GOVERNMENT OF INDIA
MINISTRY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
LOK SABHA
UNSTARRED QUESTION NO. 1061
(TO BE ANSWERED ON 08.02.2023)

NATIONAL AEROSPACE LABORATORIES

1061. DR. AMOL RAMSING KOLHE:

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 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 Maharashtra;

(c) the details of the target set and achievements made by these laboratories during the above-said period; and

(d) whether the Government is planning to develop drones or Unmanned Aerial Vehicles (UAVs) by these laboratories; if so, the details thereof and if not, the reasons therefor?

ANSWER

MINISTER OF STATE (INDEPENDENT CHARGE) OF SCIENCE AND TECHNOLOGY & EARTH SCIENCES

(DR. JITENDRA SINGH)

(a) CSIR-National Aerospace Laboratories (CSIR-NAL), Bengaluru, a constituent laboratory of the Council of Scientific & Industrial Research (CSIR) is the only public funded and civilian aerospace R&D laboratory in the country.

(b) The details of the funds sanctioned, allocated and utilized by CSIR-NAL for the last three years and current year are as under:

(Rs. in crore)

Financial Year	Sanctioned/ Allocated	Utilized
2019-20	237.84	237.84
2020-21	236.26	236.26
2021-22	283.75	283.75
2022-23	386.77	232.96*

***Utilized as on 31.12.2022**

(c) CSIR-NAL's mandate is to develop aerospace technologies with strong science content, design and build small, medium sized civil aircraft, and support all national aerospace programmes. The laboratory target is to take-up and implement major aircraft programmes like two-seater flying trainer (Hansa-NG), Multi-Role Light Transport Aircraft (19 seat SARAS-MkII), and the Regional Transport Aircraft (RTA) to enhance the air connectivity under Govt. of India's UDAN scheme. The aircraft programs aim to meet the country's civil aviation requirements and to synergize the multidisciplinary expertise of the laboratory meeting the objectives of Atmanirbhar Bharat.

Further, the endeavor of the laboratory is to support major national aerospace programmes of Indian Space Research Organisation (ISRO) & Defence Research and Development Organisation (DRDO). The laboratory is being continued to support the major national aerospace programmes notably the Light Combat Aircraft (LCA)-Tejas of Aeronautical Development Agency (ADA); satellite & launch vehicle programmes of ISRO; and missile programmes of DRDO. CSIR's developmental work in strategic areas has helped the country in overcoming the technological denial regimes especially ADA's LCA-Tejas programme with critical technology inputs like composite air frame parts and fly-by-wire control laws

etc., Additionally, it has helped to protect confidentiality of strategic data and enhanced the nation's prestige in the international arena.

The significant achievements/contributions of the laboratory during the last three years and the current year is at Annexure-I.

(d) Yes, Sir. CSIR-NAL has developed medium class Beyond Visual Line of Sight (BVLOS) multi-copter Unmanned Aerial Vehicles (UAVs). The brief details are at Annexure-II.

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Annexure-I

Significant Achievements of CSIR-NAL during the year 2019-2020

Contributions to the Civil Sector

- **During the year, considerable progress was achieved in the design of SARAS Mk-2 (19 seater aircraft) towards optimization of configuration. The drag reduction and aerodynamic efficiency, reduction in Operating Empty Weight (OEW) and increase in useful load, improvements in Flight Control System (FCS) and general systems were addressed. Significant progress was made with preliminary layouts, preliminary configuration documentation, Computational fluid dynamics (CFD) analysis, wind tunnel testing, configuration design, performance estimation, stability and controllability and critical load cases for structural design has been achieved for SARAS Mk-2 aircraft.**
- **Significant efforts were made towards the development of Hansa-New Generation (NG) aircraft with the improvements such as all-glass cockpit, advanced fuel efficient Rotax 912iSc engine with better performance (increased range and endurance), optimized airframe, steerable nose wheel, electrically operated flaps, Instrument Flight Rules (IFR) compliance, improved ingress-egress, better interiors/ergonomics and external finish. The new power plant system installation along with proposed aerodynamically efficient cowling to suit the Rotax 912iSc 3 Sport engine has been designed. Fuel system and engine thrust measurement test rigs were developed and realized to test the engine performance on ground. Design changes were incorporated in the cockpit for the installation of full Glass-cockpit MIP with improved aesthetics and ergonomics.**
- **CSIR-NAL's Drishti crossed more than century mark - 105 systems working in 21 Civilian International Airports (51 systems) and 18 Indian Air force airbases (54 systems). Kempegowda International Airport (KIA), Bengaluru, had the honour of getting the 50th system in November 2019 – a golden land mark for Civilian Airports when 4 Drishti systems were installed in the new Runway of KIA.**

- **CSIR- NAL has successfully designed and developed various multi-copters for different applications. The developed Multi-copters are 0.5 Kg payload Quad-Copter, 5.0 Kg Payload Hex-Copter and 20.0 Kg Payload Octa-Copter. The developed Quad-Copter is extensively used in acquiring Arial Multi-Spectral images of selected medicinal and aromatic crops covering 1,99,754 m2 area maintained by CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur. Successful flight trials for the Octa-Copter carrying payload either hyper spectral camera or pesticide sprayer were completed. For the first time in the country, Drone based Earth Magnetic field survey was conducted by joint team of CSIR-NGRI and CSIR-NAL. In this flight campaign, the magnetometer AirBird is integrated as a slung load to the NAL Hex-Copter. The results of the drone based survey are compared with other methods and found that the drone based magnetic survey data is consistent and reliable.**

Contributions to Strategic Sector

- **CSIR-NAL's National Trisonic Aerodynamic Facility has completed 1632 blowdowns in the 1.2m and 629 blowdowns in the 0.6m wind tunnels. The major users of the facility were Defence Research and Development Organisation (DRDO), Indian Space Research Organisation (ISRO) and CSIR-NAL. For Defence Research & Development Laboratory (DRDL), wind tunnel tests were conducted for full scale model of missile configuration to obtain the basic aerodynamic characteristics and control effectiveness.**
- **Continued support to the ADA's LCA-Tejas Programme. CSIR-NAL continued to make contributions in the areas of design, fabrication and R&D of composite structures.**
- **CSIR-NAL has significantly contributed to flight mechanics parameter analysis and controller design for unmanned aerial vehicle (UAV) - unmanned combat aerial vehicle (UCAV) program. Performance verification of the flight control laws was carried out in the nonlinear simulation environment to ensure the flight worthiness of the flying wing UCAV.**

- **34 investigations involving incidents/ accidents of aircraft, helicopters and ground equipment used for defence aircraft were referred to the laboratory for investigation by the various organizations like Indian Air Force (IAF), Hindustan Aeronautics Limited (HAL) & Ministry of Civil Aviation (MoCA). In most of these investigations, the primary cause(s) of failures could be identified and after each investigation, recommendations were suggested for prevention of similar incidents/accidents in future.**

Contributions to Space Programmes

- **The Indian Space Programme has been ably supported by the CSIR-NAL's Acoustic Test Facility (ATF) over the last three decades. Acoustic qualification of space bound hardware has been very crucial to ensure the reliability of the hardware and successful completion of the mission. ATF carried out a major acoustic test programme on four numbers of the L40 Strapon Nosecone decks for the F10 mission of the GSLV-MKII in addition to acoustic tests on the PSLV-PS4 Flexible Solar Panel. ATF also successfully completed acoustic test programmes on two subsystems of the new Small Satellite Launch Vehicle (SSLV) of ISRO during the year. ATF completed the design, fabrication, testing and supply two numbers of high intensity octave band microphone calibrators to the Vikram Sarabhai Space Centre, Thiruvananthapuram and one calibrator to Satish Dhawan Space Centre (SHAR) of ISRO. Various units of ISRO require such calibrators for use in calibration of microphones used in satellite launch missions.**
- **Wind tunnel tests conducted for Vikram Sarabhai Space Centre (VSSC) include aerodynamic characterization of various launch vehicles and Crew Escape System (CES) test vehicle configuration for the ambitious Gaganyaan project. The wind tunnel tests involved various types of measurements such as force, steady and unsteady pressure measurements in the 0.6m and 1.2m trisonic wind tunnels. Various scaled down models for Crew Module (CM), Crew Escape System (CES) and CES test vehicle configurations were also designed for Gaganyaan SSLV projects.**

Special Materials Development

- **CSIR-NAL has made significant contributions in the area of special materials. The laboratory has taken up collaborative R&D work with Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum for development of three specific products, viz., (i) Aortic Stent Grafts (ASG), (ii) Atrial Septal Defect (ASD) occluder and (iii) flow diverter. These endovascular implants have been developed for minimally invasive treatments of aneurysms in thorax, brain and for closure of atrial septal defect respectively.**
- **A GMHLT – XX series Hydrostatic Level Transmitter has been developed based on GMR technology. The sensor is designed in both digital and analog interface with a wide operating range from 1.5 m to 10 m of liquid level. M/s Filpro Sensors Pvt. Ltd, Bangalore have evaluated few sensor prototypes and given satisfactory remarks.**
- **A process technology on the "Development of an Electrolyte Formulation for Electro polishing of Stainless Steel Needles" has been transferred to M/s Sutures Ltd., Bangalore for surgical needle applications on 25th September 2019. Polished needles have been handed over to cancer care India.**

Societal Mission Activities

- **CSIR-NAL continued the dissemination of 1 kW wind solar hybrid (WISH) systems to S&T institutions in and around Bengaluru and demonstration of 10 kW systems. The commitments towards an important public outreach program of CSIR, namely the Mass Housing project were successfully met through the installation of WiSH systems at CSIR-SERC, Chennai and CSIR-CBRI, Roorkee, Uttarakhand. The other achievements include the installation of a roof-top 1 kW class WiSH system at the Parala Maharaja Engineering College in Berhampur, Odisha. Keeping pace with the latest Internet of Things (IoT) technology, the data acquisition and**

monitoring of NAL's WiSH systems have been WiFi and internet-enabled.

Significant Achievements of CSIR-NAL for the year 2020-2021

Contributions to the Civil Aviation Sector

- **Preliminary Design Review (PDR) of Saras Mk2 19 seater aircraft has been completed. In the process of optimizing the configuration, various intermediate versions were studied through several Computational fluid dynamics (CFD) and wind tunnel campaigns. Performance and stability-control characteristics of the aircraft were also evaluated at every step. Constant effort has been made to develop the simulator simultaneously and aero-data is updated and evaluated by pilots at regular intervals. Air loads were estimated using CFD for structural analysis. Feasibility of operations at high altitude airfields like Leh, Kargil, Shimla, Kulu and Pakyong were studied and optimized for higher load factor. Cabin thermal analysis was carried out and oxygen requirement was fulfilled for such operation.**
- **CSIR-NAL has obtained Design Organization Approval (DOA) and Production Organization Approval (POA) under CAR 21 subpart G from Directorate General of Civil Aviation (DGCA) to carry out Hansa-NG design and production. Fabrication and assembly of all airframe and system components are completed. Static testing of Air Frame has been completed successfully. Engine ground runs were carried out successfully.**
- **With the installation of CSIR-NAL's Aviation Weather Monitoring System (AWMS), at Kempegowda International Airport (KIA), Bengaluru, the KIA has become the first airport in the country to install indigenous AWMS technology, developed by CSIR-NAL at both ends of the new runway. In addition, KIA has installed four Drishti transmissometers and has the unique honour of having NAL's 50th Drishti installed at its runway. KIA now has a total of six Made in India RVRs at both runways.**

- **Vibration measurement is the most essential requirement at low frequency excitation which is commonly used for overall health management of the aircraft. Piezoelectric (PE) accelerometers are widely used for vibration measurements for structural testing, flight testing and inflight vibration monitoring. Considering the in-house requirements, a ruggedized version (Prototype-2) of Piezoelectric (PE) accelerometer that suits the above requirements was designed and developed during this period. The developed accelerometer has been tested on SARAS PT1N, was calibrated with inflight data acquisition system and has passed environmental tests and received National Accreditation Board for Testing and Calibration Laboratories (NABL) accreditation.**

Contributions to Strategic Sector

- **CSIR-NAL's National Trisonic Aerodynamic Facility has completed 1028 blowdowns in the 1.2m and 254 blowdowns in the 0.6m wind tunnels during the year. The major users of the facility were Defence Research and Development Organisation (DRDO), Indian Space Research Organisation (ISRO) and CSIR-NAL. For Aeronautical Development Agency (ADA), wind tunnel tests were conducted on a typical combat aircraft configuration on the basic aerodynamic characteristics.**
- **CSIR-NAL continued its support to the LCA-Tejas Programme. CSIR-NAL continued to make contributions in the areas of design, fabrication and R&D of composite structures.**
- **For the Advanced Medium Combat Aircraft (AMCA) program High Cycle Fatigue (HCF) data was generated for the indigenously developed Titanium alloy Beta21S (Titan 44A) material which intended to be used in AMCA airframe structural applications in high temperature zones. Ground Vibration Testing (GVT) based flutter analysis and store separation studies carried on Mirage 2000 aircraft. Further, GVT and GVT Based Flutter Analysis of Su-30 Mk-I Aircraft for Derby Integration was addressed and clearance was provided for captive trials as part of the DOS-30 (Derby on Su 30) programme. A total of 20 configurations were considered for**

clearance. Global elastic modes of the aircraft, store modes and control surface modes were analyzed and tabulated.

- **A compact version of the MZHB that houses the accessories inside the equipment case was developed with wheels for ease of transportation. The MZHB facility was extended to Light Combat Aircraft (LCA) program for the repair of drop tank and engine bay cover.**
- **During the year 2020-21, sixteen investigations involving incidents/ accidents of aircraft, helicopters and ground equipment used for defence aircraft were referred to the laboratory for investigation by the various organizations like Indian Air Force (IAF), Hindustan Aeronautics Limited (HAL) & Ministry of Civil Aviation (MoCA). In most of these investigations, the primary cause(s) of failures could be identified and after each investigation, recommendations were suggested for prevention of similar incidents/accidents in future. Towards contribution of indigenous technology for the strategic sector in stealth technology, a multi-layered FSS-based RASORBER has been designed with a transmission characteristic within the band associated with out-of-band absorption.**

Contributions to Space Programmes

- **CSIR-NAL's Acoustic Test Facility (ATF) has completed acoustic qualification of Test Vehicle Equipment Bay (EB) for testing certain critical components of the Gaganyaan Crew Escape system. ATF also qualified the Core Base Shroud of the Small Satellite Launch Vehicle which is one of the crucial subsystems of the highly modular small satellite launcher. In addition, ATF also successfully completed the acoustic qualification of the Strap on Electro Mechanical Actuator Structure for the GSLV MKIII launcher. This would help in improving reliability and also provide advantages in payload capability in comparison with the Electro Hydraulic actuators used earlier.**
- **Further, unsteady pressure measurements were carried out on a scaled model of typical crew escape system test vehicle in the CSIR-NAL's 1.2m wind tunnel. Aeroelastic testing of**

Geosynchronous Satellite Launch Vehicle (GSLV) MkII F10 configurations were also carried out at CSIR-NAL. A 1:42 scaled aeroelastic model of F10 vehicle was successfully designed, fabricated, and wind tunnel tested to assess the transonic buffet on the vehicle.

Health Sector and Societal Mission

- **CSIR-NAL has made significant contributions in the area of Health and Societal Mission. The first contribution is the Personal protective equipment (PPE) coverall suit "HINDKAVACH" for covid-19 frontline workers and the second is the "SWASTHVAYU" a non-invasive BiPAP ventilator for treating covid-19 patients. Both the technologies have been transferred to industries for commercial production which has resulted in quick deployment of about 1500 SwasthVayu units to hospitals of NCT- Delhi, Ramgarh & Chatra-Jharkhand, Bhopal-Madhya Pradesh, Mysore, Hyderabad and more than 2 lakhs units of PPE coverall to Hindustan Latex Limited (HLL), Jaslok Hospitals etc.**
- **A cost-effective indigenous thermally compensated low-range magnetic pressure sensor for medical ventilators, environment friendly sprayable solar absorber coating and thermal insulation paint for aircraft application has also been developed by the laboratory.**
- **With an increase in the practical application of UAV's in the agricultural industry and to provide an end to end solution in the agricultural domain (from crop monitoring to pesticide spraying), CSIR-NAL has developed a modular Oct-Copter UAV system that can carry a maximum payload of 20 Kg and fly for the endurance of around 20 min. The Oct-Copter has a provision to house either a hyperspectral camera for crop health monitoring or a fertilizer. First field demonstration of NAL's Oct-Copter has been carried out for the farmers of Alur Agricultural Produce Market Committees (APMC), Bangalore.**

Significant Achievements of CSIR-NAL for the year 2021-2022

Contributions to the Civil Aviation Sector

- **The major achievement during the period was the successful maiden flight of Hansa-3 (NG) on 3rd September 2021 after obtaining special flight permit by Directorate General of Civil Aviation (DGCA). The 20-minute sortie saw the first prototype of the Hansa-3 (NG) attain a maximum altitude of 4,000 feet and a speed of 80 knots before it made a successful touch down. Further, the aircraft has successfully completed the sea level trials at Puducherry between February 19 and March 5, 2022. The aircraft was flown to Puducherry, covering a distance of 140 nautical miles in one and half hours at a cruising speed of 155 km/hr, on 19 February 2022. Successful six (6) demonstration flights of Hansa-3 (NG) were performed apart from 02 ferry flights to and fro Hyderabad during the Asia's largest civil aviation event Wings India 2022 Civil Aviation Jamboree held from 24th-27th March 2022 at Hyderabad.**

- **During the year, high fidelity simulator, anthropology studies, preliminary design review, wind tunnel testing, in-board layouts, nacelle design, Finite Element Method (FEM) structural analysis, sub system sizing, weight optimization, etc. for SARAS MK II (19 seat Light Transport Aircraft) were completed. As part of facility creation, an Open Air Engine Test Bed (OAETB) has been reestablished. The innovative design engineering like 3D platform, virtual reality, model based engineering, PLM etc., are used to cut down the design and production cycle time. Saras MK II (19 seat Light Transport Aircraft) Fuselage with Interiors, Cockpit, Cabin and ECS System has been showcased at Wings India 2022.**

- **Aircraft Prototype Manufacturing Facility at CSIR-NAL carried out the indigenous manufacturing of air-craft components, metallic tooling, wind tunnel models, certification of various subassembly and assembly jigs. The major projects carried out include extensive manufacturing of Metallic components for Hansa-(3) NG aircraft, wherein over 5000 airworthy components were manufactured apart**

from Sub-Assembly and assembly jigs, fixtures, tooling. Additionally, components pertaining to Saras aircraft programme for Simulator, Engine Test Bed, Throttle Quadrant Box assembly, Artificial feel unit, Fuselage Interiors etc., were completed.

- **CSIR-NAL successfully field demonstrated Covid-19 vaccine delivery by CSIR-NAL Octa-copter drone from Chandapura PHC to Haragadde PHC at outskirts of Bengaluru, Karnataka and from CSIR-Indian Institute of Integrative Medicine (CSIR-IIIM), Jammu to Sub-District Hospital, Marh, Jammu.**

Contributions to Strategic Sector

- **CSIR-NAL's National Trisonic Aerodynamic Facility has completed 1478 blowdowns in the 1.2m (868) and in the 0.6m (610) wind tunnels during the year. The major users of the facility were DRDO, ADA, ISRO and CSIR-NAL. During the year NAL has successfully installed and com- missioned new Wide-Angle Diffuser (WAD) replacing the 55-year-old WAD of 1.2 m tunnel. The installation work was very challenging due to the size of the component and the required tunnel axis alignment accuracies.**

- **CSIR-NAL continued its support to the LCA-Tejas Programme. CSIR-NAL has made contributions in the areas of design, fabrication and R&D of composite structures for the LCA programme. A total of 35 shipsets out of 40 shipsets were delivered to HAL by CSIR-NAL's production partner. The laboratory is actively involved in the EM design and performance analysis of LCA AF Mk-2 Radome towards critical design review (CDR). Under the control laws development, design of Unified Version for LCA Control LAW (CLAW) of single seater and trainer aircraft was completed successfully and functionality released. As regards to Automatic Take-off and Landing (ATOL) activities on naval version of LCA aircraft, development of full controller and Mode Transition Logic for ATOL demonstration, implementation and pilot evaluation in DELS was successfully completed and functionality released.**

- **CSIR-NAL has undertaken 'Technology Demonstrator High Altitude Platform (HAP) Vehicle Project' to realize a technology demonstrator research, detailed design, engineering development and manufacture of two prototypes: (a) a subscale (1:3) vehicle which would demonstrate Reynolds number equivalent flight at 3 km altitude; and (b) a full scale prototype which would demonstrate flight of 2 hours endurance at 20 km. CSIR-NAL has demonstrated form Fit Functional Version of this HAP during Wings India 2022 Civil Aviation Jamboree held from 24th-27th March 2022 at Hyderabad.**

- **A multi-layered FSS-based RASORBER has been designed with a transmission characteristic within the band associated with out-of-band absorption. CSIR-NAL has been recognized as the Coordinating Centre for stealth material development.**

- **Laboratory has developed a novel monolithic RAS technology in collaboration with CSIR-IMMT, Bhubaneshwar. The laboratory has also developed RAM paint trade marked as ADRISHYA with very good EM absorption properties. This radar absorbing paint provides a 10 dB RCS reduction over a curved surface in the frontal sector. The developed RAM paint has passed all the environmental & structural tests.**

- **Micro Gas Turbine (MGT) engine of 50 N thrust has been designed and developed indigenously. The engine mass flow rate is around 0.25 kg/s with exhaust gas temperature of around 820 K. The engine is intended to power high speed UAVs and loitering munitions. The MGT was tested for its design speed of 100,000 rpm producing thrust around 53 N. The engine was run with internal bearing lubrication circuit using a mix of Jet A1 Fuel and lube oil. The critical components of the engine are manufactured through Additive Manufacturing.**

- **The laboratory has undertaken development of technologies for Wankel Rotary Combustion Engine (WRCE) which include improved wear resistance coatings for the trochoid housing and side housings of the WRCE by thermal spraying process, development of a method-ology for the health management of the WRCE, research studies on engine noise analysis & reduction and starting system for the WRCE.**

Contributions to Space Programmes

- **During the current year, CSIR- NAL's Acoustic Test Facility (ATF) has completed acoustic qualification of Test Vehicle Base shroud, as part of the crew escape system demonstration programme. The S2V, vented inter-stage of the Small Satellite Launch Vehicle (SSLV) with the instrumentation decks was also requalified after some design changes were made in the decks to reduce the vibration input to the sensitive packages mounted on the deck. ATF also carried out a detailed study on the brackets used inside launch vehicle stages to mount acoustic sensors used to measure acoustic spectrum during flight.**

- **Further, force and moment measurements on a scaled model of typical Gaganyaan ascent vehicle were carried out in the CSIR-NAL's 1.2m wind tunnel. Since it is a human rated program, it was planned to test similar configurations in various wind tunnels to verify data consistency and repeatability. The data comparison of CSIR-NAL 1.2m tunnel with other foreign tunnel was reasonably good.**

- **CSIR-NAL has taken up a project on aeroelastic clearance of the launch vehicle in various configurations to experimentally clear the vehicle design from transonic aeroelasticity in order to ensure the safe flight of the vehicle from transonic to supersonic regime. In the first phase, the team has successfully completed the design, fabrication, instrumentation, ground and wind tunnel testing of a 1:30 scaled aero- mechanically simulated aeroelastic model of 'Gaganyaan-Test Vehicle' configuration and estimated the transonic buffet on the vehicle in terms of dynamic bending moment distribution.**

Contributions to Special Materials & Coatings

- **R&D work was carried out for development of process methodology to fabricate NiTiPd high- temperature SMA wires with targeted austenite finish (A) temperature of 200±20°C. 3D-C /SiC discs (Stator and Rotor) are made with aerospace grade carbon fibre with different fibre architectures (3D and non-woven) through CVI. The dynamometer**

tests were conducted at RCI, Hyderabad and discs are found to withstand the test conditions with lower coefficient of friction.

- **All the oxygen and NO sensors are currently imported in the country. CSIR-NAL has embarked on the indigenous development of oxygen and NOx sensing elements in collaboration with an industry. CSIR-NAL has designed and fabricated the narrowband oxygen sensor that can measure air/fuel ratios between ~14.0/15.0:1. The fabricated oxygen sensor has exhibited performance equivalent to the commercial oxygen sensor and was found to be compatible with vehicle engine control units.**

Significant Achievements of the year 2022-2023 (Upto November 2022)

Development and Certification of 19 Seater Light Transport Aircraft (LTA)

- **Evaluation of the basic ECS system functionality of ECS Test Rig commissioned at CLOCTER with existing Saras PT1N LRUs completed.**
- **Review by DGCA of Design Organization Manual with Saras Mk II included in the scope has been completed and list of Audit points received from the DGCA.**
- **Fabrication of Tractor Configuration Nacelle components for Engine Test Bed nearing completion.**
- **Inboards model version 11.2 in progress for detailed structural design/engineering.**
- **Structural detail design of Airframe, outsourced to Private Company: Reports for detailed engineering design phase (D1) - Requirements capture phase finalized and D1-phase activity completed.**
- **Fabrication of part components completed, except LH Nacelle for 1/6th scale wind tunnel powered model.**
- **Saras PT1N taxi Trials BMS implementation – Phase 1 (proportional braking): modified open circuit/short circuit detection with Hardware in loop completed. Redesigned Artificial Feel Unit completed.**

Design, Development and Certification of Hansa-Ng (New Generation Hansa Aircraft)

- **Structural test, flight test reports, design documents, revised modification leaflets, compliance document, Airplane Flight Manual (AFM), etc were submitted to DGCA for obtaining the final modification leaflet approval.**
- **Aircraft Maintenance and Repair Manual (AMRM) has been prepared.**
- **Received the final approval for all the following 13 major modification leaflets from DGCA**

  - **Design Modifications in Wing, Flap & Aileron**
  - **Design Modifications in Fuselage Assembly**
  - **Design Modifications in Horizontal Stabilizer & Elevator**
  - **Design Modifications in Fin & Rudder**
  - **Design Modifications in Main Landing Gear Design**
  - **Powerplant Installation using Rotax 912 iSc 3 Sport Engine and MT Propeller MTV-21-A-175-05**
  - **Installation of Fuel System for Rotax 912 iSc 3 Sport Engine**
  - **Implementation of Electro-Mechanical Flap Control System**
  - **Canopy Door Design Modification**
  - **Modifications in Cowling, Fairings, Baggage Tray & Fire Extinguisher Inst**
  - **Avionics System Installation**
  - **Electrical System**
  - **Aircraft Performance Characteristics with Rotax 912 iSc3 Sport Engine**

- **Draft Type Certificate Data Sheet has been prepared and sent to DGCA.**
- **RFP issued for identification of production partnership. Technical bid under progress.**

Technology Demonstrator – High Altitude Platform (HAP)
CSIR-NAL has also taken up the development of High Altitude Platforms

(HAP) for applications like broadband communication, surveillance, earth observation, climate research etc. High Altitude Platform (HAP) is a solar powered unmanned aircraft envisaged to operate at the stratosphere regime, i.e. approximately 20 km altitude, and with maximum endurance so that it can emulate a perpetual flight. The subscale model aims to evaluate the Reynold Number effects, flight mechanics, stability and control as well as avionics & autopilot performance. The functional subscale model prototype was demonstrated at Wings India 2022. HAP will be a game-changer to work as a pseudo satellite for telecommunication applications in the 5G & 6G spectrum with advantages like low data latency, high bandwidth, the flexibility of launch and low cost.

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Annexure-II

CSIR-NAL has developed medium class Beyond Visual Line of Sight (BVLOS) multi-copter Unmanned Aerial Vehicles (UAVs). The UAV is made out of light weight carbon fiber foldable structure for ease of transportation and has unique features like autonomous guidance through dual redundant micro-electro-mechanical system (MEMS) based digital Autopilot with advanced flight instrumentation systems. Directorate General of Civil Aviation (DGCA), Ministry of Civil Aviation, Govt. of India has granted conditional permission to CSIR-NAL for conducting Beyond Visual Line of Sight (BVLOS) flight trials on 13th September, 2021. CSIR-NAL's octa-copter can carry a payload loads upto 5.0 kg and 20.0 Kg with hovering endurance of 40 minutes. It can fly at an operational altitude of 500 m AGL (Above Ground Level) and at maximum flying speed of 36 kmph. Its regulatory compliance includes Directorate General of Civil Aviation (DGCA)-No Permission-No Take (NPNT), Geo fencing and digital sky with 360 degree Collison avoidance making it one of the best UAV in its class. The developed Quad-Copter is extensively used in acquiring Arial Multi-Spectral images of selected medicinal and aromatic crops covering 1,99,754 m2 area maintained by CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur.

The developed drones by CSIR-NAL have made successful field demonstrations for agri applications and last-mile medicine / vaccine delivery. CSIR-NAL's Oct-Copter UAV system that can carry a maximum payload of 20 kg and fly for the endurance of around 20 minutes has a provision to house either a hyperspectral camera for crop health monitoring or a fertilizer. First field demonstration of CSIR-NAL's Octacopter has been carried out for the farmers of Alur Agricultural Produce Market Committees (APMC), Bengaluru. In medical application, CSIR-NAL has teamed with Department of Health & Family Welfare, Govt. of Karnataka for aerial delivery of covid-19 vaccine's in remote area. The Octacopter has successfully delivered 50 vials of Covid-19 vaccines along with syringes in a

special container from Chandapura Primary Health Centre (PHC) to Haragadde PHC on 13th November 2021.

On the similar lines, CSIR-NAL has teamed with CSIR-Indian Institute of Integrative Medicine (CSIR-IIIM), Jammu and Department of Health & Family Welfare, Govt. of Jammu for aerial delivery of covid-19 vaccine's in remote border area. The Octacopter has successfully delivered 50 vials of Covid-19 vaccines along with syringes in a special container from CSIR-IIIM, Jammu to Sub-District Hospital, Marh, Jammu on 27th November 2021.

The developed multi-copter technology has been licensed to four MSMEs for exploitation in agriculture and medical applications in the country.

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