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IAF CONDUCTS SUCCESSFUL FINAL DEVELOPMENT TRIALS OF ASTRA

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IAF CONDUCTS SUCCESSFUL FINAL DEVELOPMENT TRIALS OF ASTRA

Indigenously developed missile is expected to be inducted into IAF in 2019.

Indian Air Force conducted a series of flight trials of Astra Beyond Visual Range Air-to-Air Missile (BVRAAM) from 26 September 2018 to 3 October 2018 at Integrated Test Range (ITR), Balasore, as part of final development trials of the missile.

The trials were a combination of complex tests for engagement of pilotless target in different modes of manoeuvring, off-bore sight, medium and long ranges. The missiles were telemetered for evaluation of online performance of all sub-systems especially the data link, RF seeker and proximity fuse for end-game performance. Astra has been tested six times under different launch conditions and ranges as part of the final development trial. The missile has engaged targets and all the mission objectives have been met.

With IAF's active participation, DRDO has developed the missile and integrated the weapon on Su-30 and other air platforms. Hindustan Aeronautics Limited (HAL), Nasik, has been instrumental in the modification of a number of Su-30 aircraft for Astra weapon integration and support during trials. More than 50 private and public sector industries are involved in the development and production of different sub-systems of the missile. The missile is expected to be inducted into IAF in 2019.

Raksha Mantri Smt Nirmala Sitharaman congratulated DRDO, IAF, HAL and associated industries for the successful trials.

NPOL GETS INDIA'S FIRST UNDERWATER DRONE

Naval Physical and Oceanographic Laboratory (NPOL), Kochi, received India's first commercial underwater drone EyeROV TUNA from Kerala Startup Mission. Dr Saji Gopinath, CEO, Kerala Start up Mission, handed over the underwater drone to Shri S Kedarnath Shenoy, OS and Director, NPOL, at a function at Kerala Technology Innovation Zone, Kochi.

The Remotely Operated Vehicle (ROV) has been co-developed by Young Scientists' Centre (YSC-CREST) of NPOL and M/s IROV Technologies, a startup company incubated at the Makers Village. NPOL was instrumental in providing critical technical inputs for custom development of the ROV to carry sonar payloads and achieving its aesthetic and ergonomic design.

The portable micro-class ROV would be used for underwater survey and visual inspection of submerged structures at depths up to 100 meters. The product also has provision to attach external sensors like sonar, NDT testing equipment, etc., and will be extensively utilised at NPOL for in-house research activities related to High frequency sonar pioneered by YSC-CREST.

TOT

DIBER TRANSFERS TECHNOLOGIES OF ANTI LEUCODERMA AND ECZEMA FORMULATION

Defence Institute of Bio-Energy Research (DIBER), Haldwani, transferred the technical know-how of anti leucoderma formulation and anti eczema formulation to BIPHA Drug Laboratories Pvt Ltd, Kottayam. Dr Madhu Bala, Director, DIBER, handed over the Licensing Agreement for Transfer of Technology to Shri Tinku Verghese, Director, BIPHA Drug Laboratories Pvt Ltd, on 2 November 2018. A team from BIPHA Drug Laboratories was trained on the technology at DIBER Field Station Pithoragarh.

DRDO ORGANISED CONFERENCE ON CYBER SECURITY

DRDO in association with Cyber Peace Foundation and Veermata Jijabai Technological Institute (VJTI) organised a conference on 'Cyber Security—Challenges and Innovations' at DRDO Bhawan on 29 October 2018. Dr VK Saraswat, Member NITI Aayog, inaugurated the conference.

Speaking on the occasion, Dr G Satheesh Reddy, Secretary, DDR&D, and Chairman DRDO, described cyber security as one of the biggest security challenges and stressed on bringing academia, industries and DRDO together for indigenous and innovative solutions.

Addressing the gathering, Dr Saraswat emphasized on continuous innovation to resilient to threats and to keep the space secure. Adding further, he said that cyberspace is becoming more complex and the need of indigenous solutions, in-house expertise and start up eco-system to reduce dependence on foreign products and solutions for securing our critical infrastructure and defence installations.

National Cyber Security Coordinator, Dr Gulshan Rai, stressed upon the areas of strategic importance including artificial intelligence, robotics, virtual reality and augmented reality, internet of things, which would be the backbone of the country in future.

The conference focused on the current trends, needs and future requirements of innovation in the field of cyber security and helped in understanding the challenges and the way ahead for home-grown technological research and innovation. It brought together the stakeholders working in the area to showcase their innovations and future aspects.

Air Marshal Amit Dev, DG, Air (OPS) also attended the conference. More than 100 academia and 70 start-ups participated in the conference. Various indigenous innovations in cyber security were showcased on the occasion.

DRDO DIAMOND JUBILEE ORATION

Directorate of Rajbhasha and OM, DRDO HQ, and Defence Scientific Information and Documentation Centre (DESIDOC), Delhi, jointly organised the second DRDO Diamond Jubilee Oration by Maj Gen (Dr) GD Bakshi, SM, VSM (retd) on 4 October 2018 at Dr Bhagavantham Auditorium, Metcalfe House, Delhi.

Dr Zakwan Ahmed, OS and Director General (R&M & Impl), DRDO, Dr Alka Suri, Director, DESIDOC, Dr Rajeev Vij, Sc 'G', convenor of the oration, were present on the occasion. Gen Bakshi enriched the audience

with his vast experiences at various operational levels and his ideas and thoughts. Gen Bakshi talked about how the transmitters developed by DRDO has played a pivotal role.

Dr Zakwan Ahmed appreciated relentless service and sacrifices made by Gen Bakshi and Indian Armed and Paramilitary Forces. Over 600 personnel including Directors of DRDO HQ and DRDO labs/estts of Delhi, officers and staff from various Delhi-based labs attended the oration. Dr Rajeev Vij, proposed the vote of thanks.

INDIA-US JWG OS MEET

The first meeting of Joint Working Group (JWG), Other Systems (OS), under the aegis of Indo-US Defence Technology and Trade Initiative (DTTI), was held during 9-10 October 2018 at Aeronautical Development Establishment (ADE), Bengaluru. The meeting included a facility visit to UAV and LCA Simulators and Rotary UAV lab. The US delegation was led by Dr Augustus Way Fountain III, Senior Research Scientist (Chemistry), Research and Technology Directorate, Edgewood Chemical Biological Center, US Army Research, Development, and Engineering Command and Co-Chair JWG OS with members from the Army Research Laboratory (ARL),US Department of Defense (DoD), and US Embassy at New Delhi.

The Indian delegation was led by Shri V Ashok Rangan, OS, Associate Director, ADE, and Co-Chair, JWG (OS), with members from the Integrated Defense Staff (IDS), Indian Army, Gas Turbine Research Establishment (GTRE), Centre for Artificial Intelligence and Robotics (CAIR) and Snow and Avalanche Study Establishment (SASE).

Topics of mutual collaboration and proposed project plans were discussed in the areas of UAV, image exploitation, robotics and additive manufacturing. The JWG will further progress the project plans in mutually agreed interest areas at the next JWG (OS) meeting.

DR APJ ABDUL KALAM BIRTH ANNIVERSARY

DRDE, GWALIOR

Defence Research and Development Establishment (DRDE), Gwalior, organized a one-day workshop on 'Science as a Way of Life' for school students of Gwalior to commemorate birth anniversary of former President of India Dr APJ Abdul Kalam on 15 October 2018.

The main aim of the workshop was to develop inclination of students towards science and technology and to take up science as a professional carrier. Forty-five students of higher secondary level from eight local schools participated in the workshop. The DRDE scientists delivered lectures on the scientific methods, nanotechnology for daily life and science and diseases. A short movie on DRDE activities and products was also shown to the students. Dr Sanjay Upadhyay, Sc 'F', coordinated the programme.

DRL, TEZPUR

Defence Research Laboratory (DRL), Tezpur, organised a workshop entitled 'Igniting Young Minds' to commemorate the birth anniversary of Dr Kalam at Haleswar High School, Assam, on 15 October 2018. The aim of the event was to encourage young students to develop inclination towards science and technology. About 300 students from three rural government schools, viz., Hem Baruah HS School, Dekargaon High School and Haleswar High School of Sonitpur district of Assam participated in the workshop with full zeal and enthusiasm.

A science exhibition on DRL products was also organized. Dr SK Dwivedi, Director, DRL, delivered motivational talk to the students recalling Dr Kalam's dream and contribution to the nation.

Students at DRDE on the occasion of Dr Kalam's Birth Anniversary

A students reciting poem on the occasion of Dr Kalam's Birth Anniversary at DRL

INMAS, DELHI

A mini workshop was organized at Institute of Nuclear Medicine and Allied Sciences (INMAS), for medical students to mark the birth anniversary of Dr APJ Abdul Kalam. Graduate and postgraduate medical students from various medical colleges of Delhi attended the workshop.

Dr Bhuvnesh Kumar, OS and Director, Defence Institute of Physiology and Allied Sciences (DIPAS), and Officiating Director, INMAS, gave the inaugural address and provided insight into the life of Dr Abdul Kalam. He also highlighted the role of Dr Kalam in induction of flagships programme in DRDO. Dr Rashmi Aggarwal gave a brief account of the journey of Dr Kalam, from a fisherman's son to the president of India

Dr Tarun Sekri, Sc 'G', delivered a talk on Iodine Deficiency Disorder. Dr Assem Bhatnagar, Sc 'G', talked about the role of INMAS in Mitigation

of CBRN Risk and Dr Manju Popli, Sc 'F', spoke on Role of Mammography in Prevention of Breast Cancer. Product and devices developed by INMAS for CBRN preparedness were also displayed.

ITM, MUSSOORIE

The 87th Birth Anniversary of Dr APJ Abdul Kalam, former President of India, was celebrated at Institute of Technology Management (ITM) with lot of enthusiasm. ITM employees remembered the life, career and teachings of the late President and paid homage to the legendary scientist and a great teacher by offering garlands and flowers on his bust.

ITM employees paying homage to Dr Kalam

RAISING DAY CELEBRATIONS

ASL, HYDERABAD

Advanced Systems Laboratory (ASL), Hyderabad celebrated its 17th Annual Day on 6 October 2018. Dr G Satheesh Reddy, Secretary, DDR&D and Chairman, DRDO, was the Chief Guest and Shri MSR Prasad, DS and DG (MSS), DRDO, was the Guest of Honour.

Shri G Ramaguru, Sc 'H', Chairman, Organizing Committee, welcomed the august gathering. Shri AK Singh, Sc 'F', DOMS, presented the Annual Report of ASL. Dr MRM Babu, DS and Director, ASL, in his address highlighted various achievements and future programmes of ASL. Shri MSR Prasad appreciated the dedicated work done by the employees of ASL and mentioned about technologies need to be developed in coming years. Dr G Satheesh Reddy appreciated the excellent work done by ASL and emphasized on development of advanced new technologies.

Laboratory-level DRDO Awards and mementos to employees, who completed 20, 25 and 30 years of service, were presented by the Chief Guest. Dr APJ Abdul Kalam Merit Awards and Dr APJ Abdul Kalam Welfare Awards were given to the children of ASL employees. A cultural programme was organized portraying in-house talent of ASL. Dr N Kishore Nath, Sc 'G', proposed the vote of thanks.

Inaugural ceremony of ASL Annual Day

CFEES, DELHI

Centre for Fire, Explosives, and Environment Safety (CFEES) celebrated its Annual day on 10 October 2018. Dr Satish Kumar, Director, NIT Kurukshetra and former DG (MSS) was the Chief Guest. Dr Chitra Rajagopal,

DS and DG (SAM) was the Guest of Honour.

On the occasion, laboratory-level DRDO Awards and Director's Cash Awards were given to the employees for their outstanding contributions. Besides, souvenirs were given to employees who completed 25 years of service in DRDO. Commendation certificates were also given to participants of Swachhata Hi Seva Abhiyan.

DMRL, HYDERABAD

Defence Metallurgical Research Laboratory (DMRL) celebrated its 55th Annual Day on 22 October 2018. Dr G Satheesh Reddy, Secretary, DDR&D and Chairman, DRDO, was the Chief Guest. Shri MSR Prasad, DS and DG (MSS) and Dr Samir V Kamat, DS and DG (NS&M) were the Guests of Honour. Dr Vikas Kumar, DS and Director, DMRL; Shri B Gopala Krishna, Sc 'G' and Chairman, Works Committee; Shri K Srikanth Goud, President, DEFMETLAB Workers National Union and Shri P Manohar, Vice Chairman, Works Committee were present on the occasion. Shri B Gopala Krishna welcomed the guests, invitees and the audience.

Dr Satheesh Reddy appreciated DMRL for its contributions and emphasized on the management strategies to be adopted for research and technologies in view of the demanding present scenario. The Guests of Honour also addressed the gathering.

Dr Vikas Kumar gave a report on the progress of the ongoing project and briefed about the upcoming projects. Dignitaries from Hyderabad-based sister DRDO laboratories, PCDA, MES and CCE (R&D) attended the function. Officers and staff of the laboratory participated in the event enthusiastically.

MTRDC, BENGALURU

Microwave Tube Research and Development Centre (MTRDC), celebrated its Lab

CFEES Annual Day Celebration

Dr Satheesh Reddy addressing the gathering on the occasion of DMRL Raising Day

Release of MTRDC Newsletter

Raising Day on 5 November 2018 at BEL Kalakshetra, Bengaluru. Dr Sudhir Kamath, OS and DG (MED&CoS), DRDO, was the Chief Guest. Dr G Athithan, former DG (MED&CoS) and Dr V Mahesh, Director (R&D), BEL, Bengaluru, were the Guests of Honour.

Smt Manimozhi Theodore, Director, MTRDC, welcomed the gathering. Dr SUM Reddy, Associate Director, MTRDC, presented the achievements of the year 2017 and proposed targets of the upcoming year. MTRDC's quarterly Newsletter Spandan and MTRDC Coffee Table Book were released by Dr Sudhir Kamath and Dr G Athithan, respectively. Highlight of the function was the ToT of Multi-Beam Klystron to BEL, Bangaluru.

In his address, Dr Sudhir Kamath highlighted the success of the MTRDC and proposed his vision for MTRDC in the coming years.

Dr G Athithan appreciated the achievements of MTRDC and emphasised that MTRDC should also work on solid state-based high-power microwave systems, terahertz technologies for imaging, etc.

GOLDEN JUBILEE CELEBRATIONS

As part of its Golden Jubilee Celebrations, Aerial Delivery Research and Development Establishment (ADRDE), Agra, organised an exhibition of live demonstration of paradropping of various parachutes developed by it at Malpura Dropping Zone on 20 November 2018 at Agra.

Established in 1969, ADRDE demonstrated its indigenously developed Tandem Combat Freefall System, Combat Freefall System, RAM Air Parachutes, 500 kg Controlled Air Delivery System, and prototype of Unmanned Small Airship System. Paratroopers jumped from eight thousand, five thousand and three thousand feet with the ADRDE developed systems.

Speaking to the DRDO Newsletter, Director ADRDE Shri AK Saxena, said that it is a matter of great pride that in the last 50 years ADRDE has developed a number of aerostats and parachutes including personal parachutes, motorised parachutes, recovery parachutes, brake parachutes for aircraft, emergency escape parachutes for pilots, heavy drop systems, etc., many of which have already been inducted in the Indian Armed Forces. Elaborating on the future R&D programmes of the ADRDE, Director ADRDE said that the establishment is working on crew re-entry module for the ISRO's Human Space Flight Programme design validation and system level testing of which has been completed in the Crew Module Atmospheric Re-entry Experiment.

Special attraction of the show was the para jumping by 20 young NCC women cadets from 3000 feet from AN-32 aircraft and paramotoring by the Army Adventure Wing. ADRDE also displayed autonomously guided and controlled Unmanned Small Airship System, CUSAT, being developed by the young scientists centre of the establishment. A large number of ADRDE employees and their families witnessed the show.

VIGILANCE AWARENESS WEEK

DIC, PANAGARH

DRDO Integration Centre (DIC), Panagarh, observed 'Vigilance Awareness Week' from 29 October 2018 to 3 November 2018 with the theme 'Eradicate Corruption -Build a New India'. An integrity pledge on anti-corruption was taken by the employees. They were sensitized about eliminating security breaches, vigilance and security. A webcast from DRDO HQ on "Innovation in Cyber Security" was screened for the DIC employees. Posters on the significance of vigilance and corruption were displayed at prominent places in the campus. An invited talk was delivered by Col D Chahal highlighting security awareness on using social media in the concluding session.

NPOL, KOCHI

Naval Physical and Oceanographic Laboratory (NPOL), observed 'Vigilance Awareness Week' from 29 October to 3 November 2018 to promote the awareness and relevance of vigilance against corruption. Integrity pledge on anti-corruption was taken by the employees. An invited talk focusing on the significance of anti-corruption practices and vigilance by Shri K Karthick, IPS, SP, Vigilance Anti-Corruption Bureau, Ernakulam. 'VIGILATHON 2018' a short distance run, a video show and quiz programme on vigilance and corruption and essay competitions on the above theme were conducted to create awareness among the employees, students and society.

RCI, HYDERABAD

As part of the week, Research Centre Imarat (RCI) organised a marathon walk. An oath was taken by all the employees on the integrity and on anti-corruption.

Vigilance Awareness Week (from top) at DIC, NPOL, and RCI

RASHTRIYA EKTA DIWAS

DMRL, HYDERABAD

On the occasion of National Unity Day, DMRL organised a unity run on 31 October 2018 in which several employees participated enthusiastically. The run started from Works Committee Office and culminated at the Main Building via Wet canteen, Powder Metallurgy Plant and Tamhankar Auditorium.

DRL PARTICIPATES IN TAWANG FESTIVAL 2018

Defence Research Laboratory (DRL), Tezpur, participated in the Tawang Festival 2018 during 26-29 October 2018 and exhibited Life Sciences products and technologies including farm produced fresh vegetables cultivated at DRL Detachment. Shri Kiren Rijiju, Hon'ble Union Minister of State for Home Affairs inaugurated the Festival. Shri Pema Khandu, Hon'ble Chief Minister of Arunachal Pradesh also visited the DRL stall. Dr AK Singh, DG (LS), DRDO and Dr SK Dwivedi, Director, DRL, visited the DRL stall on 27 October 2018 and interacted with the local civil populace.

DIBER GETS ISO 9001:2015

Defence Institute of Bio-Energy Research (DIBER), Haldwani, received ISO 9001:2015 certification for R&D and support activities. The certificate has been awarded by M/s RIR Certification Private Limited, Gurugram. Dr AK Singh, OS and DG (LS) handed over the ISO certificate to Dr Madhu Bala, Director, DIBER.

INDIGENOUS DEFENCE TECHNOLOGIES SHOWCASED IN INDIA-INTERNATIONAL SCIENCE FESTIVAL

Ministry of Science and Technology and Earth Sciences in association with Vijnana Bharati organized 4th India-International Science Festival 2018 with the theme 'Science for Transformation, at Indira Gandhi Pratishthan, Lucknow, during 5-8 October 2018. The goal of the science festivity was to help the youth develop century skills with a focus on scientific knowledge, creativity, critical thinking, problem solving and teamwork.

The IISF-2018 was inaugurated on 6 October 2018 by Hon'ble President of India, Shri Ram Nath Kovind, in the presence of Dr Harsh Vardhan, Hon'ble Union Minister of Science and Technology, Ministry of Environment, Forest and Climate Change and Ministry of Earth Sciences; Chief Minister of UP, Yogi Adityanath; Secretary Department of Biotechnology, Dr Renu Swarup; and Secretary, Department of Science and Technology, Professor Ashutosh Sharma.

Dr G Satheesh Reddy, Chairman DRDO and Secretary, DDR&D addressed the gathering of young scientists and highlighted the products and technologies of DRDO.

Centre for Fire, Explosive and Environment Safety (CFEES), was the nodal agency for organizing DRDO pavilion in the Mega Science, Technology and Industry Expo. Dr Harsh Vardhan inaugurated the DRDO pavilion. Twenty DRDO laboratories showcased state-of-the-art indigenous military systems and technologies portraying India's march towards self-reliance in the cutting-edge defence technologies and realization of Hon'ble Prime Minister's 'Make in India' initiative. The wide-ranging display included models of latest Aeronautical systems, Armament and Combat Engineering System and Communication System. Displayed models of Long Range Surface-to-Air Missile, NBC Permeable Suit Mk-IV, Ship-Launched Heavy-Weight Torpedo, Water Mist Aerator for Water Conservation, Instant Fire Detection and Suppression System (IFDSS) for Armoured Fighting Vehicles (AFVs), Fire Protective Suit, Hazardous Chemical Decontamination Apparatus and Eco-friendly Materials for Environment Safety gave the pavilion a magnificent look.

DRDO was awarded "Second Best Exhibitor Award" for its products and technologies.

Dr Harsh Vardan at DRDO Stall

COURSE ON SCIENTIFIC, INDUSTRIAL, PRODUCT PHOTOGRAPHY & MULTIMEDIA TECHNOLOGIES

Defence Scientific Information and Documentation Centre (DESIDOC), Delhi, organised a three-day course on "Scientific, Industrial and Product Photography and Multimedia Technologies" under the Continuing Education Programme (CEP) of DRDO, during 10-12 October 2018. Dr Rajeev Vij, Sc 'G', Course Coordinator, in his welcome address, explained the need and purpose of this CEP and asked the participants to be interactive. Shri Rajan Bhatnagar, Course Director, briefed about the schedule of the course.

Dr Alka Suri, Director, DESIDOC, inaugurated the CEP and elucidated the importance of such need-based courses. Topics covered during the course included: Portrait Photography, Scientific Product Photography—Ambient Lighting, Industrial Photo Shoot–Studio Lighting, Architecture Photography, Light, Dimensions, and Equipment for Outdoor Photography, Image Enhancement Techniques, Filters and Special Effects, Candid Photography: Tips and Techniques, Production of Video Magazine, etc.

Participants of the course on Scientific, Industrial and Product Photography and Multimedia Technologies

WINTER TRAINING PROGRAMME IN SIACHEN SECTOR

DIHAR organised a two-day winter training capsule on vegetable cultivation and animal husbandry for the defence personnel deployed in Siachen sector along with local farmers of Nubra valley during 12-13 October 2018. The programme covered various aspects of winter season vegetable cultivation, micro-farming techniques, animal husbandry and poultry rearing practices. On-ground demonstration of the agro-animal technologies was given to the participants. The participants were given variety of saplings and seeds for propagation at their respective Unit locations.

COURSE ON RECENT TRENDS IN DATA ANALYTICS

Defence Institute of Physiology and Allied Sciences (DIPAS), Delhi, conducted a three-day CEP course on 'Recent Trends in Data Analytics' during 9-11 October 2018. Dr Bhuvnesh Kumar, OS and Director, DIPAS, welcomed the participants and briefed them about the objectives and purpose of the course. The course aimed to update the knowledge of the participants on the recent data analytics tools and techniques and also its applications in the field of medical health and scientific research.

Dr AK Bhateja, OS and Director, DFMM, inaugurated the CEP and stressed on the need for data analytics in the field of defence applications. The topics covered during the course were: Basics of Clinical Data Analytics, SAS, Biological Data Analysis, Defence applications of Data Analytics, Fundamental of R and Python, Machine Learning in Data Analytics, Applications of ML in Health analytics, Applications of Deep Learning Techniques in Health Care Analytics, etc.

Twenty-nine participants from different DRDO labs attended the course. Dr YK Sharma, Sc 'F', Dr R Sugadev, Sc 'E', Dr Pankaj Khurana, Sc 'D' and Ms Pavitra Rani Gautam, Sc 'D', were the Course Coordinators.

TRAINING ON CAMOUFLAGE FOR E-CAM-48 COURSE

Training on Camouflage for E-CAM-48 course for Service Officers was organised during 15-18 October 2018 at Defence Laboratory, Jodhpur (DLJ). The course was attended by 20 Service Officers from Army, Navy and Air Force.

Shri Ravindra Kumar, Director, DLJ, inaugurated the course. Eleven lectures covering various aspects of camouflage were delivered during the course. Practical training on Sigma Mk II software was also given to the participants and laboratory visits were organised.

Shri NK Agarwal, Sc 'G', was the Course Director and Shri RK Khatri, Sc 'E', was the Course Coordinator.

NBCD SPECIALIZATION COURSE FOR INDIAN NAVY & COAST GUARD

Defence Research and Development Establishment (DRDE), Gwalior, organised 'NBCD Specialization Course (61.0350) for Indian Navy and Coast Guard Officers' during 10-12 October 2018. The course intended to update the knowledge of the Service officers on recent advances in the field of Chem-Bio Emergencies. Twenty-five Naval officers and two Coast Guard officers attended the course.

Dr DK Dubey, Director, DRDE, inaugurated the course and briefed about the significance of the course. Dr ASB Bhaskar, Sc 'F', briefed about the objective of the course and its contents. Lecture covered topics like detection, physical protection, decontamination and medical counter measures against CW and BW agents. Demonstrations covered live agent animal exposures. Participants also underwent training on latest physical protection methods using Mk-V NBC Suite and visited High Containment Facility of DRDE to get familiarized with the ongoing R&D activities pertaining to high risk BW agents.

COURSE ON ADVANCES IN PYROTECHNICS

A three-day CEP course entitled 'Advances in Pyrotechnics' was organised by HEMRL during 8-10 October 2018. The course was inaugurated by Shri SK Sinha, IOFS, GM, Ordnance Factory, Dehu Road. Shri KPS Murthy, OS and Director, HEMRL presided over the inaugural function. The course covered current trends and future avenues including Electro-Explosive Devices, Smokes, Flares, Illuminating, Chaff and Delay devices. Exclusive lectures on safety, certification and modelling for pyrotechnic stores were also deliberated during the course. Practical demonstrations were given about laser initiated pyro-devices, friction sensitivity testing, impact sensitivity testing, radiometer and measurements, firing of flares, etc.

TRAINING PROGRAMME ON EXPLOSIVES & FIRE SAFETY

A training programme on 'Explosives and Fire Safety' was conducted from 22 October 2018 to 24 October 2018 for new recruits of HEMRL. The course was inaugurated by Shri Rajiv Narang, OS and Director, CFEES, Delhi, who delivered a talk on 'Explosive Safety'. Shri Rajiv Narang highlighted the importance of safety in processing and storage of explosive.

Thirteen lectures were delivered by the experts on various aspects of safety. The topics covered included explosives safety, electrical safety, fire safety, hazard analysis techniques, accident case studies, occupational safety and health, and safety aspects of pyrotechnics, gun propellants, solid rocket propellants, high explosives, etc. A fire demo was also arranged during this course.

Participants of the course on Explosives and Fire Safety at HEMRL

WORKSHOP ON EMERGING TRENDS IN MICROELECTRONICS & INFORMATION SECURITY

A one-day workshop on "Emerging Trends in Microelectronics and Information Security" was organised on 10 October 2018 at Swarn Jayanti Bhawan, Solid State Physics Laboratory (SSPL), Delhi, by the Micro Electronic Device, Computational Systems and Cyber Security Cluster (MED,CoS&CS) towards evolving new engineering, architectural design and establishing information security thinking.

The inaugural talk was delivered by Dr G Athithan, DS and DG (MED,CoS& CS) followed by eight talks delivered by academic experts from IIT, IISc and other esteemed institutions on various verticals of the technologies related to Microwave, Microelectronics

and Information/Cyber Security. The workshop facilitated dialogue on cooperation between academia and DRDO to enhance the knowledge and take-up new project activities in futuristic technologies.

PERSONNEL NEWS

APPOINTMENTS

DG (MED & COS), DRDO

Dr Sudhir Kamath, OS and Director, Microwave Tube Research and Development Centre (MTRDC), Bengaluru, has taken over as DG of DRDO Micro Electronic Devices and Computational Systems (MED&CoS), DRDO w.e.f. 1 November 2018. He holds MTech and PhD in Electronics Engineering from Institute of Technology, Banaras Hindu University, Varanasi. He joined MTRDC as Sc 'B' in September 1985 and took over as Director, MTRDC on 1 July 2015.

Dr Kamath has handled various responsibilities as Project Manager, Group Head, Divisional Head & Project Director and has contributed to a number of projects and technologies for development of Microwave Tubes such as Gridded Electron Guns, Collectors, Electronic Power Conditioners etc. He has been involved in the design and development of various types of Helix- and Coupled-Cavity TWTs for Defence Systems. As a Project Director he has guided a team to successfully develop Microwave Power Modules (MPM) and MPM-based Transmitters for Radar, EW and Communications systems. A number of MPMs developed are in regular production.

He is the former President of Vacuum Electronics Devices and Applications Society (VEDAS), Senior Member-IEEE, Fellow-Institution of Electronics and Telecommunication Engineer (IETE), Fellow-Vacuum Electron Devices and Applications Society (VEDAS), Member-Magnetic Society of India (MSI) and Society of EMC Engineers India. He was General Chair for International Symposium on Microwaves-2016 (ISM-16), General Chair for National Conference on Emerging Trends in Vacuum Electronic Devices & Applications-2015 and Co-Chairman, Local Organizing Committee for the IEEE-International Vacuum Electronics Conference (IVEC)–2011.

He is the recipient of the DRDO Agni Award for Self-reliance in the year 2003 and 2013. He has also received DRDO Scientist of the Year award in 2009 for his significant contribution in the field of Microwave Tubes. He has also received a number of awards at the laboratory level including the Laboratory Scientist of the Year Award in 2003. He has authored/co-authored more than 25 papers in national/ international journals and conferences.

DIRECTOR, ASL

Dr M Rama Manohara Babu, DS, Programme Director, Agni, has joined as Director, Advanced Systems Laboratory (ASL), Hyderabad, w.e.f. 5 October 2018. He obtained MS in Mechanical Engineering from JNTU, Hyderabad in the year 1994 and PhD from College of Engineering, Andhra University in Marine Engineering on Acoustic Emission Testing of Carbon Epoxy Filament Wound Pressure Vessels in the year 2014.

Dr MRM Babu started his career in DRDL in Project Agni as Sc 'B' in 1986. In the initial phase he contributed in the development, fabrication of airframe structures, testing and evaluation and integration in the capacity of System Manager and subsequently as Deputy Project Director.

He took over as Technology Director of Reliability and Quality Assurance Group in ASL in the year 2001 and established Total Quality Management System encompassing the entire life cycle of design, development, production and deployment of Strategic Missile Systems of Agni series. In 2012, he was appointed Technology Director of Strategic Systems Centre.

He is founding Director, Centre for Advanced Systems (2014 to 2016) and was responsible for the production of missile systems. Later he was anointed Programme Director, Agni Programme consisting of eight Project Directors across different DRDO labs covering various configurations of Agni strategic missile systems, ground support systems, and sites. As Programme Director he was responsible for the design, development, production and deployment of long-range strategic missile systems of various Agni variants.

He is presently member of Indian National Society for Aerospace and Related Mechanisms, Member of Aeronautical Society of India, Member of Society for Aerospace Quality and Reliability and also Associate Member of Institution of Engineers (India)

He was awarded Agni Award for Excellence in Self-reliance, DRDO Award for Pathbreaking Research/ Outstanding Technology Development, and Commendation Certificate from SA to RM.

HIGHER QUALIFICATION ACQUIRED

Smt Chandrika Kaushik, Director Directorate of Interaction with Services for Business (DISB), DRDO HQ, has been awarded the Doctorate of Philosophy (PhD) degree by the Indira Gandhi National Open University

(IGNOU), Delhi, for the thesis entitled "Leveraging Public Private Partnership (PPP) for Achieving Self-Reliance in Defence."

Shri Pothuri Rambabu, Sc 'E' of RCMA (Materials), CEMILAC, has been awarded PhD in Metallurgical and Materials Engineering by National Institute of Technology, Warangal, for the thesis entitled "Tensile, Mode I and Mixed Mode I/III Fracture Behaviour of Aerospace Grade Aluminum Alloy AA 2219 Forgings."

Shri Thomas KA, Sc 'D', Naval Physical and Oceanographic Laboratory (NPOL), Kochi has been awarded PhD by Cochin University of Science and Technology (CUSAT), Kochi, for the thesis entitled "Studies on Fringing Field Impedance Spectroscopy as a Tool for the Evaluation of Underwater Encapsulants."

AWARDS

VISVESVARAYA AWARD

On the occasion of 51st Engineer's Day, the Government of Telangana and the Institution of Engineers (India), Telangana State Centre presented Sir Mokshagundam Visvesvaraya Award –2018 to Dr G Madhusudhan Reddy, OS and Associate Director, DMRL, in recognition of his innovative and outstanding work in the field of materials joining and surfacing technologies.

FELLOW OF EMSI

Dr DV Sridhara Rao, Sc 'G', of DMRL has been conferred as a Fellow of the Electron Microscope Society of India (EMSI).

SPORTS ROUNDUP

DLJ WON DRDO NORTH ZONE BADMINTON CHAMPIONSHIP 2018

Defence Laboratory, Jodhpur won the major titles in the DRDO North Zone Badminton Championship 2018 including North Zone Team Championship, organized at Aerial Delivery Research and Development Establishment (ADRDE), Agra, during 3-6 October 2018. Nineteen team from North Zone participated in the tournament.

In addition to the Team Championship, DLJ won open singles title and Player of the Tournament Award in the tournament.

Besides, five players of DLJ were selected for the North Zone team of DRDO to play in the DRDO National Tournament.

SECRETARY DDR&D INAUGURATES RESEARCH & INFRASTRUCTURE FACILITIES AT DMRL

Dr G Satheesh Reddy, Secretary, DDR&D and Chairman, DRDO, inaugurated three major technical and infrastructure facilities, viz., Centre for Structural Integrity and Product Engineering (C-SIPE), Technical Facilities Phase-II at Armour Technology Centre (ATC), Devatalagutta and Chemical Vapour Impregnation (CVI)-Chemical Vapour Deposition (CVD) Facility at Defence Metallurgical Research Laboratory (DMRL), Hyderabad.

Dr Samir V Kamat, DS and Director General (NS&M), DRDO, and Dr Vikas Kumar, OS and Director, DMRL, were also present on the occasion.

DG (LS) INAUGURATES DRDO TRAINEE HOSTEL FOR SKILL DEVELOPMENT IN NORTH EAST

Dr AK Singh, OS and DG (LS), DRDO inaugurated DRDO Trainee Hostel for local entrepreneurs and resource persons DRL Detachment at Salari in West Kameng district of Arunachal Pradesh on 25 October 2018. The hostel would be utilised for the personnel undergoing skill development and entrepreneurship in food processing of locally available fruits and vegetables under the DRDO TD Programme Arunodaya. Dr SK Dwivedi, Director, DRL, was also present on the occasion. Dr Ajitabh Bora, Sc 'D' presented an overview of the R&D activities undertaken at Salari. Col I Aslam, Project Manager of PMU [CCE (R&D) East], Tezpur made a presentation on the various infrastructure works being implemented in DRL Detachments at Salari and Tawang. DG (LS) also inaugurated an approach road to the DRL Detachment.

DR SR RANGANATHAN LECTURE HALL INAUGURATED AT ITR

Dr BK Das, OS and Director, ITR, inaugurated Dr SR Ranganathan Lecture Hall at Knowledge Centre on 26 October 2018. The newly built lecture hall has a capacity to accommodate 70 candidates for training. The Hall has been equipped with state-of-the-art facilities and would be utilised for various training programmes, workshops within the premises.

Dr BK Das also inaugurated a Book Exhibition at Knowledge Centre to mark the occasion. Shri Santosh Munda, Sc 'D', Head Knowledge Centre, welcomed the august gathering and appraised them about the exhibition. Director, ITR in his inaugural speech advised all to develop reading habit. More than 1500 latest edition of books on different subjects, viz., radar, optoelectronics, telemetry, communication, fire safety and management were put on display to update scientific community of ITR.

FOUNDATION STONE LAYING OF BIOFUEL RESEARCH COMPLEX AT DIBER

Foundation stone for Biofuel Research Complex at Defence Institute of Bio-Energy Research (DIBER), Haldwani, was laid down by Dr AK Singh, OS and DG (LS) on 12 November 2018. Dr Madhu Bala, Director, DIBER, briefed about the complex, which is coming up in around 14 acres and would comprise technical building and sheds to house state-of-the-art facilities for research and development of Biofuels and Bioenergy. Basic amenities such as electricity sub-station, roads, water supply, etc., are part of the project. Shri PK Gupta, Dy CCE R&D (Central) briefed about the project specifications, timeline and other details.

Dr AK Singh also visited and reviewed various R&D activities and existing facilities of DIBER. He also inaugurated three new state-of-the-art laboratory facilities, viz., HPTLC, Fluorescent microscope and Real-Time PCR.

ADVANCED LIFE SUPPORT SYSTEMS FOR AIR FORCE

This column covers the pathbreaking and successful projects and programmes of the DRDO.

The Advanced Life Support System (ALSP) was taken up to match the state-of-the-art systems by employing innovative and advanced technologies for enhancing combat efficiency of pilots flying fighter aircraft and helicopters. Under the project, prototypes have been realized and technologies like On-Board Inert Gas Generation using polymeric hollow fibre membranes, High Purity Oxygen Concentrator using Zeolite and advanced carbon molecular sieves, Electronic Demand Breathing using miniature sensors and actuators, Oxygen Sensing using miniature Zirconia sensor element based on Amperometric and Tunable Diode Laser-based Absorption Spectroscopy (TDLAS) principles, enhanced protective equipment—Advanced Anti G Suit, Lightweight Helmets having advanced visor locking mechanism have been demonstrated.

On-Board Inert Gas Generating System

Aircraft fuel tank fire protection has been the focus of intensive research for many years because of the importance of protecting the crew and increasingly valuable assets against fuel tank fires and explosions. Without a protection system, the fuel/air mixture in the fuel tank ullage is susceptible to ignition due to combat damage, lightning, electrostatic discharges and electrical arcing resulting from equipment malfunction.

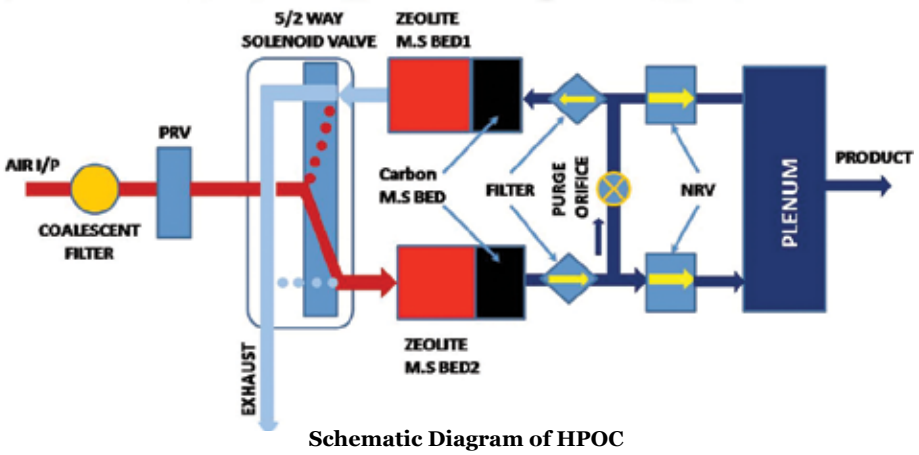
To mitigate the potential for a catastrophic fuel tank ullage explosion, it is necessary to reduce the oxygen concentration from the 21 percent that is present in a standard volume of air to 9.8 percent at sea level when inerting fuel tank ullage with nitrogen gas. This provides the aircraft and its crew with the necessary protection from an enemy threat of up to and including 23 mm high explosive incendiary rounds.

Prototype of OBIGGS

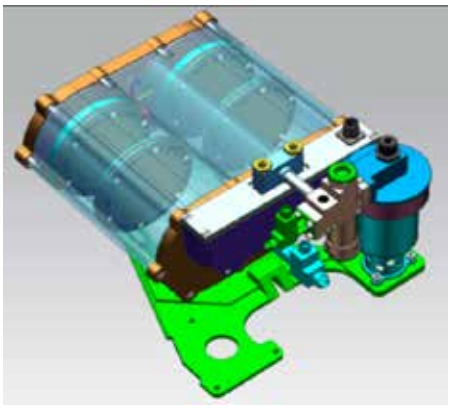
OBIGGS is a full-time inert gas generation system based on hollow fibre membrane systems. Membranes separate gases by the principle of selective permeation across the membrane wall. The OBIGGS utilizes cooled engine bleed air as the air source and then separates the inlet air into a nitrogen-enriched product air stream and a slightly oxygen-enriched vent stream (through a physical and not chemical based process). The vent stream is then routed either overboard or into an unpressurised bay to maximize the effectiveness of the OBIGGS system. The OBIGGS approach has significant advantages in that it will provide an aircraft fuel system with continuous and unlimited supply of nitrogen gas while being maintenance free.

High Purity Oxygen Concentrator

On-board oxygen generation using molecular sieves has become an accepted method of providing breathable oxygen on military aircraft. These systems employ Pressure Swing Adsorption (PSA) technology for separating oxygen from air. Nitrogen is preferentially adsorbed in molecular sieves at moderate pressures, thereby concentrating oxygen. Control of oxygen concentration is achieved either by diluting product gas by cabin air or by varying one of the concentrator operating like cycle time or product flow. However, the inability of current zeolite molecular sieves to discriminate between oxygen and argon results in oxygen purity limitation of 93 per cent to 95 per cent as both oxygen and argon concentrate in these oxygen generators. Currently, zeolites of Type



Schematic Diagram of HPOC



Prototype of HPOC

A (5A) and Type X (13X- NaX, LiX) are used in on-board oxygen generators. High purity Advanced Molecular Sieve Oxygen Concentrator that generates up to 99 per cent oxygen directly from engine bleed air has been reported and such concentrators employ in series a zeolite molecular sieve for nitrogen adsorption and a carbon molecular sieve for argon separation from oxygen-argon mixture received from the zeolite bed. The process of oxygen concentration developed by DEBEL involves four adsorbent beds, two containing zeolite molecular sieves and two containing carbon molecular sieves. The technology for military aircraft can also find applications in industries and hospitals.

TDLAS-based Oxygen Sensor for OBIGGS/Aircraft Ullage Space

The monitoring of oxygen in the fuel-air mixture along with fuel tank inerting is an important requirement for preventing the explosion of the fuel tank. TAUS was proposed based on DEBEL's earlier R&D activity on TDLAS based oxygen sensor for OBOGS, with relevant modifications including the developed Multi-pass Optical Gas Cell to meet the critical requirements of monitoring oxygen in the ullage space as oxygen sensors based on other physical principles will not work effectively inside the fuel tank environment.

Indigenous Multi-pass Optical Gas Cell for TAUS

Design & Development of Zirconia-based Amperometric Oxygen Sensor

The Zirconia Amperometric Oxygen Sensor (ZAOS) has the advantage of working without reference gas, has a linear response, besides being small in size/weight and consumes reduced electrical power (approx. 8 W). The developed sensor uses Oxygen ion conducting solid state electrolyte Yttria stabilized Zirconia.

Prototype of Zirconia Amperometric Oxygen Sensor

Electro-Pneumatic Demand Breathing Regulator

The current mechanical or pneumatic oxygen regulators used by the aircrew have inherent lag and inertia due to the various mechanical linkages and backlash errors. The development of EPDBR, wherein the breathing functions are controlled in an electro-mechanical way, will result in a significant performance improvement of the breathing regulators over a wide input pressure range thereby improving the breathing characteristics offered to the aircrew. The prototype of EPDBR has been realized and tested in the lab.

Enhanced Protective Clothing and Devices

The role of an effective life saving equipment and protective clothing has long been recognised to play a key role in the battlefield operations and in hostile environments. It is proposed to exploit the recent advances in the field of technical textiles to develop protective clothing for the benefit of the armed forces. A few of the significant developments are outlined below.

Flame Retardant Common Anti G Suit

FR Anti G Suit is an inflatable garment designed to enhance the +Gz tolerance of pilots of fighter aircraft and ameliorate the effects of the enhanced acceleration on the fighter pilot by applying counter pressure to

Block Diagram of EPDBR

Anti-G Suit

the abdomen, thighs and legs of the pilot in proportion to the acceleration forces. The counter pressure prevents excessive pooling of the blood in the lower portions of the body and thereby enhances the pilot's threshold levels by 1 to 1.5 G. Combination of high performance materials for outer garment and bladder ensure high levels of thermal protection on exposure to high intensity heat (Thermal Protective Performance rating of minimum 45). FR Anti G Suit is made in 5 sizes for use by the pilots flying various aircraft including MiG, Mirage 2000, Jaguar, Su-30 and Hawk. The product has undergone extensive qualification tests, user trials and airworthiness certification by RCMA (A/C) leading to the induction by IAF.

Flame Retardant Inflatable Life jacket with Helicopter Emergency Egress system for Indian Navy

Inflatable life jacket is a life saving device to save the aircrew from drowning when they crash land into the sea and consists of three sub-assemblies viz., inflatable stoles, inflating devices and provision for housing personal locator beacon and its accessories. The ILJ is also intended to house HEED

FR ILJ

for pilots operating helicopters. HEED is an emergency device to facilitate emergency egress from a submerged helicopter and provides breathing for duration of 4-5 min. The product has undergone extensive qualification tests, user trials and airworthiness certification by RCMA (A/C) leading to the induction by IAF. Five hundred thirty FR ILJ have been productionised by the approved ToT holder.

Custom and Modular Designed Aircrew Integrated Helmets

The current integrated helmets and pressure breathing oxygen masks are developed in limited number of sizes

Custom and Modular Helmet

to fit the entire population of the pilot leading to misfit and side-slips that are not desirable for the Helmet Mounted Display and Sighting (HMDS) which are routinely being used in military flying. The objective is to provide the custom fit to individual pilot by exploiting the advanced scanning and the rapid prototyping technologies. The custom helmets will be provided with the optical quality visors having ballistic and LASER protection.

Project Innovations and Impact

A number of new technologies have been realised during the project implementation. The inert gas generation using innovative hollow fibre membrane technology will meet the survivability need of the "avoid damage" link of the aircraft survivability chain as it applies to the aircraft fuel tank. This solution has minimum aircraft integration impact, negligible long-term maintenance and lifecycle costs. The removal of argon from oxygen, argon mixture in HPOC, will be a breakthrough technology in Life Support Systems for fighter aircraft.

The development of Tunable Diode Laser Absorption Spectroscopy-based Oxygen Sensor for OBIGGS is a state-of-the-art technology and will go a long way to mitigate aircraft accidents due to fuel tank explosion. The miniature Amperometric Oxygen Sensor for monitoring the Oxygen concentration in the breathing gas supplied by OBOGS to the fighter pilot reduces power consumption and weight penalty.

The electro-mechanical means of controlling the breathing functions will greatly enhance breathing comfort and combat efficiency of pilot under all adverse scenarios.

The RF weld-able, lightweight PU coated nylon fabric bladders developed for use in the anti-G suit has impacted

by reducing the bladder fabrication time to about 15 minutes as compared to the fabrication time of three days required earlier for Neoprene coated nylon fabric. This has enabled faster bulk production and induction of 1288 (for all fleets of aircraft, viz., MiG series, Mirage 2000, Jaguar, Su-30 and Hawk) bladders into the IAF. Further, the performance of PU bladder fabric is much superior in terms of bond strength and has a high weight to performance ratio.

Aircrew helmet especially customised for pilot's head size and shape will provide a comfort fit and prevent any side slips, which is a pre-requisite for helmet mounted display and sighting (HMDS). The comfort is improved while retaining the current protection levels.

Further, the world over, various agencies in this field are carrying out R&D activities to make the life support systems smarter by adjusting their performance based on the physiological inputs from the user. Such technologies can be employed only when various LRUs such as the breathing regulators are controlled in an electro-mechanical fashion. Hence, to establish a firm foundation and keep abreast of emerging technologies in this highly complex and multidisciplinary field, it is essential to widen the base and initiate programmes dictated by newer technological challenges.

Current Status

The engineering prototypes of OBIGGS and HPOC have been realized. All the performance parameters for OBIGGS have been achieved. The development of OBIGGS is a proven solution and has minimal aircraft integration impact and negligible long term maintenance and lifecycle costs. Indigenous Multipass Optical Gas Cell has been designed and tested. Oxygen concentration measurements in the range of 2 per cent O2 to 21 per cent O2 have been carried out, using indigenous Multipass Optical Gas Cell, within an accuracy of 0.5 per cent O2.

Prototype of the Zirconia Amperometric Oxygen sensors have been fabricated and tested. I-V characteristics carried out for multiple sensors, for Oxygen concentrations in the range 21 per cent to 95 per cent O2, for operating temperatures in the range 550 °C to 700 °C.

The design of the Form, Fit and Functional (FFF) model of EPDBR meeting the space and weight constraints of the ejection seat and also meeting the environmental requirements as per aerospace standards is in the final stages of completion.

The products, FR Anti G Suit Mk VI and FR ILJ, have undergone extensive qualification tests, user trials and airworthiness certification by RCMA (A/C) leading to the induction by IAF and IN. Twelve hundred eighty-eight FR Anti G Suit Mk VI have been successfully productionised by the approved ToT holder. Further, 530 FR ILJ have been successfully productionised by the approved ToT holder.

The Aircrew Helmet and Oxygen Mask are being subjected to the wind blast test at NAL Bangalore. The Helmet Mask has withstood the wind blast of 600 KEAS. The helmet was evaluated for impact (MIL-DTL-87174A), penetration and noise attenuation (MIL-DTL-83425A) as per MIL-STD. The Helmet Mask is under trial for ground evaluation by aircrew.

DEVELOPMENT PARTNERS

A number of government R&D institutions, academia, and public and private industries helped DRDO in achieving the breakthrough in the technology. The OBIGGS and HPOC have been designed and developed in-house. CSIR-NCL, Pune, is involved in development of Hollow Fibre Membrane and Zeolite Molecular Sieves.

NAL, Bangalore and C-MET, Thrissur, have contributed in the development of 4YSZ tapes that is being used in ZAOS for fabrication of sensors. Centre for Nanoscience and Engineering (CeNSe), IISc, Bangalore has helped in development of micro-heater. SJCAR, Kanchipuram, was associated to develop Control and measurement electronics unit for the sensor.

M/s Trident Pneumatics Pvt Ltd, Coimbatore, is involved in fabrication and assembly of the system. The firm is actively participating and fully geared up for taking over the technology.

The fabrication of portable electronics of the TDLAS sensor is being carried out by Dexcel Electronics Design Pvt Ltd. The compact gas cell is being fabricated through M/s Optics and Allied Engineering Pvt Ltd.

IIT, Gandhinagar, has been an academic partner in the development and provided the algorithm for extracting the sample gas (Oxygen) parameters, its concentration, temperature and pressure from the WMS waveforms.

M/s Arnaf Futuristic Technologies Pvt Ltd, Delhi, is the development partner for Anti-G Suit and FR ILJ.

M/s Shakti Enterprises, Faridabad and M/s Vega Safety Systems Pvt Ltd, Belgavi, are the development partners for the customized Aircrew Integrated Helmets.

VISITORS TO DRDO LABS/ESTTS

DIPR, Delhi

Air Vice Marshal GS Bedi, VM, VSM, Assistant Chief of Air Staff (Personnel Officers) and Gp Capt AK Chaudhary, VM, Gp Capt (PO 3) visited DIPR on 26 October 2018. AVM overviewed the work and assignments being done by DIPR and witnessed the Mental Work Load lab. He appreciated the research work being under taken in DIPR and looked forward for more association.

Air Vice Marshal GS Bedi being briefed about DIPR activities

DL, Jodhpur

Maj Gen SS Suhag, ADG EME (A), visited Defence Laboratory (DL) on 25 October 2018 along with Brig KP Krishna Kumar, Brig EME, HQ 12 Corps, Col SS Grewal, Director EME (CV) and Col Samarjit Singh, CO 12 Corps Zone (Wksp). Director DLJ briefed the visitors about the charter of duties, core competence, technical infrastructure, technical activities and achievements of the laboratory. Maj Gen Suhag deliberated on the specific requirements of Armed Forces related to nuclear radiation measuring and surveillance equipment, mock ups, Soil Stabilisation techniques, and PCM Cool Vest developed by DLJ.

Maj Gen SS Suhag being briefed about Laundry Monitoring System

DRL, Tezpur

Dr AK Singh, OS and DG (LS), DRDO, visited Defence Research Laboratory (DRL) and HQ 4 Corps on 30 October 2018 and interacted with GOC 4 Corps Lt Gen GS Sangha, SM, VSM, on the various aspects of the DRDO TD Programme Arunodaya and the combat efficiency of troops posted in the Tawang sector. He also interacted with Maj Gen MU Nair, Chief of Staff, HQ 4 Corps. Dr Singh, also addressed the Officers of Higher Command Course from Mhow and senior officers of HQ 4 Corps. He also reviewed ongoing DRDO projects at forward formations in Tawang sector.

Dr AK Singh, DG (LS), being felicitated by GOC 4 Corps Lt Gen GS Sangha

SWACHHATA HI SEVA ABHIYAN

CFEES, DELHI

Swachhata Hi Seva (SHS)-2018, a two-week long drive on cleanliness was observed at Centre for Fire, Explosive and Environment Safety (CFEES), under Swachh Bharat Mission. The other DRDO labs, viz., INMAS, DIPR, SSPL and DIPAS also participated in the drive. Waste management programmes like paper waste recycling, waste composting, biomas waste recycling, lectures on cleanliness, health and e-waste management were organised. Cleanliness drive was organised from RAC to INMAS covering the Lucknow Road and DRDO premises. Awareness programme on cleanliness was conducted in Sarvodaya Kanya Baal Vidyalaya and special children school, Massoom. Street play/folk dance/ songs were performed on swachhata to create awareness among students. Poster, essay and quiz competitions on swachhata were also organized. Winners of all events were awarded.

CVRDE, CHENNAI

The 4th anniversary of Swachh Bharat Mission, SHS, was observed in Combat Vehicles Research and Development Establishment (CVRDE) with the theme "Sanitation is Everyone's Business." SHS was launched by Shri Praveen Kumar Mehta, DS and DG (ACE) in the presence of Shri V Balamurugan, OS and Director, CVRDE. The programme began with swachhta pledge. Posters on Swachh Bharat were displayed to create awareness about the cleanliness in the working place and health hygiene.

Quiz and Poster competition sunder the topic "Water Sanitation and Hygiene" were conducted. Around 33 ton of material and 875 documents were condemned and weeded our as per standard operating procedures. Invited lectures on "Sanitation is Everyone Business" and "Good Sanitation Practices" were delivered by Shri NSV Arivarasan, former Deputy Chief Labour Commissioner.

DL, JODHPUR

SHS campaign was organised to create awareness on maintaining cleanliness. Dr Manoranjan Patri, Director, DLJ, along with employees carried out pruning in and around laboratory premises. Banners in various places in the laboratory were displayed to create awareness. 'Shram Daan' was conducted to clean the areas near by electrical installations, drainage channels along the boundary. An essay competition was organized on the topic "Swachh Bharat – Swasth Bharat."

DMRL, HYDERABAD

Works Committee, DMRL conducted a "Swachh Bharat" Campaign on 5 October 2018. Officers and staff enthusiastically participated in Swachhta Abhiyaan inside the laboratory premises.

READERS' VIEWS

(Your feedback is important to us as it gives scope for improvement and serve the organisation in a better way)

1. **Name of the Establishment:**_____

2. **How would you rate the *DRDO Newsletter* as a medium to adequately present DRDO developments?**

   Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Satisfactory ☐

3. **How would you rate the technical contents of the *Newsletter*?**

   Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Satisfactory ☐

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The Editor, DRDO Newsletter, DESIDOC, DRDO, Metcalfe House, Delhi - 110 054

DRDO HARNESSING SCIENCE FOR PEACE & SECURITY

CHAPTER 4: MARCHING FORWARD

The article is 33nd in the Series of extracts of the monograph, "Defence Research & Development Organisation: 1958-1982", by Shri RP Shenoy, former Director of Electronics and Radar Development Establishment (LRDE).

INTRODUCTION

In Chapters 2 and 3, the growth of the DRDO as an Organisation under the helmanship of four eminent physicists of the country has been traced. The DRDO was established in 1958 and it took nearly a decade to transform a collection of individuals and laboratories with diverse backgrounds into a single Organisation dedicated to apply science and technology to the needs of the Services.

The first decade was one of learning by doing and the response of the DRDO was to meet the short-term requirements of the Services in their effort to maintain, substitute or improve the major weapons, sensors and other equipment procured from outside sources. In the second decade, the goal was set higher to undertake contemporary system development. Competence to do so would be generated through activities related to technological advancements of the components/sub-systems as well as of the system. In this chapter, the progress made by some of the major laboratories of the Organisation towards the goal are described.

AERONAUTICS

In the field of aeronautics, there are two laboratories namely the Gas Turbine Research Establishment and the Aeronautical Development Establishment, both at Bangalore which are focussed on aircraft as the weapon platform.

Gas Turbine Research Establishment

The charter of GTRE is to carry out research on gas turbine components with a view to design and develop gas turbine engine systems to meet military aircraft requirements. In the early 1960's, the development programme launched by M/s HAL for Hindustan Fighter HF-24 (Marut) had generated a lot of enthusiasm and hope that this was a forerunner of many more opportunities and challenges to come in aeronautics in the future. Though the proposals for the development of HF-24 was based on an engine which was being developed abroad, the move to shift GTRE to Bangalore to be nearer to the aircraft manufacturer was to prepare itself for the day when it might be called upon to develop a power plant for a military aircraft. Thus, at this stage, the main thrust of GTRE was in the building of the facilities and expertise in the area of gas turbine engine technology.

However, as the aircraft development progressed at HAL, the promised engine from abroad did not materialise. The development of the engine was halted by the foreign manufacturer and M/s HAL had the difficult choice of either abandoning aircraft development programme or searching for an available engine and accept the shortfall in the performance of the aircraft. HAL chose the latter and a search was on for a suitable candidate engine. GTRE was called upon to re-engineer one of the possible options, namely RD-9F of Russian origin. But the aircraft designers preferred the Orpheus-703, a non-reheat engine which rendered HF-24 at best an underpowered transonic fighter. DRDO through GTRE offered to take on the development of a reheat for the Orpheus–703 whereby the engine could boost its thrust by another 35 per cent for short crucial bursts. For GTRE, it involved the design, development, and fabrication of prototypes of the complete reheat system including changes on the basic Orpheus engine. Theoretical studies and experimental verification of the efficiency of combustion, flame stability, fuel injection, regulation, resistance of parts to high temperature, etc., were carried out to develop the reheat system. The success of a limited reheat system tried out on Marut led to the development of the full reheat system. Eleven prototypes were built and extensive bench testing of over 2000 hr under extreme tropical conditions were also carried out. The reheat engine Orpheus 703-1700K was fitted on a prototype of Marut and over 250 hr of flight testing were completed. These tests indicated that there was substantial improvement in performance by the Orpheus 703-1700K engine in respect of takeoff, run, climb, acceleration, maximum speed etc., over the non-reheat engine. The Orpheus 703-1700K engine was type certified in December 1973.

The aircraft designers launched the Marut MK II design around the GTRE-developed Orpheus-703 reheat engine. Subsequently GTRE took up the design and development of Orpheus 703-2000 K reheat system. Two prototypes were built, successfully bench tested for about 160 hr and then subjected to simulated flight testing at the Altitude Test Facility in UK. It was a pity that

the crash of the redesigned Marut fitted with the reheat engine in one of the early development flights put an end to the Marut Mk II and the Orpheus reheat engine programme. As future events unfolded, the crash of Marut MK ll was a set back of catastrophic proportions to aeronautics in India because no effective programme for the development of either civil or military aircraft would be undertaken in the country till the mid of 1980's. The silver lining for GTRE was the valuable experience and inputs its scientists gained for design of afterburners and in the area of altitude testing of aero gas turbine engines. Simultaneously with these activities, GTRE made an attempt to improve the dry performance of HF-24 by integration of a transonic compressor to the basic engine without resorting to afterburner operation. It involved the replacement of the first stage of the seven-stage subsonic compressor of the Orpheus with a transonic stage and matching it with the rest of the subsonic stages. The integrated research engine system was test run in May 1974 and the results were encouraging.

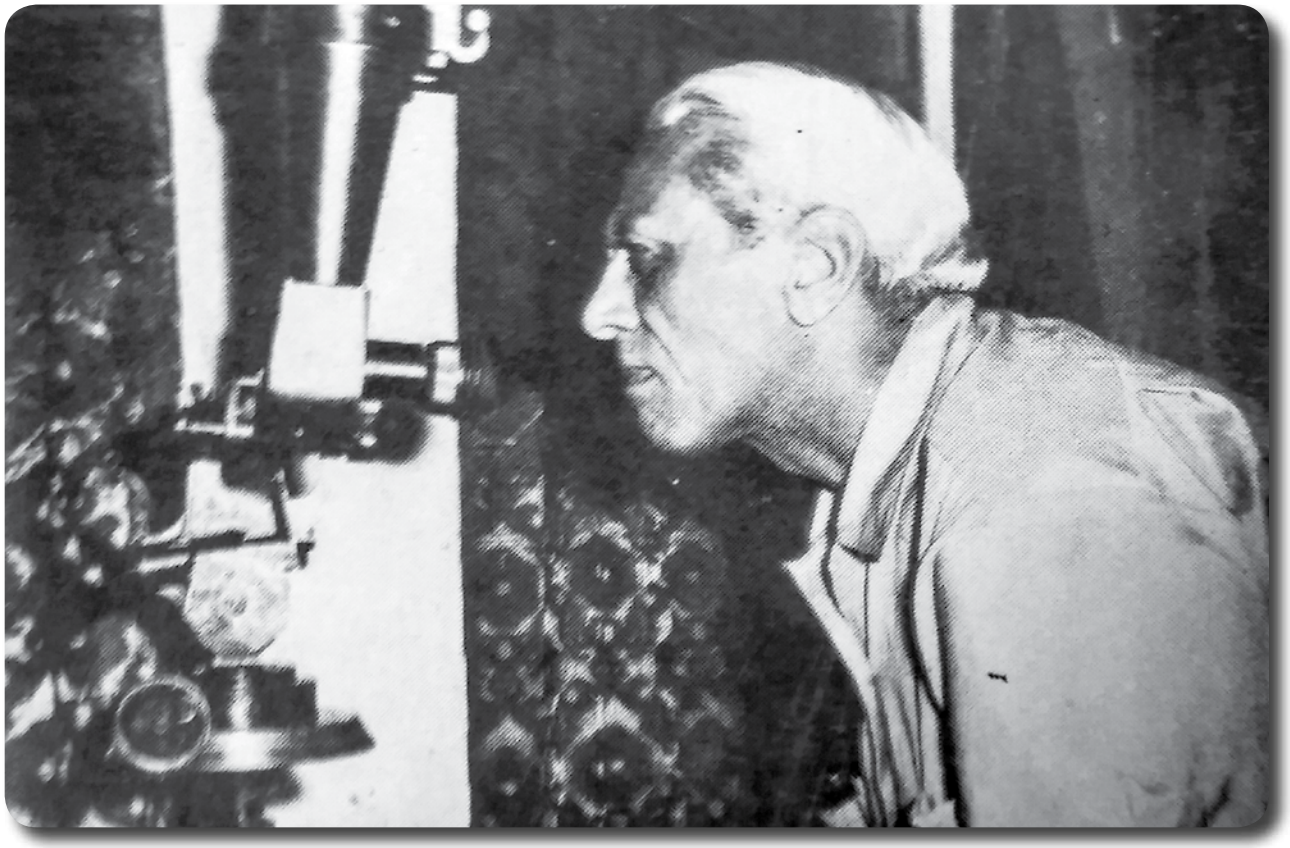
Besides these tasks, the scientists carried out a number of basic studies and initiated work on a number of competence building tasks for gas turbine components so that an adequate technology and knowledge base would be built and would enable GTRE to evolve a family of advanced gas turbine technology engines that could meet the whole range of power plant requirements of futuristic military aircraft. The absence of a viable aircraft development programme was considered as an opportunity to build up the competence and expertise in this area so that some time in the future when a programme for design of aircraft materialised, an indigenous engine system could be developed to power the aircraft. Such a project would however, have a long gestation period of the order of 10-15 years, and hence the engine system would run the risk of becoming obsolescent unless there was an ongoing research and development programme on the major components of the engine system. The long time scale and massive investment was necessary because the process of development involved technology exploration, concept proving, design validation, full-scale development, and finally qualification of the engine system. In 1974, GTRE embarked upon the programme of designing and developing an engine demonstrator programme based on a straight jet engine. The plan called for development of important subsystems incorporating latest technological advances for the demonstrator engine. The laboratory adopted the flat rating concept presently well known as high throttle ratio so that the configured engine system would be optimised at high forward speed and high ambient temperatures.

The starting point for design and development of the gas turbine engine would be aerothermodynamic design followed by mechanical/ structural design. Once the aerothermodynamic design for a given performance requirement was arrived at, techno-economic considerations would play a major part in deciding the structural design. Thus, the aerothermodynamic design of the main components, namely, compressor, combustor, turbine, afterburner, etc., was the first step to obtain the gas flow path geometry of the engine4. Therefore research and development activity focussed on the important areas of compressors, combustors, highly loaded turbines, engine control systems, catalytic ignition systems and heat transfer with the objective of putting a full-scale gas turbine engine. In addition to being a technology demonstrator, the engine would also serve as a technology acquisition and design validation test bed.

In the decade of the 1970's GTRE had to tackle the problems related to materials, hardware manufacture, measurement, testing and validation of hardware. Side by side with development, establishment of aerothermodynamic experimental facilities for validation of the major components singly as well as the full-scale engine, was taken up. Single-stage and multi-stage compressor testing, low pressure air supply, high mass flow high pressure air supply, and full-scale engine facilities capable of measuring up to 15000 kg thrust with afterburner and with automatic data acquisition, were planned and implemented. A cost- effective setup was designed using grounded aero engine exhaust to drive the free power turbines so that adequate motive power for testing of components was available. A number of component test facilities were established in areas of compressors, turbines, combustors, reheat systems, fuel system, nozzle system, and so on. An expandable fabrication facility which would be versatile, sophisticated and technologically in the forefront, in order to process materials from conventional to exotic was also included in the plan. In collaboration with Bhabha Atomic Research Centre (BARC), National Aerospace Laboratory (NAL), HAL Koraput Division, electron beam welding, electrochemical spark erosion techniques with precision casting blades were implemented. The setting up of such a facility was fully justified later when it turned out that an estimated 0.25 million to 0.5 million man-hours were invested for manufacture of about 25,000 components per engine. As these engine components would have to pass the stringent military standards of performance, durability and life, several highly specialised test facilities, such as vibration fatigue, thermal fatigue, shaft torsional fatigue, gear box test facilities, which were unique to engine development and which were not commercially available, were also planned, designed in-house and rigged up for design validation and mandatory certification tests. Computational facilities were also set up and commercial standard software packages were purchased to facilitate computation of stress and life of the engine components.

To be continued...

DOWN THE MEMORY LANE



Prof. Satish Dhawan the then Chairman of Space Commission & ISRO inspecting Deep Observation Binocular Periscope at IRDE.

The then Prime Minister speaking on the occasion of 19th DRDO Directors' Conference.

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