

**GOVERNMENT OF INDIA
MINISTRY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
LOK SABHA
UNSTARRED QUESTION No. 1449
(TO BE ANSWERED ON 19.12.2018)**

NATIONAL AEROSPACE LABORATORIES

1449. SHRI ANIL SHIROLE:

SHRI PARBHUBHAI NAGARBHAI VASAVA:

SHRI GEORGE BAKER:

Will the Minister of SCIENCE AND TECHNOLOGY be pleased to state:

- (a) the details of the number of National Aerospace Laboratories across the country, State/UT-wise including West Bengal, Gujarat and Maharashtra;**
- (b) the details of the funds sanctioned, allocated and utilized by these laboratories during the last three years and the current year, State/UT-wise including West Bengal;**
- (c) the details of the target set and achievements made by these laboratories during the above-said period;**
- (d) whether the Government is planning to develop drones or Unmanned Aerial Vehicles (UAVs) by these laboratories;**
- (e) if so, the details thereof and the reasons therefor; and**
- (f) the details of the funds likely to be sanctioned for this purpose along with the details of the target likely to be set for this?**

ANSWER

**MINISTER OF SCIENCE AND TECHNOLOGY AND EARTH SCIENCES
(DR. HARSH VARDHAN)**

- (a) Council of Scientific & Industrial Research (CSIR) has a constituent laboratory namely, National Aerospace Laboratories (CSIR-NAL), is involved in Research & Development activities of the aerospace sector. The laboratory is located in Bengaluru, Karnataka. There are no extension centres or units of CSIR-NAL established in other states of the country including West Bengal, Gujarat and Maharashtra.**

(b) The funds allocated and utilized by CSIR-NAL for the last three years and current year are given below:

(Rs. in crore)

Year	Funds Allocated/utilized
2015-16	232.710
2016-17	258.751
2017-18	318.455
2018-19*	283.082

***upto 30-11-2018**

(c) CSIR-NAL's target as per its mandate is to develop aerospace technologies, pursue cutting edge science in the domain, design and build small, medium sized civil aircraft, and support national aerospace programmes. CSIR-NAL has been involved in all the major aerospace programs in the country, notably the Light Combat Aircraft (Tejas) of Aeronautical Development Agency (ADA), the Satellite and Launch Vehicle Programs of Indian Space Research Organization (ISRO), and the Missile Programs of Defence Research and Development Organization (DRDO). The S&T contributions of CSIR-NAL in these strategic areas has helped the country in overcoming the technology-denial regimes at critical junctures. Additionally, it has helped to protect confidentiality of strategic data and enhance the nation's prestige in the international arena. A brief note on significant achievements for the last three years is provided at Annexure-I.

(d)&(e)Yes, Madam. The details of activities in area of drones / Unmanned Air Vehicle being undertaken by CSIR-NAL is given at Annexure-II.

(f) The details of funds sanctioned under different projects and the targets set in the area of Drones/Unmanned Air Vehicles is given at Annexure-III.

I. SIGNIFICANT S&T ACHIEVEMENTS 2015-16

Integrated Global bus Avionics Processing System (IGAPS)

Integrated Global Bus Avionics Processing System (IGAPS) is one of the most technologically challenging aircraft core computing platform ever designed within the country. The Integrated Global bus Avionics Processing System (IGAPS) with features like Avionics Full Duplex Ethernet, ARINC 653 compliance and wide bandwidth for communication has been successfully designed, developed and integrated for the first time in India at CSIR-NAL. It has been integrated with sophisticated real time Automated Test Station for simulation, debugging and application integration. Indigenized IGAPS can be used effectively across different types of aircraft like fighter, civil or Unmanned Air vehicles. The system is state of the art product with core technologies like ARINC 664, ARINC 818, ARINC 653 and VITA 46 backplane system. The indigenous cost is 70% lesser as compared to FE cost.

Micro Aerial Vehicle (MAV) Programme

CSIR-NAL is one of the lead agencies for Micro Aerial Vehicle (MAV) development in the country. Significant achievements in the current reporting period include; the consistency and reliability in the flight performance of 200 mm and 150 mm MAVs, successful flight of the 2.5 kg mini UAV under autonomous operation, aerial mapping of an ancient archaeological site under a joint program with National Institute for Advanced Studies (NIAS) and the initial aerial survey of wild life at the Muthangya forest (Wayanad District) in cooperation with the Kerala Forest Department. A few user demonstrations have been carried out jointly with Aeronautical Development Establishment (ADE) and promotional flight demos given to Chhattisgarh Police, CRPF (Dhantawade), NSG (Manesar) and Artillery Center (Deolali).

Towards achieving self-reliance in technologies for MAVs/UAVs, the laboratory has successfully completed the design, development and implementation of a range of Miniature digital Autopilots for MAVs achieving a minimum weight budget of 2.6 grams. Autopilot system (APV4.2) with weight of 4.2 grams (including onboard connectors) and dimensions of 30x28 mm has been successfully designed, developed, integrated and flight tested.

Nickel-Titanium (NiTi) Shape Memory Alloys (SMAs)

CSIR-NAL has made significant contributions in the area of special materials. The pseudo-elastic NiTi shape memory alloy (SMA) wires in the diameter range 0.2-0.5 mm with properties suitable for biomedical applications have been developed and fabricated. The functional response of the NiTi wires for orthodontic application has been demonstrated successfully using a mouth simulator.

Development and characterization of PVDF film for surface pressure sensing

CSIR-NAL polyvinylidene fluoride (PVDF) sensors were designed, fabricated and tested for operational pressure range 0–5 bars. The performance was compared with a commercially available pressure sensor and the results were found to be in good agreement. Further, PVDF sensors were tested on NACA 4415 airfoil in wind tunnel and variation in output peak voltage was measured for wind speed in the range 0-20 m/s.

DRISHTI – Fast & Accurate Transmissometer

DRISHTI, an airport runway visibility assessor system developed by NAL is a fast and accurate transmissometer. Under the MoU with Indian Metrological Department the systems were installed and commissioned at New Delhi, Jaipur, Amritsar, Lucknow, Dehradun, Patna, Ahmedabad, Varanasi, and Guwahati airports. Soon other airports across the country would also be equipped with NAL's indigenously developed DRISHTI systems. Considering the success of DRISHTI, Tata Power Systems has placed firm order on NAL to procure and install Drishti systems (54 nos.) at IAF airfields. NAL has supplied 22 systems to eight Air Force Stations in a record time of three weeks in the month of March 2016.

Contributions to LCA-Tejas Programme

During the year, three sets (7 parts/set) of Centre fuselage parts, one set of Fin & Rudder assembly and two sets (10 parts/set) of MLG aft doors with Fairings for Tejas were delivered to the production group (HAL) for the series production (SP) aircraft. As a part of validating the LCA fuselage design, structural testing of fuselage F1A tank test box with individual CFC panel assemblies was tested up to 180% of design load at RT to meet the design and certification requirements. Further, Control laws of LCA-Tejas (Air force Variant) were upgraded to include advance features like the Automatic Low Speed Recovery (ALSR). Following the success of the first SKI jump launch at Goa of the LCA-Naval variant, an advanced SKI jump Take Off mode (SJTO mode) was designed and included in the naval version of flight control laws.

Contributions to IAF's Mirage Up-Gradation Programme

CSIR-NAL has contributed significantly to the Mirage aircraft up-gradation programme of IAF. The significant contributions include: (a) studies on effect of the new stores on Mirage, Euler computations using Fluent and RANS computations using SU2 performed over Mirage aircraft with Crystal maze missile at transonic Mach numbers. Both solvers were also used for side slip studies on Mirage with Crystal maze missile.

Contributions to ISRO's RLV-TD programme

CSIR- NAL was proud to associate with the successful launch of ISRO's Reusable Launch Vehicle – Technology Demonstrator (RLV-TD). Acoustic tests on the RLV-TD were carried out at the Acoustic test Facility (ATF) of CSIR-NAL during April 2016. These tests were primarily to assess the integrity of the vehicle under acoustic loads during the lift-off phase and during the flight through the denser portions of the atmosphere.

Weather Radomes – Installation of Radomes at Gopalpur, Odisha and Kochi, Kerala

As a part of a multi-organizational weather monitoring programme involving Indian Metrological Department, Department of Space, Bharat Electronics Ltd., and NAL, the CSMST team of CSIR-NAL has successfully completed the installation of DWR Mark II Radome at Gopalpur seashore, near Chandipur, Odhisa in May 2015 and at Kochi, Kerala in December 2015. With the successful completion of these two installations, the DWR Mark II Radome indigenization program, that has a significant role in weather monitoring activities of IMD, has successfully met the objectives and culminated with dissemination of the technology to industry.

II. S&T ACHIEVEMENTS 2016-17

Development of Acoustic Based Hit Identification and Analysis System (ABHIAS)

CSIR-NAL has taken up the development of Acoustic Based Hit Identification and Analysis System (ABHIAS) for marksmanship training in the subsonic range. It is primarily aimed at the strategic market consisting of the Armed Forces-Army, Navy and Air Force, CRPF, CISF, NSG, BSF etc. Considering there are more than 2000 firing ranges across India requiring at least 8 systems per firing range, this indigenous system has good market potential. Apart from low maintenance cost this indigenous system is 60% of the cost of comparable imported system.

Certification of indigenous Carbon Fiber

During the year certification of airworthiness of indigenously developed standard modulus grade carbon fibre were tested for the certification by the Centre for Military Airworthiness & Certification (CEMILAC) under inspection coverage by the Directorate General of Aeronautical Quality Assurance (DGAQA).

The Ministry of Defence (MoD) will be taking up this technology for establishing 100 TPA carbon fibre plant through MIDHANI

ADA's LCA-Tejas Programme

CSIR-NAL continued its support to the ADA's LCA-Tejas Programme and made contributions in the areas of design, fabrication and R&D of composite structures. During the year, three sets of fin and rudder assemblies were delivered from SP4 to SP6 aircraft. Four sets (10 parts/set) of MLG aft doors with fairings were delivered to SP4 to SP7 aircraft. Three out of seven centre fuselage parts were supplied to aircraft up to SP18. All parts of fin, rudder and 6 centre fuselage parts produced at TAML, Bengaluru under the QA coverage of NAL. Further the National Control Law team for LCA-Tejas led by CSIR-NAL completed the control law design modifications for Final Operation Clearance (FOC) of LCA-Mk1 aircraft and trainer variant. Air data algorithms were developed for AIR - to- AIR refuelling mode. LCA Navy successfully completed 12 ski jumps with the modified SKI jump take off mode. All variants were flown during Aero India 2017.

IAF's Mirage Aircraft Up-Gradation Programme

CSIR-NAL has contributed significantly to the Mirage aircraft up-gradation programme of IAF. The significant contributions include: (a) store separation suite consists of CFD mesh free solver developed to carry out weapon integration studies involving trajectory computations for about 96 configurations including single as well as multiple release of stores, (b) Finite element model of the aircraft having dynamic characteristics generated from 3-D CAD model which can be used for static stress and dynamic analysis of the aircraft with different store configuration, (c) aero-mechanical load analysis to compute the load envelopes and reactions, and (d) aeromechanical studies of new stores on the Mirage aircraft were carried out to provide data for stability and control (S&C) analysis in support of flight clearance.

Wind Solar Hybrid (WiSH) for societal benefit

The renewable energy initiative launched by CSIR-NAL along with its industrial partner M/s Aparna Renewable Energy Systems (ARES) has culminated in installing 1 kW WiSH at science and technology educational institutions in Bangalore. In addition, four units of 1 kW hybrid systems will be installed at the CSIR-IMMT campus at Bhubaneswar.

Hansa-Next Generation Aircraft

Studies related to design and production of New Generation Hansa (Hansa-NG) featuring an all glass cockpit were carried out during the reporting year. Hansa -3 successfully made its flight in the eleventh edition of Aero India 2017. Showcasing the static display of Hansa-NG glass cockpit was a major attraction. The event provided a significant platform in bolstering business opportunities in international aviation sector. One Hansa-3 aircraft was handed over to M/s Mesco Aerospace Limited. The firm has shown keen interest in licensed production and marketing of Hansa-NG aircraft.

DRISHTI

DRISHTI, an airport runway visibility assessor system developed by NAL has completed installation in ten international airports of India. All the systems have been validated and Class-1 certification have been issued. Further, supply of 54 Drishti systems to eighteen Indian Air Force airfields through Tata Power SED completed successfully during the year. The Integrated Drishti Aviation Weather Monitoring System (D-AWMS) installed at IGI Airport, New Delhi went through rigorous validation and emerged as a successful product.

Mini UAV SUCHAN

CSIR-NAL has taken up project to translate the mini UAV 'SUCHAN' into a marketable product. In this project, successful efforts were made to increase the endurance of the vehicle and safety modes are included in the NAL autopilot. With wings made out of EPP foam and GFRP skin has reduced the weight of SUCHAN around 300-400 grams compared to Kevlar wings. With these modifications and high capacity, the vehicle could successfully fly more than 100 minutes. As part of the user interaction, SUCHAN UAV flight demonstrations were shown to Air Force officials of western command in Gandhinagar, Gujarat.

GMR based gear tooth position sensor

A giant magnetoresistance (GMR) based gear tooth position sensor was successfully developed at CSIR-NAL. The developed speed sensor module (NAL GSTM-14xx) as per the system required specification (SRS) provided by TVS motor Limited, Tamilnadu. NAL GSTM-14xx was certified by Automotive Research Association of India (ARAI), Pune and the vehicle test was covered more than 10000 km.

III. SIGNIFICANT S&T ACHIEVEMENTS 2017-18

Multi Zone Hot Bonder for Composite Repairs

Two Non- Exclusive License Agreements for production, marketing and commercialization Multi Zone Hot Bonder were signed with MSME industries M/s SAN Process Automation, Bangalore and M/s Ajay Sensors, Bangalore during the year. Both are targeting the Maintenance, Repair & overhaul (MRO) of airline industries, base repair depots of IAF and wind farms. CSIR-NAL will provide the hand holding assistance for absorption of technology, dissemination, demonstration, manufacturing of product and associated prove outs for a period of one year in order to ensure smooth technology transfer to the MSME industries.

ADA's LCA-Tejas Programme

CSIR-NAL continued its support to the ADA's LCA-Tejas Programme. Advanced Composites Division (ACD) - NAL continued to make contributions in the areas of design, fabrication and R&D of composite structures. For Series Production programme of LCA, four sets of Fin and Rudder assembly from SP 7 to SP 10 aircraft, seven sets of Trouser duct and Circular duct top parts were realized from the production partner Tata Advanced Materials Ltd.,(TAML). Three out of seven Centre fuselage parts were supplied for aircraft up to SP 20 by TAML. Eight sets (10 parts/set) of MLG forward doors with fairings from SP9 to SP16, ten sets (10 parts/set) of MLG aft doors with fairings from SP8 to SP16 were delivered by NAL. All parts of fin, rudder and six centre fuselage parts are being produced at TAML under the Quality Assurance coverage of CSIR-NAL. Further, all three variants of the LCA Tejas aircraft underwent safe envelope expansion to meet the objectives of the final operating clearance under the leadership of National Control Law team for LCA-Tejas led by CSIR-NAL. The LCA Tejas simulation activities were supported with the Engineer in Loop Simulator (ELS). The simulator was augmented with wake models for the LCA as well as Sukhoi aircraft. The Structural Technologies Division at NAL has contributed to LCA related to static aeroelastic load computation for LCA Mk-1 composite fin, bird-strike analysis on windshield and frame assembly, static structural strength testing of LCA F1A fuel tank, static strength test of fixed air to air refueling probe receiving structure for LCA Mk-1 aircraft, and damage tolerance evaluation of LCA wing root fitting box under variable amplitude loads.

Desktop Autoclave

Under the FTT project, the desktop autoclave was developed to meet the expectations of academia and research institutions in establishing an affordable, low energy consuming, aerospace grade autoclave. With a working volume of 450mm diameter and 500mm length,

operating conditions of 200°C temperature and 7bar pressure and an intuitive control system, the user can develop small size aerospace grade composites. The desktop autoclave was successfully commissioned and number of cure trials were carried out. Non-Exclusive License Agreement for production and marketing of Desktop autoclave was signed with M/s. Milvus Aero Solutions Pvt. Ltd. Bengaluru and M/s. Datasol India Pvt., Ltd. First order from IIT Madras has been received and few more orders are expected. The development of microwave hybrid autoclave development is in progress.

Airboat for Cleaning Lakes

The once-ubiquitous Maruti 800 may have lived out its life, but its engine has found a new host and is doing pretty well. The first-of-its-kind airboat, developed in India by CSIR-National Aerospace Laboratories (NAL), which was built to clear out weeds from Ulsoor Lake, has successfully undergone trials.

SARAS PT1N – First Flight

The new upgraded version of SARAS, the indigenous transport aircraft developed by NAL, “successfully” made its maiden flight on 24th January 2018 in Bengaluru. Continued with the success of first flight, SARAS was successfully test flown for the second time on 21st February 2018. Dr. Harsh Vardhan Hon’ble Union Minister for S&T, and VP CSIR along with DG, CSIR witnessed the second flight and highly appreciative of effort put in by the entire team of NAL, ASTE, DGAQA, CEMILAC and HAL in reviving the project after nearly nine years. Around 10 to 15 more flights will take place in the next year before the design for improved version of Saras (Mk2) is finalized.

DRISHTI

DRISHTI, has completed the land mark supply of 101 systems (47 systems to Civilian and 54 systems to Defence Airports). It was a notable achievement that Kempegowda International Airport, Bangalore gets a taste of Prime Minister’s Make in India with NAL’s Drishti during the year. Following this success, the Airport Weather Monitoring System (AWMS) developed by the laboratory has been installed at Mangalore International Airport in June 2017. This airport is the first airport in the country to have indigenously developed AWMS. The system measures Wind Speed, Wind Direction, Humidity, Pressure, Temperature and Dew Point along with Visibility.

SUCHAN UAV

NAL’s autopilot and Ground Control Station were integrated using NAL-UAV communication protocol. Currently, NAL mini UAV-SUCHAN flies with NAL autopilot and NAL Ground Control Station. SUCHAN UAVs endurance is increased to 90 minutes from 60 minutes by modifying wing span and incidence angle. The UAV is configured for two major applications. While surveillance is the primary objective of the project, however based on request from the users, the UAV is also configured for geo-spatial mapping applications. In collaboration with CSIR-CIMFR, one case study of geo-spatial mapping of coal mining fields (opencast coal mine in Sonapur BAZAR Area in Budwan District, West Bengal) during 19-20 December 2017 was carried out with SUCHAN. The geo-tagged images taken from UAV were further processed offline to create orthomosaic and Digital Elevation Model (DEM) models of the coal mining area.

IP Core 818

CSIR-NAL has taken-up design, development and certification of FPGA based IP core 818 as a part of the international standard RTCA DO-254 for avionics video and data widely used in Civil and Defence advanced display systems. CEMILAC has taken good initiative to start the DO 254 process for FPGA based IP core to establish the process, guidelines and complete framework to certify the IP cores in the country. This is being used for design studies, evaluation of cockpit ergonomics and interface studies for mechanical as well as electrical interfaces.

NiTi Shape Memory Alloys (SMAs)

CSIR-NAL has signed an agreement with M/s Mishra Dhatu Nigam (MIDHANI) Limited, Hyderabad on transfer of technology (ToT) for commercial production of engineering and biomedical grades of SMAs. The ToT to MIDHANI for production of engineering products such as rods, plates, wires and strips has been completed and the products are now commercially sold by MIDHANI. During the last one year, CSIR-NAL and Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST) have worked together in unison and finalized the design and fabrication scheme for NiTi SMA stent grafts. The first prototype stent graft has already been fabricated and the same is being subjected to functional and biological tests at SCTIMST. Concurrently, SCTIMST has also taken up biocompatibility and toxicology studies on the SE NiTi SMA developed at CSIR-NAL.

Chromic Acid-free Anodization process

Sealed oxide layers developed on AA 2024 by tartaric sulphuric acid (TSA) anodization have exhibited excellent corrosion resistance for more than 12 months of outdoor exposure at Mandapam Camp, Rameswaram, TN. The Chromic acid-free anodization process for airworthiness has been certified by RCMA, CEMILAC and CSIR-NAL in talks with HAL and other vendors of aerospace/aircraft industries for licensing of the technology.

Details of activities undertaken by CSIR-NAL in the area of drones or unmanned Air Vehicle:

One of the thrust areas of the CSIR-NAL is development of Micro Air Vehicles and Unmanned Aerial vehicles for strategic and civil applications. CSIR-NAL has already developed the 2m wing span mini UAV which will be used for 1) Surveillance application and 2) Geospatial mapping applications. Currently CSIR-NAL is looking for the partner to transfer the technology for mass production to meet the requirements of the country for the above applications. Currently, CSIR-NAL is involved in the following projects:

1. VTOL winged UAV for Multi-Mission Applications (VTOL-UAV):

Medium sized Separate Lift Thrust (SLT) vehicle VTOL UAV (AUW: 10 kg) upto 2 kg payload will find applications in health care service, smart city patrolling, railways, strategic, agricultural, forest dept., societal missions etc.;

2. UAV based high resolution remote sensing for modernized and efficient cultivation practices of commercially important medicinal and aromatic crops. (Acronym: DroneAgri);

Development of standardized protocols for UAV based remote sensing and geospatial mapping is important for Medicinal and Aromatic Plant (MAPs) crops. The UAVs will be equipped with multispectral cameras to survey the region and produce high resolution geo-tagged aerial images. These multiband images will be processed further to produce high definition vegetation maps which will monitor the health and improve in productivity of plants

3. DRone based Electromagnetic and Magnetic system (DREAM)

Indigenous design and development of DRone based Electromagnetic and Magnetic system (DREAM) for geophysical exploration, with under-slung Transmitter & Receiver assembly and on board Transmitter current source, data acquisition system with GPS navigation.

The ongoing projects for development of UAVs are funded by CSIR-Hq under Fast Track Translation Project (FTT - VTOL), Focused Based Research Project (FBR - DroneAgri) Mission Mode Project (MMP- DREAM) categories of the project. The funding to CSIR-NAL is as below:

(Rs. In Lakhs)

Sl. No	Title of the project	2018-19	2019-20	Grand Total
1	VTOL winged UAV for Multi-Mission Applications (VTOL-UAV)	166.60	83.00	249.60
2	UAV based high resolution remote sensing for modernized and efficient cultivation practices of commercially important medicinal and aromatic crops (Acronym: DroneAgri): NAL component	58.00	90.00	148.00
3	DRone based Electromagnetic And Magnetic system (DREAM) : NAL component	511.20	132.20	643.40
Grand Total		735.80	305.20	1041.00

Targets/Deliverables:

Project Title: VTOL winged UAV for Multi-Mission Applications (VTOL-UAV)

- SLT-VTOL Design and System Configuration
- UAV structure
- Aerodynamic and aeroelastic testing/analysis
- Obstacle avoidance and smart mission planning software
- VTOL UAV with all integrated subsystems
- Flight Testing of SLT-VTOL UAV

Project Title: UAV based high resolution remote sensing for modernized and efficient cultivation practices of commercially important medicinal and aromatic crops. (Acronym: DroneAgri)

CSIR-NAL targets :

- Field experiments and Air borne Image acquisition
- High resolution geo-tagged aerial images
- Band ratio and vegetation indices (e.g. NDVI, Red Edge, etc.) maps
- Maps on species under cultivation
- Crop canopy density map
- Canopy stress/health map
- Thermal emissivity map
- Protocols for non-destructive and quick assessment of crop growth, crop stress and biochemical parameters

DRone based Electromagnetic And Magnetic system (DREAM)

CSIR-NAL targets :

- Fabrication of Tx & Rx Loop
- Stability Analysis of Slung Load
- Integration of Payload
- Flight Operations
