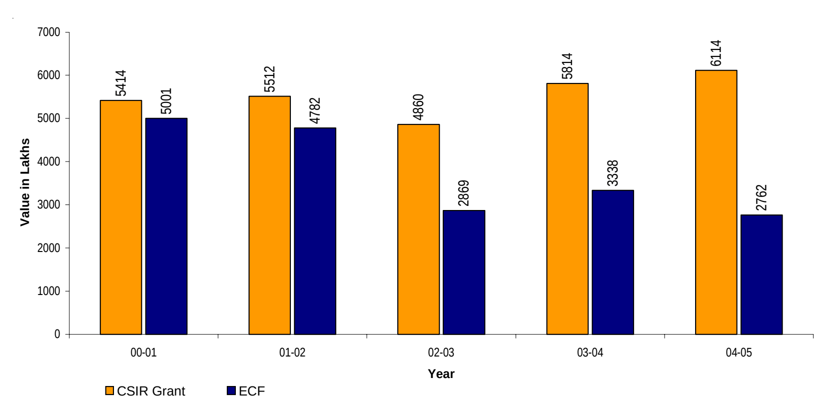
Prof Javed Iqbal of Dr Reddy's Laboratory, Hyderabad, delivered the 2005 National Science Day lecture on 28 February 2005 on *Joys of drug design and discovery in the era of information technology* (*Figure 15*). Prof Iqbal explained that drug discovery was all about "targeting the protein causing the disease with a high amount of precision". This year's National Technology Day function, on 11 May 2005, featured the lecture by Mr Yogesh Kumar, Executive Director (Design), Design Complex, HAL, Bangalore, on *Management of technology – a challenge in R&D programmes.* The lecture was notable for its brevity and sharp focus.

Mr A Krishnappa, a former Karnataka Minister for Social Welfare, and presently MLA, was the chief guest at this year's Dr B R Ambedkar birthday celebration function on 20 April 2005 and delivered the Dr B R Ambedkar Birthday Lecture on *Education and social justice laid by Dr B R Ambedkar* (*Figure 16*). The Hindi Day function, and all the contests held to mark the function, proved to be both educative and enjoyable. Dr K P Singh of ADA was this year's chief guest.

The other major events in 2004-05 included the CSIR Directors' Conference on 21-22 August 2005 (*Figure 17*), graced by the Minister of State for Science and Technology, featuring the SARAS inaugural flight; Aero India 2005, where NAL registered an impressive presence, and the visit of the Parliamentary Standing Committee on Science and Technology on 24 September 2004. Dr R A Mashelkar, DG-CSIR, laid the foundation stone for the proposed national test facility for rolling element bearings at the Propulsion Division on 6 August 2004.

Dr R V Krishnan, Adv (M&A) and Head, Materials Science Division retired on 31 January 2005 after a distinguished career spanning 30 years. His role as Adviser (M&A) to my two immediate predecessors, and to me personally for a brief period, is greatly appreciated.

⇧ *Fig. 17 NAL hosted the CSIR Directors' Conference on 21-22 August 2005 at the new ACD Conference Hall. The photograph shows Dr R A Mashelkar, DG-CSIR, making his opening remarks.*



⇧ *Fig. 18 A depiction of the CSIR grant to NAL, and NAL's external cash flow (ECF) over the past five years. On most years, NAL's ECF hovers around the Rs 30 crores mark. In 2004-05 NAL's ECF was Rs 27.62 crores – still the largest among all CSIR labs – while the CSIR grant for 2004-05 added up to Rs 61.14 crores.*

5. Dr B R Pai as NAL Director (2002-2004)

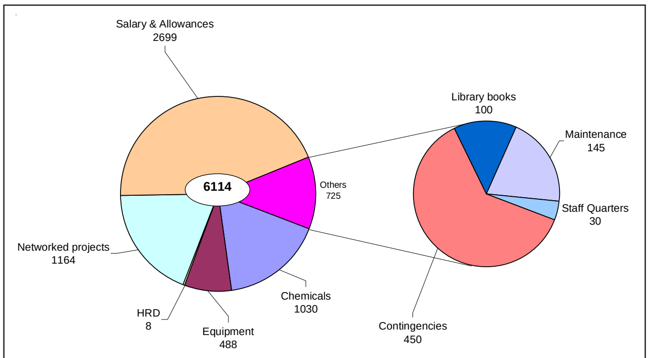
It is a privilege to acknowledge the contributions of my illustrious predecessor, Dr B Ramchandra Pai, both as a scientist, and in the last 2½ years, as Director of NAL.

NAL made impressive strides under Dr Pai's leadership. The successful SARAS flights fired national imagination. I am well aware how hard Dr Pai worked in the tumultuous months preceding the first flight.

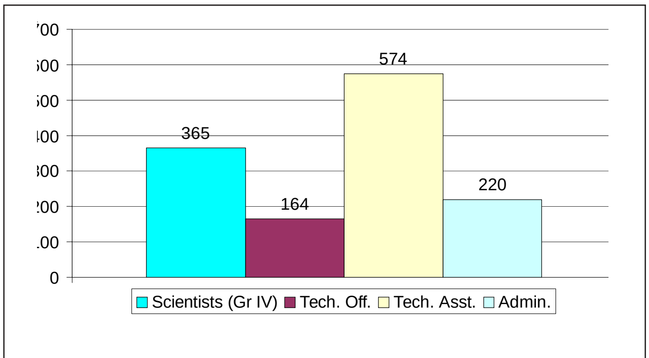
Under Dr Pai's tutelage, NAL further enhanced its reputation as a valuable leader or confederate in every national aerospace programme. The remarkable support to the Tejas programme continued, and big successes were achieved in supersonic propulsion in projects for VSSC and DRDO. The programme to augment NTAF infrastructure continued smoothly. The strategically important IFCAP facility to develop carbon fibres and prepregs was commissioned.

Some other R&D programmes that blossomed under Dr Pai include the radio controlled Blimp project to design and develop lighter-than-air systems, design of medium scale wind turbines suitable for India's wind environment, engineering radomes both for aerial and ground-based applications and using the Wankel engine to develop powered hang gliders and low-cost helicopters.

NAL bid a fond farewell to Dr Pai upon his retirement on 30 November 2004.



⇧ *Fig. 19 The break-up of how CSIR's 2004-05 grant to NAL was spent. About 44% of this grant was spent on salaries and allowances; the funding received for CSIR's networked projects amounted to Rs 11.64 crores -- about 19% of the total grant.*



⇧ *Fig. 20 The break-up of NAL's staff strength of 1223. R&D scientists make up about 30% of this number. NAL's staff strength doesn't appear to rise even though at least 50 new appointments are made every year – because NAL's employees are retiring at practically the same rate.*

This is the first annual report that I am presenting as NAL's Director. I would like to take this opportunity to recall the remarkable contributions of all my illustrious predecessors: Dr P Nilakantan, Dr S R Valluri, Prof R Narasimha, Dr K N Raju, Dr T S Prahlad and Dr B R Pai (*Box 5*). It will be my endeavour to take NAL forward with the same passion, commitment and motivation exhibited by NAL's first six Directors.

STATISTICAL SUMMARY

45 new sponsored projects (total value: Rs 9.79 crores) and 18 new grant-in-aid projects (value: Rs 5.89 crores) were taken up during 2004-05.

Our external cash flow (ECF) this year was Rs 27.62 crores; we continue to have the largest ECF among all CSIR establishments (*Figure 18*). The major ECF contributors were ADA (Rs 6.56 cr), ISRO (Rs 5.59 cr), DRDO (Rs

5.19 cr) and HAL (Rs 4.10 cr). About 3-4% of the cash flow in 2004-05 came from international sources.

The CSIR grant for 2004-05 was Rs 61.14 crores. 44% of this grant was spent on salaries and allowances. CSIR's "networked projects" accounted for 19% of this grant (*Figure 19*).

The NAL staff strength is currently 1223. This includes 365 scientists, 164 technical officers, 574 technical assistants and support staff and 220 officers and staff from the administrative cadre (*Figure 20*).

HONOURS

Finally, it is a pleasure to mention the many laurels and awards won by my colleagues in 2004-05. Both my predecessors were honoured last year: Dr T S Prahlad received the H K Firodia Award for "excellence in science and technology" and Dr B R Pai was the recipient of the Distinguished Alumnus Award of IIT Madras. Dr K Yegna Narayan received the 2004 National Aeronautical Prize of the Aeronautical Society of India. Mr D V Venkatasubramanyam received the Mechanical Design Award 2004 of the Institution of Engineers (India). Dr Somenath Mukherjee was awarded the Raman Research Fellowship for 2005-06. Dr P R Viswanath took over as the Coordinator of AR&DB's Aerodynamics Panel, and I have taken over as the Coordinator of the AR&DB Structures Panel. Dr J R Raol was elected a Fellow of Institution of Electrical Engineers (IEE). I congratulate all my colleagues.

Dr A R Upadhya
Director