CSIR-National Aerospace Laboratories, Bengaluru

IN FOCUS: CSIR-NATIONAL AEROSPACE LABORATORIES

At the Forefront of the Country's Aerospace Needs

The decade of 1980s turned the fledgeling NAL on to the road of self-reliance to combat expensive technologies and western embargoes, a path that it continues to tread successfully even today

Science India Bureau

The National Aerospace Laboratories (NAL) is India's premier R&D establishment in the civilian sector under the Ministry of Science and Technology. NAL is a constituent of the autonomous Council of Scientific & Industrial Research (CSIR), established on 1 June 1959, as the National Aeronautical Research Laboratory (NARL) in Delhi by CSIR. Barely nine months later, in March 1960, it made its humble beginnings in Bangalore by setting up its office in the stables of the Mysore Maharaja's Palace on the Jayamahal Road as the National Aeronautical Laboratory (NAL).

Subsequently, new campuses were set up at Kodihalli and Belur. On 1 April 1993, National Aeronautical Laboratory (NAL) was renamed as the National Aerospace Laboratories (NAL) to reflect its major involvement in the Indian space programme, its multidisciplinary activities and global positioning. It is India's only civilian aerospace laboratory with a high level of competence and the expertise of its scientists is globally acknowledged. NAL is a high technology-oriented institution concentrating on advanced topics in aerospace and related disciplines.

THE BEGINNINGS

The early years (1960-67) of NAL were spent in setting up wind tunnels across the Bellandur Lake, Bangalore; notably the 1.2m trisonic blowdown wind tunnel which continues its splendid run to this day. Then followed a decade of remarkable consolidation, facility build-up and the creation of R&D divisions encompassing practically every facet of aeronautics: theoretical and experimen-

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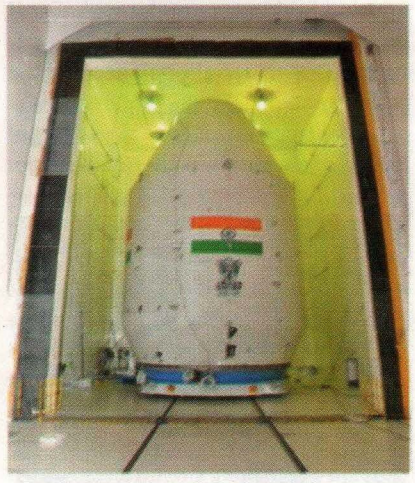
tal aerodynamics, structures, materials, propulsion, electronics and systems.

NAL's finest engineering achievement in the 1970s was the development of a full-scale fatigue test facility for testing fatigue life of aircraft which significantly contributed to life extension of various aircraft. By the mid-1970s, NAL had become one of the major actors on the Indian aeronautical scene. It was recognised as the best-managed national laboratories undertaking over a hundred high science high technology R&D projects in aerospace. A very striking feature of NAL's activity during the period was the amazing range of capability of digital equipment development like data logging & load measuring systems, temperature controllers, etc. An exceptionally successful group in Failure Analysis and Accident Investigation evolved. The activity has been designed to cater to the needs of Indian Aerospace Organisations. Many investigations involving incidents/ accidents of aircraft, helicopters and ground equipment used for defense aircraft were referred to the laboratory for investigation by IAF (Indian Air Force), HAL (Hindustan Aeronautics Limited), MoCA (Ministry of Civil Aviation), etc. This group has investigated more than 1,500 civil and military aircraft accidents/incidents as of date. NAL will explore the introduction of Artificial Intelligence (AI) and data analytics in the failure analysis for speedy results. Fibre Reinforce Plastics (FRP) pilot plant was created to build large radomes to house sensitive electronic equipment.



Above: India's largest Trisonic Wind Tunnel (1.2 m); Below: Acoustic Test Facility (ATF) for testing satellites and launch vehicle stages for ISRO

TURNING SELF-RELIANT

The 1980s was the decade when the NAL graduated as a major national player in aerospace. Many technologies were either too expensive or under embargo constraints by developed countries. Therefore, NAL initiated the development of critical technologies like composites, carbon fiber prepreg, parallel computers, etc., NAL developed India's first parallel computer "Flosolver" for computational fluid dynamics and aerospace engineering. Flosolver's success triggered parallel computing projects in the country. The autoclave was built to fabricate composite parts. NAL fabricated an all-composite aircraft LCRA. Acoustic Test Facility was established and is a national facility for testing satellites and launch vehicle stages & subsystems for the Indian Space Research Organisation (ISRO). The facility is an approved certification agency for noise. It has completed more than 3000 acoustic blowdowns and tested more than 100 spacecraft, launch vehicles and its systems.

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The 1990s was a very busy decade for NAL with its continued involvement in national aerospace programmes and NAL's initiative in the area of civil aviation. Based on the successful flight of LCRA, NAL designed and developed an all-composite two-seat trainer aircraft HANSA which had its maiden flight on 23 November 1993. An improved version of HANSA-3 was developed in 1996.

NAL has a major share in the design of LCA-Tejas in the following areas: Development of critical advanced composite parts such as fin, rudder, center fuselage, etc., (around 32 sets delivered to HAL); Support to and leadership of the National C –Wing and Control Law teams; Design and development of digital flight control law; Fabrication of wind tunnel models; Aeroelasticity testing of LCA models; CFD studies on LCA configurations. LCA experience provided confidence to take up the development of Light transport Aircraft SARAS, the first-ever LTA by an R&D organisation.

During the 2000s, SARAS aircraft was successfully designed and developed and had its maiden flight in 2004; HANSA 3 was commercialised; Carbon fiber technology matured; Composites were commercialized; and Airworthiness

obtained for Digital Fly by wire flight control systems.

INDUSTRIAL AND SOCIETAL CONTRIBUTIONS

NAL made significant contributions to a large number of aerospace programmes like aircraft programmes (civil and military), space programmes, engine development programmes, defense and strategic programmes of the country and has also contributed vital industrial and societal outputs. NAL has many collaborative projects with reputed international agencies.

In the 2010s, NAL successfully executed some innovative research projects in advanced topics of relevance like smart materials, parallel processing, advanced flow diagnostics, airport instrumentation, etc. Its societal contributions include harnessing solar and wind energy, streamlining vehicles for fuel economy and weather prediction systems. NAL has also developed many critical technologies for the strategic sector and continues to support the mission-mode programmes of DRDO, ADA & ISRO.

Jitendra J Jadhav took charge as the Director in June 2016 and revived the SARAS programme by modifying the SARAS PT1 to comply with the safety requirements and improvements in handling qualities including engine asymmetry, Nacelle performance etc. The modified SARAS named SARAS PT1N made its maiden flight on 24 January 2018. Subsequently, NAL made about 26 flights to collect the data which is being used for designing the SARAS-Mk II. Based on the Airline and Armed Forces requirement and the flight data, they carried out the feasibility study including the market survey of SARAS-Mk II and submitted the proposal to the government. The government of India sanctioned the project in June 2019.

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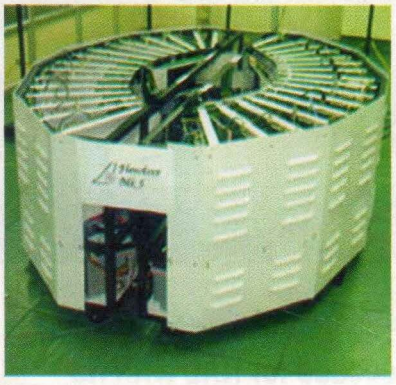
SARAS-MK II

SARAS-Mk II is a 19-seat Light Transport Aircraft with multirole capabilities like passenger transport, troop transport, VIP transport and Casevac (Air Ambulance). The aircraft is exclusively designed for operations from short runways, hot and high airfields, and semi-prepared runways for connecting Tier 1 and Tier 2 cities/towns. SARAS-Mk II is one of the unique aircrafts where operational benefits are maximized through the pressurised cabin, digital antiskid braking, autopilot with Cat II landing, two lever engine operation, lightweight materials etc., keeping the cost minimum.

The armed forces have already committed a few numbers for initial induction. The aircraft will be complied to FAR 23 standards and will be certified by DGCA and CEMILAC for civil and military use. The first flight is likely to be in June 2024 and the production will be from 2026-27 onwards at HAL. The SARAS-MKII will be a game-changer to boost air connectivity under the UDAN scheme.



HANSA-NG

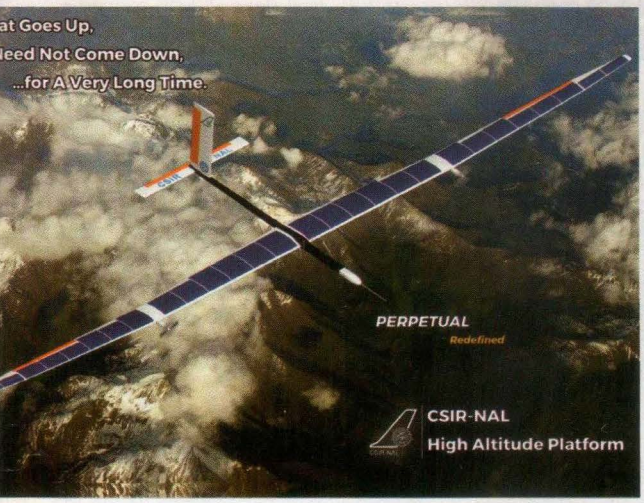
HANSA-NG is one of the most advanced flying trainers powered by Rotax Digital Control Engine with unique features like Just-In-Time Prepreg (JIPREG) composite lightweight airframe, glass cockpit, bubble canopy with wide panoramic view, electrically operated flaps, etc. HANSA-NG is designed to meet the Indian flying club needs and it is an ideal aircraft for Commercial Pilot Licensing (CPL) due to its low cost and low fuel consumption. NAL has already received more than 80 nos. of LoIs (Letter of Intents) from various flying clubs.

HANSA-NG aircraft had a successful maiden flight on 3 September 2021. The aircraft has completed 38 flights including sea-level trials at Puducherry; over 50 hours of flying is completed and a few more flights will be conducted before obtaining Type Certification by DGCA.

Above: India's first parallel computer, Flosolver Right: Medium-class BVLOS (Beyond Visual Line of Sight) multi-copter UAV

SKILLING INDIA

Towards implementing the Skill India mission of the Government of India, NAL has setup its aerospace skill development centre, under CSIR's Integrated skill initiative programme. This centre will offer a number of skill development and skill upgradation courses in partnership with the aviation and aerospace sector skill council to the ITI and



Diploma qualified youth, in addition to industry workers. The main aim of these courses is to create the high quality, industry ready skilled work force relevant to current and emerging industry needs in the aerospace manufacturing, assembly, design and development and airlines operation sectors. This is achieved through training / reskilling in areas catering to different national skill qualification framework levels.

LOOKING AHEAD

Regional Transport Aircraft

CSIR-NAL is working on the feasibility of the development of Regional Transport Aircraft since 2018. The requirements are evolved through interactions with airline operators and the Armed Forces. The aircraft will have 90-seat capacity and can be adaptable to military transport aircraft by modification of the rear fuselage. The proposal has been submitted to the government and we are expecting in-principle approval to initiate the project definition phase shortly.

BVLOS UAV

CSIR-NAL has developed a medium-class BVLOS (Beyond Visual Line of Sight) multi-copter UAV. The UAV is made out of a lightweight carbon fiber foldable structure for ease of transportation and has unique features like autonomous guidance through dual redundant MEMS-based digital autopilot with advanced flight instrumentation systems. The DGCA, Ministry of Civil Aviation, government of India granted conditional permission to CSIR-NAL for conducting BVLOS flight trials on 13 September 2021. Subsequently, the NAL drone has completed about 50 hrs of flying to verify the performance parameters and the report is being submitted to MoCA for type approval.

The uniqueness of this UAV is its higher payload and higher endurance which is perfect for last-mile delivery, floriculture mapping, geo exploration, precision agriculture, pesticide spraying and medical transport at remote places. NAL has demonstrated these capabilities to government authorities all over India. Technology is being transferred to private industries to build about 100-200 drones per month.

mach33.aero

NAL has launched mach33.aero, along with NRDC and Social Alpha (an initiative supported by Tata Trusts). With access to multi-stage funding, regional, national and global market linkages, mach33.aero will offer start-ups strategic connections with the government, academia and industry resources and accelerate pathways for technology commercialisation and also encourage scientists and engineers to pursue entrepreneurial opportunities.

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This unique model will also allow access to physical and virtual infrastructure, certification and testing facilities to carry out pilots for product deployment and validation.

NAL currently has taken major steps in deep technology innovations like intermediate modulus grade carbon fiber, carbon prepreg, special coatings for aerospace applications, Cf-SIC composites, Just-In-time-Pre-preg, thermoplastic composites and ARINC 818 IP core.

High Altitude Platforms

NAL has also taken up the development of High Altitude Platforms (HAP) for applications like broadband communication, surveillance, earth observation, climate research, etc. HAP is a solar-powered UAV with Beyond Visual Line of Sight operation capability. HAP will be a game-changer to work as a pseudo satellite for telecommunication applications in the 5G and 6G spectrum with advantages like low data latency, high bandwidth, the flexibility of launch and low cost.