

DRDO

NEWSLETTER



A Monthly Bulletin of Defence Research
and Development Organisation

www.drdo.gov.in

JUNE 2018

VOLUME 38

ISSUE 6



RAKSHA MANTRI PRESENTS DRDO AWARDS

INNOVATION >> p08

TOT >> p09

EVENTS >> p10

FOCUS >> p14

VISITS >> p24

DRDO IN PRESS >> p27

CONTENTS

JUNE 2018
VOLUME 38 | ISSUE 6
ISSN: 0971-4391

COVER STORY

04

Raksha Mantri reiterated Indigenization of Defence Equipment



INNOVATION

08

DRDO Robotics & Unmanned System Exposition



TOT

09

EVENTS

10

INFRA DEVELOPMENT

13

FOCUS

14

HRD ACTIVITIES

17

SOCIAL ACTIVITIES

23

VISITS

24

DRDO SERIES

25

DRDO IN PRESS

27

DOWN THE MEMORY LANE

28

Editor-in-Chief: Dr Alka Suri
Managing Editor: B Nityanand; Editor: Manoj Kumar
Editorial Assistance: Biak Tangpua and Naresh
Multimedia: RK Bhatnagar
Printing: SK Gupta, Hans Kumar; Distribution: Tapes Sinha, RP Singh
For feedback, please contact: director@desidoc.drdo.in
Tel: 011-23902403; 23902474; Fax: 011-23819151

LOCAL CORRESPONDENTS

Ahmednagar: Lt Col. AK Singh, Vehicles Research & Development Establishment (VRDE); **Ambarnath:** Dr Susan Titus, Naval Materials Research Laboratory (NMRL); **Balasore/Chandipur:** Shri Santosh Munda, Integrated Test Range (ITR); Dr AK Sannigrahi, Proof & Experimental Establishment (PXE); **Bengaluru:** Shri Subbukutti S, Aeronautical Development Establishment (ADE); Smt MR Bhuvanewari, Centre for Airborne Systems (CABS); Smt Faheema AGJ, Centre for Artificial Intelligence & Robotics (CAIR); Ms Tripty Rani Bose, Centre for Military Airworthiness & Certification (CEMLAC); Smt Josephine Nirmala M, Defence Avionics Research Establishment (DARE); Shri Kiran G, Gas Turbine Research Establishment (GTRE); Shri KM Veerabhadra, Electronics & Radar Development Establishment (LRDE); Dr Vishal Kesari, Microwave Tube Research & Development Centre (MTRDC); **Chandigarh:** Dr HS Gusain, Snow & Avalanche Study Establishment (SASE); **Chennai:** Shri PD Jayaram, Combat Vehicles Research & Development Establishment (CVRDE); **Dehradun:** Shri Abhai Mishra, Defence Electronics Applications Laboratory (DEAL); Shri JP Singh, Instruments Research & Development Establishment (IRDE); **Delhi:** Shri Ashutosh Bhatnagar, Centre for Personnel Talent Management (CEPTAM); Dr Rajendra Singh, Centre for Fire, Explosive & Environment Safety (CFEES); Dr Dipti Prasad, Defence Institute of Physiology & Allied Sciences (DIPAS); Dr Dolly Bansal, Defence Institute of Psychological Research (DIPR); Shri Navin Soni, Institute of Nuclear Medicine and Allied Sciences (INMAS); Shri Anurag Pathak, Institute for Systems Studies & Analyses (ISSA); Dr Indu Gupta, Laser Science & Technology Centre (LASTEC); Ms Noopur Shrotriya, Scientific Analysis Group (SAG); Dr Rupesh Kumar Chaubey, Solid State Physics Laboratory (SSPL); **Gwalior:** Shri RK Srivastava, Defence R&D Establishment (DRDE); **Haldwani:** Dr Atul Grover, Defence Institute of Bio-Energy Research (DIBER); **Hyderabad:** Shri Hemant Kumar, Advanced Systems Laboratory (ASL); Shri Pramod K.Jha, Centre for Advanced Systems (CAS); Dr JK Rai, Advanced Numerical Research & Analysis Group (ANURAG); Shri JP Singh, Centre for High Energy Systems & Sciences (CHESS); Shri ARC Murthy, Defence Electronics Research Laboratory (DLRL); Dr Manoj Kumar Jain, Defence Metallurgical Research Laboratory (DMRL); Dr K Nageswara Rao, Defence Research & Development Laboratory (DRDL); Shri N Venkatesh, Research Centre Imarat (RCI); **Jagdalpur:** Dr Gaurav Agnihotri, SF Complex (SFC); **Jodhpur:** Shri Ravindra Kumar, Defence Laboratory (DL); **Kanpur:** Shri AK Singh, Defence Materials & Stores Research & Development Establishment (DMSRDE); **Kochi:** Shri S Radhakrishnan, Naval Physical & Oceanographic Laboratory (NPOL); **Leh:** Dr Dorjey Angchok, Defence Institute of High Altitude Research (DIHAR); **Mussoorie:** Dr Gopa B Choudhury, Institute of Technology Management (ITM); **Mysuru:** Dr M Palmurugan and Shri NV Nagraj, Defence Food Research Laboratory (DFRL); **Pune:** Dr (Mrs) JA Kanetkar, Armament Research and Development Establishment (ARDE); Dr Vijay Pattar, Defence Institute of Advanced Technology (DIAT); Shri AM Devale, High Energy Materials Research Laboratory (HEMRL); Shri SS Arole, Research & Development Establishment (Engrs) [R&DE (E)]; **Tezpur:** Dr Jayshree Das, Defence Research Laboratory (DRL); **Visakhapatnam:** Dr (Mrs) V Vijaya Sudha, Naval Science & Technological Laboratory (NSTL)

Cover: RM presenting Titanium Trophy to Director DMSRDE, Kanpur

FROM THE DESK OF THE CHAIRMAN



Dr S Christopher

CHAIRMAN

Defence Research & Development Organisation

&

SECRETARY

Department of Defence Research & Development

Dear friends,

The show goes on, characters change. Each one of us in this great organisation, play our part and move on. What the organisation has achieved, name, fame and reputation is the result of dedication put in by each one of us. We are duty bound to ensure that DRDO attains greater heights in the time to come. Remember “Nothing is Impossible”.

The month gone by saw many important events. “DRDO Awards” recognised the hard and exemplary work put in by our scientists. These torch bearers are the future of DRDO and the guiding light for others to emulate. Keep up the good job. ‘NavRachna’ saw the best of the best ideas emerging. This is the beginning of our relentless efforts to get new, dynamic, implementable and futuristic ideas for use by our defence forces. The curtain comes down on DRDO Robotics and Unmanned System Exposition (DRUSE) with eye-opener entries pan-India students. My complements for smooth conduct of such a mega event. “Young Scientist Meet” as usual was bubbling with young confidence, with sparkles in the eyes of all our youngsters. A major milestone was achieved with the life extension and indigenous sub-systems trials of BrahMos missile. Kudos to the well deserving team. A major and commendable effort was the release of the “DRDO Product Portfolio” by the DPI in a very short time-span. My complements to the Director, Directorate of Public Interface (DPI), and his team for the job done very well.

Friends, ‘Media’ plays an important role in creating awareness about an organisation and maintain its reputation. I expect each one of you to forward your achievements, important activities shaping the future of technology, to DPI, duly vetted by your cluster head, for forwarding to media. The nation should know that we are working 24x7, leaving no stone unturned, to provide best to our defence forces. Wishing you all a satisfying time ahead.

Jai Hind.

RAKSHA MANTRI REITERATED INDIGENIZATION OF DEFENCE EQUIPMENT



Hon'ble Raksha Mantri presenting Silicon Trophy 2016 to Dr BK Das, Director, Integrated Test Range

Hon'ble Raksha Mantri (RM) Smt Nirmala Sitharaman reiterated indigenization of the defence equipment if India was to be a manufacturing hub for Defence products. Indigenization has got to be on the top of the agenda as manufacturing cannot be done continuously and constantly with borrowed technology and hence that is where DRDO's Research and Development plays a very critical role, she said. RM was speaking at the DRDO Awards 2016 and 2017 Ceremony held at DRDO Bhavan on 14 May 2018.

Congratulating all the awardees,

Smt Sitharaman said, "DRDO has been making steady progress and probably talking less where they actually should be talking a lot more about their achievements". She enunciated the 'Make in India' in her statement, and called upon every stakeholders to actively participate in the campaign.

Raksha Mantri gave the awards to various DRDO scientists for their outstanding contributions. Some of the prominent awardees included: Dr VK Saraswat, former SA to RM, Secretary Department of Defence R&D (DDR&D), and DG, DRDO who received DRDO Lifetime Achievement Award-2017;

Dr Vasudev Kalkunte Aatre former SA to RM, Secretary DDR&D, and DG, DRDO who received DRDO Lifetime Achievement Award-2016, and the SA to RM, DS and DG (Missiles and Strategic Systems) Dr G Satheesh Reddy who received Technology Leadership Award- 2016.

Dr S Christopher, Chairman DRDO, and Secretary DDR&D e-launched the NavRachna and released DRDO@60 Portfolio on the occasion. The function also witnessed handing over of technologies developed by DRDO to three firms. Dr Christopher, in his address, shared the success story and



posited the achievements of DRDO in the recent past and encouraged scientists to continue the good work. He congratulated the awardees and reminded them to always keep the team-spirit alive.

DRDO also celebrated National Technology Day on the occasion. Two invited speakers, Shri Nitin Sharma, Scientific Analysis Group (SAG) and Dr Manjit Singh, DS and Director Terminal Ballistics Research

Laboratory (TBRL), delivered talks on “The Emerging Defence Technologies and Research Initiatives in DRDO”, and “Shakti-98: My Experiences and Chronology”, respectively.

THE AWARDEES

Award	Year 2016	Year 2017
DRDO Lifetime Achievement Award	Dr Vasudev Kalkunte Aatre , former SA to RM, Secretary, DD R&D, and DG DRDO	Dr Vijay Kumar Saraswat , former SA to RM, Secretary, DD R&D, and DG DRDO
Technology Leadership Award	Dr CP Ramanarayanan , DS & DG (Aeronautical Systems) Dr G Satheesh Reddy , DS & DG (MSS), and SA to RM	Dr P Sivakumar , DS and Director Combat Vehicles Research & Development Establishment (CVRDE) Dr Ashim Kumar Mukhopadhyay , OS, Defence Metallurgical Research Laboratory (DMRL)
Scientist of the Year Award	Shri Patrick D’Silva , Sc ‘G’, Defence Research & Development Laboratory (DRDL) Dr Manju Lata Gupta , Sc ‘G’, Institute of Nuclear Medicine and Allied Sciences (INMAS) Dr Madhusudan Pal , Sc ‘F’, Defence Institute of Physiology & Allied Sciences (DIPAS) Ms Navneet Gaba , Sc ‘F’, Scientific Analysis Group(SAG) Dr Dev Vrat Kamboj , Sc ‘F’, Defence Research & Development Establishment (DRDE) Shri PVS Ganesh Kumar , Sc ‘G’, Naval Science Technological Laboratory (NSTL) Shri Sanjay Chaudhuri , Sc ‘F’, Vehicles Research Development Establishment (VRDE) Shri VK Dixit , Sc ‘G’, Armament Research & Development Establishment (ARDE) Dr Vemuri Madhu , Sc ‘G’, Defence Metallurgical Research Laboratory (DMRL) Shri Anindya Biswas , Sc ‘G’, Research Centre Imarat (RCI) Shri YST Raju , Sc ‘G’, Combat Vehicles Research and Development Establishment (CVRDE) Shri BS Reddy , Sc/Engg ‘G’, Aeronautical Development Agency (ADA)	Dr Kandikattu Siva Kumar , Sc ‘G’, Defence Metallurgical Research Laboratory (DMRL) Smt Sunita Devi Jena , Sc ‘G’, Defence Research & Development Laboratory (DRDL) Dr Rahul Bhattacharya , Sc ‘G’, Defence Research & Development Establishment (DRDE) Shri Sudhir Khare , Sc ‘G’, Instruments Research & Development Establishment (IRDE) Shri RD Misal , Sc ‘G’, Aerial Delivery Research and Development Establishment (ADRDE) Shri S Pazhanikumar , Sc ‘F’, Combat Vehicles Research & Development Estt. (CVRDE) Dr Manu Korulla , Sc ‘G’, Naval Science & Technological Laboratory (NSTL) Shri Dilip Yammanuru , Sc ‘G’, Aeronautical Development Establishment (ADE) Shri Saumendra Nath Datta , Sc ‘F’, Centre for High Energy Systems & Sciences (CHESS) Dr Manmohan Parida , Sc ‘G’, Defence Food Research Laboratory (DFRL) Shri Praveen Kumar Srivastava , Sc ‘F’, Snow & Avalanche Study Estt (SASE) Dr Gurudutta Gangenahalli , Sc ‘G’, Institute of Nuclear Medicine & Allied Sciences (INMAS)



Award	Year 2016	Year 2017
Scientist of the Year Award	Shri Jaikumar Venkatraman , Sc 'G', Electronics & Radar Development Establishment (LRDE) Shri APVS Prasad , Sc 'G', Aeronautical Development Establishment (ADE) Smt R Sheena Rani , Sc 'G', Advanced Systems Laboratory (ASL)	Dr SC Bhattacharyya , Sc 'G', Advanced Centre for Energetic Materials (ACEM) R Venugopal , Sc 'G', Advanced Systems Laboratory (ASL) Smt U Jeya Santhi , Sc 'G', System Planning Implementation Centre (SPIC)
Academy Excellence Award	Prof SR Chakravarthy , IIT, Chennai	Prof V Ramgopal Rao , IIT, Delhi
Best Techno Managerial Services/ Popular Science Communication Award	Shri Ajay Singh , Chief Executive, DCW&E, DRDO HQ and his team Shri Gopal Bhushan , Sc 'G' and Director, Defence Scientific Information and Documentation Centre (DESIDOC) and his team	Shri Anil Kumar Aggarwal , Sc 'G' & Director, Extramural Research & Intellectual Property Rights (ER&IPR), DRDO HQ and his team Shri Manish Bhardwaj , Sc 'G' and Director, Directorate of Public Interface (DPI) and his team
Silicon Trophy	Integrated Test Range (ITR)	Centre for Air Borne System (CABS)
Titanium Trophy	Defence Materials & Store Research & Development Establishment (DMSRDE)	Solid State Physics Laboratory (SSPL)
DRDO Award for Path Breaking Research/Outstanding Technology Development	Dr Seema Vinayak , Sc 'G' and Dr Renu Tyagi , Sc 'G', Solid State Physics Laboratory (SSPL), and their team Shri Faisal Khalid , Sc 'F', Naval Physical & Oceanographic Laboratory (NPOL), and his team	Dr Suman Roy Choudhary , Sc 'G', Naval Materials Research Laboratory (NMRL), and his team Smt V Prameela , OS, Defence Research & Development Laboratory (DRDL)
Agni Award for Excellence in Self-Reliance	Dr Manjit Singh , DS, and Director, Terminal Ballistic Research Laboratory (TBRL) and his Team Shri M Raghavendra Rao , Sc 'G', Defence Research & Development Laboratory (DRDL) and his team Shri MW Trikande , Sc 'G', Vehicles Research & Development Establishment (VRDE) and his team Shri S Ramakrishnan , Sc 'F', Electronics & Radar Development Establishment (LRDE) and his team Shri MV Rajasekhar , Sc 'F', Research Centre Imarat (RCI), and Shri Prashant T Rojatkar , Sc 'G', Armament Research & Development Establishment (ARDE) and their team Shri VS Radha Krishna , Sc 'G', Defence Electronics Research Laboratory (DLRL) and his team Shri S Kedarnath Shenoy , OS and Director, Naval Physical and Oceanographic Laboratory (NPOL), and his team	Shri MH Rahaman , DS & former DG, Technology Management (TM) and his team Dr Shailendra Vasant Gade , OS, Armament Research & Development Establishment (ARDE) and his team Dr Binay Kumar Das , OS and Director Integrated Test Range (ITR) and his team Shri Sushil Raina , Sc 'G', Microwave Tube Research & Development Centre (MTRDC) and his team Shri P Jayapal , OS and Chief Executive, Centre for Military Airworthiness & Certification (CEMILAC) and his team Dr Manoj Gupta , OS, High Energy Materials Research Laboratory (HEMRL) and his team Shri SM Bhawe , Sc 'G', Naval Science & Technological Laboratory (NSTL) and his team Ms Shashikala Sinha , Sc 'G', Research Centre Imarat (RCI) and her team



Award	Year 2016	Year 2017
DRDO Award for Performance Excellence	<p>Shri A Joseph, OS, Defence Research & Development Laboratory (DRDL) and his team</p> <p>Shri M Ugender Reddy, OS, Research Centre Imarat (RCI) and his team</p> <p>Shri KPS Murthy, OS, High Energy Materials Research Laboratory (HEMRL) and his team</p> <p>Shri Rajiv Narang, Sc 'G', Centre for Fire, Explosives and Environment Safety (CFEES) and his team</p>	Dr RS Pundir , OS and Director, Defence Electronics Application Laboratory (DEAL) and his team
Special Award for Strategic Contribution	<p>Shri Arun Agarwal, Sc 'G', Terminal Ballistics Research Laboratory (TBRL) and his team</p> <p>Shri Vishnu Chandra Jha, Sc 'G', System Planning Implementation Centre (SPIC) and his team</p>	<p>Shri PK Mehta, DS & DG (ACE), Advanced Centre for Energetic Materials (ACEM) and his team</p> <p>Shri Amod Mathur, Sc 'G', System Planning Implementation Centre (SPIC) and his team</p>
Defence Technology Absorption Award	M/s Jain Agro Food Products Pvt. Ltd and M/s Amado Tools M/s SMPP and M/s Tirven Industries Pvt. Ltd.	M/s Godrej & Boyce Mfg. Co. Ltd and M/s Lakshmi Machine Technologies & Engineering Industries Ltd and M/s Lakshmi Machine Works Ltd.
Defence Technology Spin-Off Award	Research & Development Establishment (Engineers), Defence Bioengineering and Electro-medical Laboratory (DEBEL) and Centre for Air Borne Systems (CABS)	Defence Food Research Laboratory (DFRL) and Gas Turbine Research Establishment (GTRE)
Best Innovation/Futuristic Development	Smt D Anuradha , Sc 'F', Electronics & Radar Development Establishment (LRDE) and her team	Shri Anup Lal Shah , Sc 'G', Centre for High Energy Systems & Sciences (CHESS)

**DRDO NEWSLETTER
CONGRATULATES ALL
THE AWARDEES.**

DRDO ROBOTICS & UNMANNED SYSTEM EXPOSITION

As part of its Diamond Jubilee Celebrations, DRDO organised DRDO Robotics and Unmanned System Exposition (DRUSE) for Indian engineering students. The exposition is an open platform to popularize and synergise the national talent in the areas of robotics and unmanned systems for defence applications. The competition focuses on generating innovative ideas and novel concepts for development of robotics and unmanned systems for some of the challenging operational requirements and needs of the Indian armed forces.

Around 1088 proposals were received and screened at 1st level for plagiarism, quality of proposals in terms of scope, relation of problem being addresses to the selected themes, clarity of solution offered, innovation, originality and reliability. After 1st level of screening, 162 teams were declared qualified on 31 January 2018 for the 2nd level of screening planned at six zonal centres to facilitate wide participation from engineering students all over the country.

SOUTH ZONE DRUSE

The 2nd level screening for 30 qualified proposals was carried out by the Centre for Artificial Intelligence and Robotics (CAIR) during 28-29 March 2018. Out of the 30 teams, five teams were selected for 3rd level screening. Smt Manimozhi Theodore, Director, CAIR, distributed certificates and cheques to all the 30 teams.

NORTH ZONE DRUSE

Laser Science and Technology Centre (LASTEC) organized North Zone DRUSE during 31 March and 1 April 2018 at IIT Delhi. Thirty teams from various engineering colleges of North Zone participated and showcased their



Smt Manimozhi Theodore taking keen interest in models made by the students

innovations in the area of Robotics. The event was inaugurated by Prof. BR Mehta, Dean (R&D), IIT Delhi. The occasion was graced by Shri M H Rahman, former DG (HR&TM), DRDO and Director Joint Advance Technology Centre, Shri RK Jain, Sc 'G', LASTEC, and the Chairman of Screening Committee. Senior scientists from R&DE (E) and Professors from IIT

Delhi were also present.

The two-day event bring to view presentations by students along with demonstration of various working models. The students came up with lot of innovative ideas. Top five teams from North Zone were selected for final round of screening.



Students with their model at IIT Delhi



**NORTH-EAST ZONE
DRUSE**

Defence Research Laboratory (DRL), Tezpur, in coordination with Research and Development Establishment Engineers [R&DE(E)], Pune, organised the 2nd level screening for DRUSE NE zone at IIT Guwahati on 6 April, 2018. The event was inaugurated by Shri MH Rahman, former DG HR, DRDO. A total of 13 teams from various technical institutes of North-East region participated in the event.



DRUSE at IIT Guwahati

TOT

DFRL SIGNS LATOT WITH M/S BTW INDIA

Defence Food Research Laboratory, Mysuru, signed Licensing Agreement for Transfer of Technology (LAToT) for Retort Processed Ready-to-Eat Foods and Shelf-Stable No Preservative Chapatias with M/s BTW India, New Delhi. Dr Rakesh Kumar Sharma, Director, DFRL and Mr Harvind Sharma, Head (Operations), M/s BTW India, signed

the agreement on 24 April 2018 at DFRL, Mysuru.

The technology is essentially based on three important critical factors, namely, packaging systems, processing schedule and the requirement of product recipes. The process schedule has been optimized for various food products with respect to compositions as well as volume.

Shelf-stable No Preservative Chapatias are processed in retort amenable special flexible polymeric films to achieve commercial sterility. The product is in ready-to-eat form and could be warmed up by dipping the pack in hot water or keeping the same on hot plate before consumption. The shelf-life of the product is 12 months under ambient storage condition.



NATIONAL TECHNOLOGY DAY

National Technology Day (NTD) is celebrated every year on 11th May to commemorate successful nuclear tests conducted at Pokhran, Rajasthan, on 11 May 1998. Defence Science Forum (DSF) celebrated the day at Bhagvantham Auditorium, Metcalfe House, Delhi, by organising National Technology Day Oration on “The Challenges and Opportunities in Waste Management in India” by Dr Ajay Pradhan, Chairman National Solid Waste Association of India.

Shri AK Singh, Convenor DSF, elucidated history of India’s technological innovations and excellence and described the day as a quest for scientific temperament, technological creativity and integration of science, society and industry.

In his informative oration Dr Ajay Pradhan emphasised the need to reduce, reuse and recycle waste and said that the responsibility not only lies with the government but with the citizens also. He lamented that waste infrastructure, waste management technology, waste policy and consultant engineer on waste management are almost negligible. He exhorted DRDO to take up this opportunity and use their expertise in filling the technology gap needed for the waste management. He also said that it is imperative to sensitise, make awareness about management of waste in order to make the Swachh Bharat Abhiyan a success.

Speaking about the waste management, Dr Ajay Pradhan reminded that everyone shares an equal responsibility and should segregate waste and believe in the concept of considering waste a resource.

Dr Ajay Pradhan also highlighted some of the sustainable approaches in solid waste like strengthening urban institutions, incorporation of informal sector in mainstream, incentives and disincentives, PPP model, etc., and suggested that bio-methanation, among



many others, as a viable approach in tackling the problems of waste in India.

Shri GH Kumara, Sc ‘E’, Gas Turbine Research Establishment (GTRE), Bengaluru; Shri Yashpal Singh, Sc ‘F’, Terminal Ballistics Research Laboratory (TBRL), Chandigarh; Shri Amit Prabhat Singh Yadav, Sc ‘D’, Solid State Physics Laboratory (SSPL), Delhi, presented their papers on “Design of High Speed Gearbox Components and High Speed Test Rig”, “Development of Advanced Concrete Penetration Warhead Technology”, “Design and Development of L-band Digitally controlled MMIC Phase Shifter for Radar System using G7S Technology of GAETEC”, respectively.

The following DRDO labs also celebrated NTD:

ANURAG, HYDERABAD

Shri Yogesh Kumar Verma, Project Director, AESA Seeker, Program AD, was the Chief Guest on the occasion and gave a talk on “Design and Development of RF Seeker and Opportunities



for ANURAG in Design of Seeker Components”. Smt Uma Gupta, Sc ‘F’, gave NTD oration on “Big Data Analytics: A Disruptive Technology”. She was presented NTD Oration Medal and Certificate by the Chief Guest.

DEBEL, BENGALURU

Dr Sanchita Sil, Sc ‘D’, delivered an oration titled “Raman Spectroscopy: Challenges and Opportunities”. She gave an introductory brief on the evolution of Raman Spectroscopy after the discovery of Raman Effect in 1928 and highlighted the potential of Raman spectroscopy in materials and biology. She explained her contribution in this field towards using this tool in detection of NBC agents. She was presented NTD Oration by Dr UK Singh, OS and Director, DEBEL.





DL, JODHPUR

Dr SR Vadera, Director, DLJ, in his address emphasised on converting the functionality of the products into its operationality. A technical exhibition was organized for the general public exhibiting items and technologies developed by DLJ. Forty working science models prepared by 143 students from various schools of Jodhpur were also displayed in the exhibition. The three best models were awarded. Technology Day Oration was delivered by Dr Prashant Vashishtha, Sc 'F', on 'Indigenous Development of Chaff'. Dr Vashishtha was presented NTD Oration Medal and Certificate.



DRL, TEZPUR

Dr Vanlalhmua, Sc 'E', delivered NTD oration on "Scope of CRISPR-based Technology for Control of Vector Borne Diseases and Agricultural Pest." His talk covered various methods for combating vector-borne diseases of both human and agricultural crops. Science exhibition and quiz competition were organised for senior secondary science students. Over 50 students participated in this event.

Dr BJ Gogoi, Sc 'E', and Dr S Sharma, Sc 'C', also delivered talks on "Products and Technology of DRDO and DRL", respectively.



INMAS, DELHI

Dr Paban Kumar Agrawala, Sc 'E', delivered NTD oration on "Development of Radiation Countermeasure Agents: a Novel Approach" on 10 May 2018 at INMAS Delhi. He highlighted the contributions of INMAS in conducting research and development in nuclear and radiological eventuality management including protection, decontamination, and decorporation of radioactivity. Dr G Athithan, DS and DG, Micro Electronic Devices & Computational Systems (MED, CoS & CS), DRDO, presented NTD oration medal and certificate to Dr Agrawala.



ITR, CHANDIPUR

Dr BK Das, OS and Director ITR, inaugurated the programme. In his inaugural address, Dr Das highlighted the importance of technology in modern life and encouraged all scientists, technologists to be more creative and innovative in their approach in addition to their normal assignment. Shri Pradipta Roy, Sc 'E', presented the oration on "Real Time Visibility Enhancement of Foggy Videos for Range Tracking Applications" for which he was presented with a DRDO commendation certificate. Prizes were also distributed among employees being winners in the competitions organized on the occasion of NTD.



NPOL, KOCHI

Shri G Vijay Gopal, Sc 'E', delivered the technology day oration on "Sound and Vision", elaborating the technologies and challenges in the area of acoustic imaging, and opportunities in using imaging sonars for underwater surveillance. Shri S Kedarnath Shenoy, OS and Director, NPOL, presented the NTD medal to the technology day orator. As part of the celebration, an invited talk on "Leveraging Technology for the Real World" by Shri G Vijayaraghavan, CEO, Techno Park, and former Planning Board member of Kerala was also organized. The informative talk focused on the significance of S&T innovations in India and their applications for societal missions.



RCI, HYDERABAD

Shri K Sambasiva Rao, Sc 'D', delivered NTD oration on "Development of Electronic Beam Switching Antenna" for long range data link applications. Prof. (Dr) K Senthil Kumar, MIT, Anna University, Guest of Honour, highlighted current trends in UAVs and its role in disaster management and societal applications. Shri MV Gowtama, CMD, BEL, Chief Guest, spoke about need for better interaction between DRDO and BEL. Shri BHVS Narayana Murthy, OS & Director, presided over the function.



RAISING DAY CELEBRATION

ANURAG, HYDERABAD

Advanced Numerical Research and Analysis Group (ANURAG), Hyderabad, celebrated its Raising Day on 4 May 2018. Dr G Athithan, DS and DG (MED, CoS & CS), was the Chief Guest on the occasion. Dr (Smt) Mala Iyengar, IFA (R&D) and Dr RK Sharma, DS and Director, Solid State Physics Laboratory (SSPL) were the Guests of Honour.

The program began with lighting of lamp and invocation song. It was followed by addresses by Shri K Santeppa, Associate Director, Dr JVR Sagar, Director, ANURAG, and the Chief Guest.

Cultural programme was organized with performances by employees and their children. Lab-level DRDO Awards and Cash Awards were distributed for the commendable performance for the year 2017. Mementos were distributed to employees who completed 20 and 25 years of service. Awards were also distributed for innovative idea contest.



Arjun MBT Mk-II, Arjun ARRV, Arjun Catapult and about the upcoming AFV and aircraft projects. He also appreciated the cooperation rendered by the family members of CVRDE.

Cultural programme was conducted by the officers and staffs of CVRDE.

The employees who have rendered 25 years of outstanding services were felicitated with mementoes. Lab awards were distributed on this occasion. Prizes were also distributed for the winners in sports and cultural activities.

CVRDE, CHENNAI

Combat Vehicles Research and Development Establishment (CVRDE), Chennai, celebrated DRDO diamond Jubilee and its Raising Day on 17 and 18 April 2018 in a grand manner. As part of diamond jubilee, cultural programs were organized by inviting Tamil Nadu Nattupura Kalaigal artists. CVRDE employees, retired officers and staffs attended the function.

Shri P Prince Paul, Vice Chairman, Works Committee welcomed the gathering. Dr P Sivakumar, DS and Director, CVRDE, delivered the Raising Day message and spelt out the achievements of CVRDE in 2017. He highlighted the major milestones of CVRDE such as development of





DR CHRISTOPHER INAUGURATES YOUNG SCIENTISTS FORUM, HYDERABAD REGION

Young Scientists Forum, Hyderabad Region was inaugurated by Dr S Christopher, Chairman, DRDO and Secretary, DDR&Dat Advanced Systems Laboratory (ASL), Hyderabad on 15 April 2018. Dr Tessy Thomas, DS and Director, ASL, expressed that the forum would provide a platform to the young scientists to share their knowledge and contribute towards achieving organizational goals. Dr S Christopher delivered the inaugural address. Presentation on DRDO@60 was given by Ms Priyanka, Sc 'D', INMAS and Ms Nupur, Sc 'C', SAG.



CHAIRMAN DRDO LAYS FOUNDATION STONE OF SUVIDA

Dr S Christopher, Chairman, DRDO and Secretary, DDR&D laid the foundation stone of Supercomputing and Visualization Centre for Defence Applications (SUVIDA) at Advanced Numerical Research and Analysis Group (ANURAG), Hyderabad, on 15 April 2018. The multi Peta FLOPS facility would meet the futuristic high performance computing requirements of DRDO. Dr G Athithan, DG (MED CoS&CS), Shri PK Mehta, DG (ACE), Shri Sudhir Gupta, DG (TM) and other dignitaries including Directors of Hyderabad-based DRDO labs were present on the occasion.



DTRL RENOVATED BUILDING INAUGURATED

Renovated building of the Defence Terrain Research Laboratory (DTRL) was formally inaugurated by DG (ACE) Shri PK Mehta. Maj Gen Girish Kumar, VSM, Surveyor Gen of India, and Shri Gagan Inder Wadhwa, CCE (R&D), Delhi, along with Dr MR Bhutiyani, Director, DTRL were present on the occasion.



GaN HIGH ELECTRON MOBILITY TRANSISTOR TECHNOLOGY: EPI WAFERS & DEVICES

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

Gallium Nitride (GaN)-based High Electron Mobility Transistor (HEMT) technology is revolutionizing the modern defence RF and electronic warfare systems. The capability of AlGaN/GaN HEMT to deliver high power, high frequency, high linearity, high efficiency and high temperature performance renders it the most sought after device for applications in advanced radars, data links, satcoms, etc. Particularly for RF power applications, GaN-based HEMT technology offers a significant advantage over the existing gallium arsenide (GaAs) Monolithic Microwave Integrated Circuits (MMICs). This is primarily due to the capability of GaN devices to operate at higher voltages owing to very high breakdown fields associated with them. Additionally, the GaN devices offer much higher impedance resulting in the requirement of less complex matching networks in RF power amplifier integrated circuits. On the whole, GaN technology results in minimizing the sizes of RF ICs by a factor of ten or even higher over the competing RF technologies. Moreover, the low current operation aided with a higher efficiency results in power saving and reduced costs for cooling the system. Therefore, the GaN-based power amplifiers constitute the heart of present day transceiver (T/R) modules in AESA (Active Electronically Scanned Array) radars and communication systems.

To harness the potential of

this technology, a project entitled AlGaN/GaN High Electron Mobility Transistors: Material and Device Technology Development (BALRAM) was undertaken by Solid State Physics Laboratory (SSPL) as a first step towards achieving long term self-reliance in GaN-based material, high power devices/MMICs for RF applications. SSPL evolved process control and characterization methodologies, besides, timely development of facilities for (a) epi-wafer growth and characterization, (b) device simulation, (c) device fabrication and (d) DC, RF and load pull measurement etc.

TECHNOLOGY DEVELOPMENT

EPI-Wafer Growth Technology

AlGaN/GaN hetero-structures having a two dimensional (2D) electron gas with a high electron density of $\sim 10^{13} \text{ cm}^{-2}$ and electron mobility of $\sim 2000 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ are required for fabrication of high performance HEMT devices. A typical GaN HEMT hetero-structures consists of a multilayer hetero-epitaxial structure with strict control over composition as well as thicknesses at nanometer scale. The desired smoothness/abruptness of various interfaces at sub-nanometer level requires atomic scale control over growth process. Metal Organic Chemical Vapour Deposition (MOCVD) was selected for developing AlGaN/GaN HEMT epi-wafer growth process for

its capability of scaling up for volume production and low manufacturing cost. A specially designed MOCVD reactor was established and a production worthy GaN HEMT epi-wafer growth technology was developed with sustained R&D efforts.

A variety of crystalline substrate options, namely, Sapphire, SiC and Si, were explored for growing the desired epitaxial hetero-structures. However, the technology development was finally confined on SiC due to its least mismatch in lattice constant and thermal expansion coefficient with GaN. Further, a high thermal conductivity of SiC renders it most suitable for high power RF applications.

The main challenges in developing the GaN HEMT material technology included achieving the desired 2D electron density and mobility with reduced dislocation density and control over impurities acting as deep electron traps. Other crucial requirements for AlGaN/GaN HEMT structure included (a) the growth of high resistivity GaN buffer layer, (b) precisely controlled 1 nm AlN exclusion layer with sharp interfaces and (c) growth of crack free AlGaN layers with step flow morphology while maintaining minimum particulate generation during growth. The indigenous GaN HEMT materials technology is matured and device quality epi-wafers are regularly produced for fabrication of Power HEMT devices and MMICs.



Power HEMT Device fabrication, RF and Power Characterization

Development of HEMT device fabrication technology involves a large number of unit processes that are integrated to realize the devices with reliable and reproducible performance. The first tryst with GaN power device development involved generation of complete technological know-how *ab initio*.

The design of Process Evaluation Vehicles (PEVs) for process development and assessment was the first step. Suitable Process Control Monitor (PCM) structures were incorporated for a strict monitoring of the fabrication process. Unit processes like formation of ohmic and Schottky metal contacts, device passivation, dry etching for contact-formation/device-isolation, plated air bridge interconnection for reduced parasitic, etc., were successfully developed and integrated.

Surface passivation is one of the most important processes in GaN

power HEMT technology. Optimum passivation mitigates the well-known phenomena of current collapse and I-V knee walkout. Reduced current collapse and knee walk-out results into higher output power density and long term device reliability in GaN HEMTs. The process of GaN HEMT surface passivation was optimized for current recovery and achieving high breakdown voltage.

RF measurements on GaN HEMT involving high power densities require development of a thorough understanding of the complexities therein. Specialized measurement set-up and methodologies were developed for this purpose. A dedicated load pull system was assembled in-house and is now being utilized regularly. As the power devices in general are oscillating and need special measurement techniques, a stabilization network was designed and fabricated to carry out the measurements.

Devices fabricated with gate length of 0.4 μm and 0.25 μm demonstrated the cut-off frequencies of 33 GHz and

43 GHz, respectively. In order to achieve high performance for a given AlGaIn/GaN HEMT, features holding the maximum importance are high off-state breakdown voltage, current recovery, low gate and buffer leakage and low on-state resistance. Optimization of these features through simulations, process technology development and characterization was achieved.

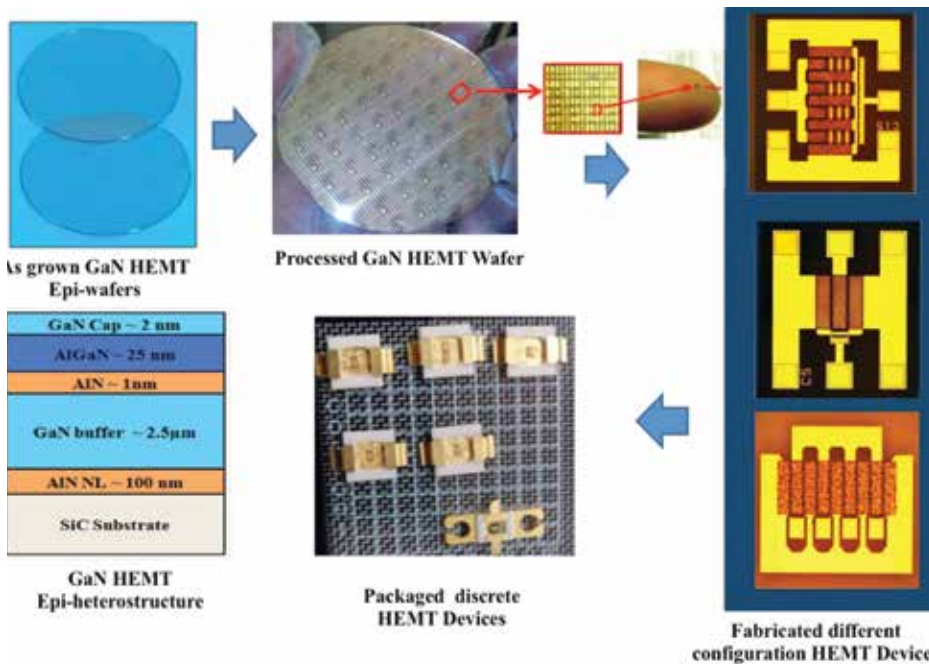
The main technology breakthrough included the control over breakdown voltage and knee walkout after device surface passivation through the incorporation of field plates over gates. The technology has been developed on 75 mm AlGaIn/GaN on SiC substrates. Depletion mode HEMT devices with peak drain current density of 1 A/mm, peak DC trans-conductance of ~ 230 mS/mm and extrapolated power output of 5-6 W/mm for small periphery devices have been achieved.

Post Project Developments

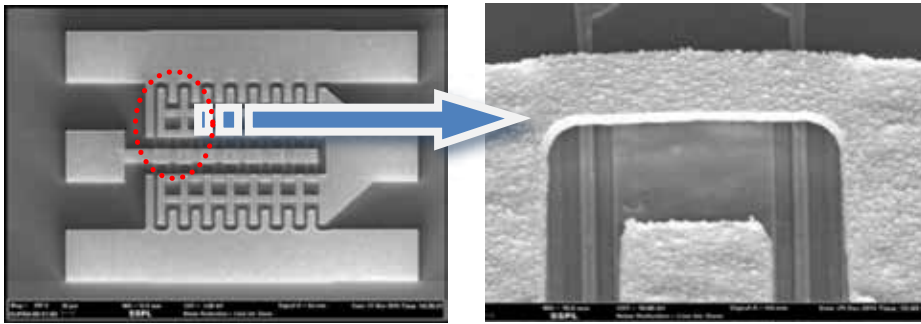
Packaged devices with gate width of up to 2.4 mm were measured to give saturated output power of 7-8 W in S and C bands. The in-house developed bias tees have enabled the on-wafer load pull measurement of large periphery devices. The 3 mm devices in fish bone configuration could be measured to deliver a saturated output power of 15 W.

The enhancement of breakdown voltage by incorporating field plates, increased the device operating voltage suitability up to 50 V from 28 V operation. Also with field plates, due to reduction in peak electric field, the availability of active electron taps between gate and drain reduces drastically resulting in minimum current collapse and knee walkout.

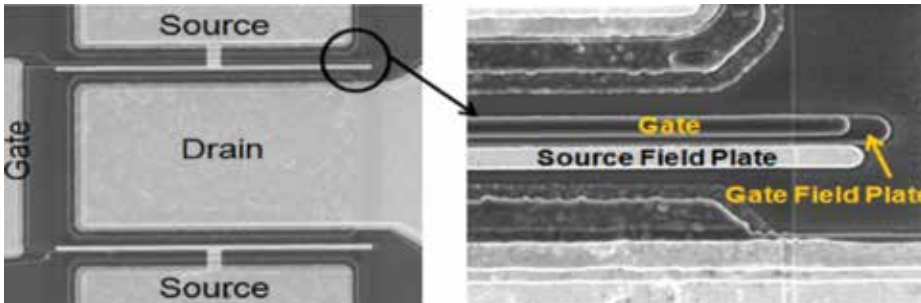
The in-house fabricated field plated devices have successfully delivered an output RF power density ~ 5 W/mm at 28 V and ~ 10 W/mm at 50 V operation up to 6 GHz.



Complete cycle from material growth to Device fabrication and packaging developed at SSPL



30 Finger, 3 mm GaN HEMT device delivering 15 W power



FE-SEM image of fabricated GaN HEMT with gate and source field

GaN TECHNOLOGY FOR PRODUCTION

Complete process sequence of GaN HEMT device fabrication has been established at GAETEC. This involved establishing all unit processes on production systems and their integration. The main challenge in transferring and establishing any process on production system is the identification of critical factors causing

process drift and their control. The production process is now established to deliver discrete HEMTs in S/C band. A completely processed GaN HEMT wafer fabricated at GAETEC was released in 2017.

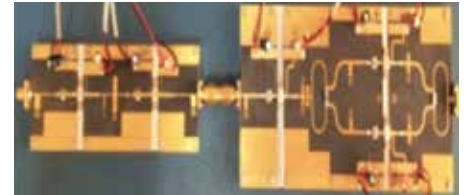
ACHIEVEMENTS

AlGaIn/GaN HEMT EPI-wafers have been developed on SiC substrates, achieving mobility $>2000 \text{ cm}^2 \text{ V}^{-1}\text{s}^{-1}$ with 2° density of $\sim 10^{13} \text{ cm}^{-2}$. On-wafer

uniformity and process repeatability has been established over a large numbers of runs. The achieved material characteristics are comparable to the state-of-the-art in material technology. The current status of achieved power density is $\sim 10 \text{ W/mm}$ at 50 V and breakdown voltage greater than 150 V with field plate integration and is comparable with state-of-the-art device technology for S band applications.

CURRENT STATUS AND WAY FORWARD

AlGaIn/GaN HEMT epi-wafers grown are being used for device fabrication. Currently further advancement in material technology is under process for growth of iron and carbon doped buffer-based heterostructures for further higher breakdown voltage operation in X band and beyond. Apart from this, growth technology



1.7-2.1 GHz 10W Linear Power Amplifier

is being upgraded to 4" diameter. The device process technology for $0.7 \mu\text{m}$ GaN HEMT has been stabilized and established for production at GAETEC. Using the indigenously developed $0.7 \mu\text{m}$ gate GaN HEMT discrete device, a 1.7-2.1 GHz 10 W linear power amplifier circuit is successfully designed, fabricated, assembled and tested for the desired performance. The amplifier can be used in the chain as driver amplifier to feed higher capacity power amplifiers. The development for $0.25 \mu\text{m}$ technology for X band applications is at advanced stage along with passive components. This will enable speedy development of GaN-based MMICs with applications up to X band.



Processed GaN HEMT wafer was released by Shri Arun Jaitely, the then Raksha Mantri



COURSES ON COMMUNICATION & PRESENTATION SKILLS

A two-day off-campus course on “Communication & Presentation Skills for DRTC” was conducted by Institute of Technology Management (ITM), Mussoorie at Aerial Delivery Research and Development (ADRDE), Agra, from 22 to 23 March 2018. Twenty-nine DRTC Officials of ADRDE attended the course.

The course was inaugurated by Shri Arun Kumar Saxena, Director,

ADRDE, who in his inaugural address, deliberated upon the effectiveness of the communication and presentation skills for personal as well as professional success.

The course comprised lectures on Introduction to Communication and Interpersonal Relationship, Assertive Communication Guidelines and Exercise, Power of Non-Verbal Communication, Effective Presentation

Skills, etc. Apart from lectures, several exercises were also conducted during the training programme. The participants were allotted different management topics, which were prepared and presented by them on the second day.

A similar course was also organised by Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur, during 19-20 March 2018.



COURSE ON PARTICIPATIVE PROJECT MANAGEMENT FOR DRTC PERSONNEL

A three-day course on “Participative Project Management for DRTC Personnel” was conducted by Centre for Artificial Intelligence and Robotics (CAIR), Bengaluru, under DRDO’s Continuing Education Programme (CEP) during 18-20 April 2018.

The CEP included topics covering all the stages of project life cycle such as pre-project activities, execution and closure to other support areas such as procurement, stores and project accounts and finance, etc.

Twenty-four DRTC personnel attended the CEP as registered

participants. There were a series of presentations and interactive sessions focusing on various aspects of project management in the context of DRDO and the roles and expectations from the DRTC personnel in various areas.

WORKSHOP ON SAMEEKSHA WEB PORTAL

A half-day workshop on SAMEEKSHA (Software Assurance Made Effective by Knowledge Sharing) Web Portal was conducted on 24 April 2018 at CAIR. SMAKEESHA is a centralized compute infrastructure comprising of Automated Program Analysis Tools, extended to scientists' desktops over the CAIR backbone network.

Program Analysis Tools help in detecting vulnerabilities in the program, which can be missed by the compiler. These tools not only aid in discovering vulnerabilities earlier in the program development cycle but also suggest possible remedial code corrections automatically. Thus a combination of error detection and a possible correction enables programmer/developer to

develop better Quality Software that promises to be more stable, perform optimally and also have reduced security vulnerabilities. SAMEEKSHA Web Portal is web interface to the SAMEEKSHA facility.

Forty-one personnel attended the workshop.

DRDO WEB COORDINATORS' MEET

Defence Scientific Information and Documentation Centre (DESIDOC), Delhi, organised a meeting of the DRDO Web Coordinators on 5 April 2018. Sixty-five delegates from various DRDO labs/estts and Directorates from DRDO HQ attended the meeting. Dr Rajeev Vij, Sc 'G', convener of the meeting, welcomed the

participants and briefed them about the programme. He also briefed them about the current status of the DRDO website.

Dr Alka Suri, Director, DESIDOC, Chaired the meeting and presented the vision of Chairman DRDO on making DRDO globally visible through DRDO website and how DESIDOC is trying to meet with his aspiration. She said that

all DRDO labs are equal stakeholders in this effort and therefore must do their bid as expected from them.

Topics covered during the meeting included: Inputs/suggestions/feedback related to technology and content for revamped DRDO website, issues of labs/estts related to website content, etc.



TRAINING-CUM-USER AWARENESS PROGRAMME

DESIDOC organized 5th Training-cum-User Awareness Programme at ADRDE, Agra on 7 May 2018 for increasing users' awareness of the publications and information services provided by the Centre. Seventy scientists/officers from

ADRDE and DRDE participated in the programme.

Shri Vivek Agarwal, Sc 'F', ADRDE welcomed the participants and gave an overview of the programme. Smt Alka Bansal, Sc 'F', DESIDOC, briefed the participants about the

purpose of this programme.

Dr Alka Suri, Director, DESIDOC, informed the participants about the new initiatives taken by the centre to augment the information services and future roadmap of DESIDOC. Shri AK Saxena, Director, ADRDE,



appreciated DESIDOC's efforts in conducting such awareness programmes and asked participants to optimally use the DESIDOC services. Smt Sumati Sharma, Sc 'F'; Smt Alka Bansal,

Shri Sudhanshu Bhushan, Sc 'E'; Shri Nishant Kumar, Sc 'D'; and Shri Yogesh Modi, Sc 'D', briefed the participants about the various publications and information services

being provided by the DESIDOC. Special lectures from E-Journals' publishers to train the participants regarding e-journals' access and use were also organised by DESIDOC.

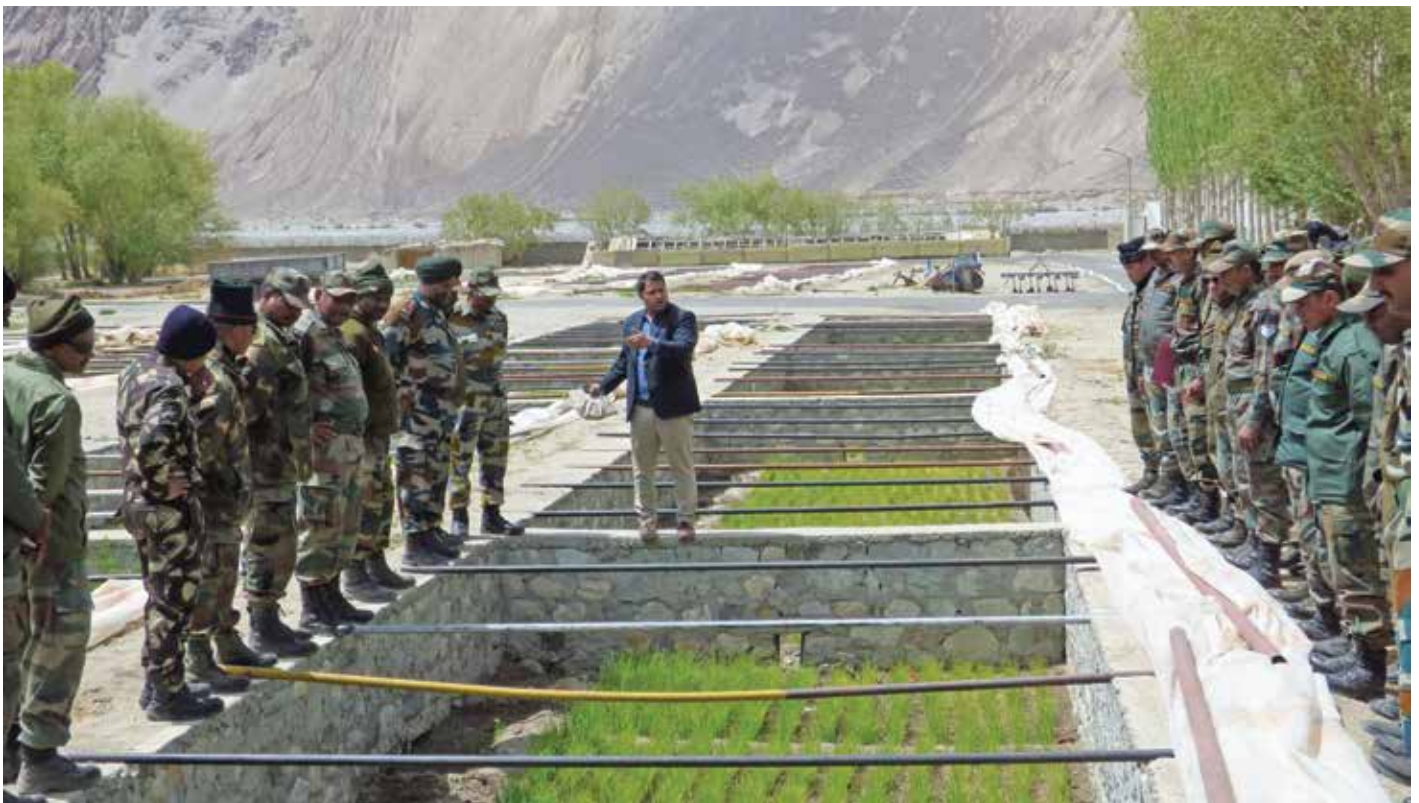
CAPACITY BUILDING PROGRAMMES

For the defence personnel deployed in Leh and Siachen sector, Defence Institute of High Altitude Research (DIHAR), Leh, organized four capacity building programmes (three in Leh and one in Siachen sector) pertaining to unit greening, vegetable cultivation and greenhouse management. The trainees

were nominated by the army units and were very highly enthusiastic to learn novel techniques whereby they can produce fresh foods within their unit premise all round the year, even during cold winter months in greenhouses.

Due to the frequent movement of personnel in and out of this sector

accompanied by new development of new agro-animal technologies, DIHAR regularly conducts such capacity building programme and is being sought after by every army units in the Ladakh sector.



YOGA CERTIFICATE COURSE FOR ARMED FORCES

Imparting yoga training for maintaining good health of soldiers in different adverse environmental conditions is an important activity of Defence Institute of Physiology and Allied Sciences (DIPAS). To continue this as a Skill Developmental

Programme, DIPAS organized a one-month Yoga Certificate Course with monitoring of physiological responses of participants from 5 April to 4 May 2018 in collaboration with Central Council for Research in Yoga and Naturopathy (CCRYN), Ministry of AYUSH.

Twenty-Seven participants from Army, Navy, Paramilitary Forces underwent the training course, which included theory and practical classes, taken by eminent faculty members and experts from reputed institutions, with Audio-visual demonstrations.

While introducing the participants on yoga and yoga practices, they were exposed to basic principles and physiology of yogic practices, Diet, Health and Hygiene, and Yoga for Wellness. Practical demonstrations on Loosening Exercises, Yoga shatkarmas /cleansing process, Yogasanas,

Pranayama, Concept of Mudras, Bandhas and Meditation, were given as doing is learning.

The Participants also visited Naturopathy Hospital and were given demonstration of various naturopathy treatment and techniques of mud bath, oil massage, mud pack therapy, steam

bath and hydrotherapy followed by a theory session.

Physiological monitoring revealed improvement in blood pressure, heart rate, lung functions, muscular strength, body flexibility, body composition and cognitive functions.



HINDI WORKSHOP

A one-day Hindi workshop was organised by Defence Metallurgical Research Laboratory (DMRL), Hyderabad, on 5 April, 2018. Shri Satyapal Singh, Sc 'G', Secretary & Convener, Official Language Implementation Committee (OLIC), welcomed the participants. Smt Kaushalya, Assistant Director, Hindi Teaching Scheme, explained various articles and sub-articles of Rajbhasha implementation programme and familiarized the participants with incentive schemes of Rajbhasha implementation.





COURSE ON TURBOCHARGERS

Gas Turbine Research Establishment (GTRE), Bengaluru, under the aegis of Gas Turbine Enabling Technologies (GATET) initiative, organised a Special Interest Group Course on Turbochargers during 19-23 March 2018.

Shri Debabrata Roy, Director, GTRE, inaugurated the course and briefed

the participants about the importance of turbocharger. Shri Kishore Prasad, Sc 'G', mentioned about the various topics and expertise of CONCEPT NERC in the field of turbocharger development. Shri Kishore Kumar, Sc 'D', explained turbocharger activities in GTRE.

A team of experts from CONCEPT

NERC, USA, with vast experience in design, development and production of turbochargers were the key speakers. Turbocharger end users and combat vehicle certifying members were part of the course along with various DRDO and public sector units. Turbo match software demonstration was also conducted during the course.



ORIENTATION COURSE FOR RETIRING EMPLOYEES

Naval Physical and Oceanographic Laboratory (NPOL), Kochi, organized a two-day orientation course INCREON (IN-house Course for Retiring Employees of NPOL) during 14-15 March 2018. The objective of the course was to prepare the retiring employees make a smooth transition

from an active service life to an equally fulfilling retired life.

Shri S Kedarnath Shenoy, OS and Director, NPOL, inaugurated the course and cited many living examples of successful people with commendable achievements in their post retirement life.

The topics covered during the course included: Psycho-sociological aspects of retired life, healthcare in old age, Pension Pay Order (PPO) and pensionary benefits, planning for judicious post retirement fund management, etc. Fifteen participants attended the course.



PERSONNEL NEWS

APPOINTMENT

Director, CVRDE



Shri V Balamurugan, Sc 'G', has been appointed as Director, Combat Vehicles Research and Development Establishment (CVRDE), Chennai, wef from 1 May 2018. Prior to this, he was working as Addl Director (Arjun).

Shri Balamurugan obtained his Bachelor's degree in Mechanical Engineering from College of Engineering, Guindy in 1984, Master's in Industrial Metallurgy from Indian Institute of Technology, Madras in 1987, and Master's in Business Administration in Technology Management from Bharathidasan Institute of Technology, Trichy, in 1999. He had a brief stint as Management Trainee at Steel Authority of India Ltd (SAIL) before joining DRDO as Sc 'B' in CVRDE in 1987.

He has more than three decades of experience in the development programme of Arjun Main Battle Tank (MBT) wherein he played an active role in the Pre-Production Series (PPS) of Arjun with focus on establishing the produceability and development of production agencies. He guided and developed BHEL, Bhopal, as one of the production agencies as part of the PPS programme. He successfully engaged major research institutions, viz., Welding Research Institute (WRI) and Central Manufacturing Technology Institute (CMTI), in developing production documents during this phase. As Project leader Arjun, he contributed immensely towards transfer of technology of Arjun to various stakeholders such as Heavy Vehicles Factory (HVF) DGQA, EME and the users. He also provided technical expertise and guidance during the production of hull and turret structures, assembly of chassis

automotive system, assembly of turret and weapon system, integration as a tank and its field evaluation before issue. This resulted in free-flow production and operationalization of two regiments (124) Arjun Mk I. During the course, he successfully coordinated and completed various major activities such as medium fording demonstration, conduct of Accelerated Usage Cum Reliability Trials (AUCRT) on two selected production tanks and comparative trials. Under his leadership, a third party auditing of Arjun by expert tank manufacturer from outside India was completed successfully involving DRDO labs, HVF, DGQA and the user for both design and trials. He was instrumental in transfer of AHSP of Arjun MBT Mk I to DGQA.

As Project Director, Arjun MBT Mk II, he was instrumental in interacting with the users for finalisation of upgrades and ensured fast track decision-making through Arjun Core Committee. He extensively coordinated for the successful DRDO and the user's trials of Arjun MBT Mk II resulting in Indian Army obtaining AON from DAC for two regiments of Arjun MBT Mk II.

As Additional Director (ToT), he was instrumental in coordinating and conducting of ToT of CCPT and other products. He also spearheaded formulation of trial directives and its successful conduct on various products such as Arjun MBT Mk I, Arjun MBT Mk II, 400 hp powerpack for BMP II, 1000 hp engine for T72, IAVS systems, etc.

He is the recipient of the Lab Scientist of the Year Award, Lab Technology Group Award, and DRDO Performance Excellence Award. He has also received Commander's Commendation Card in recognition to his devotion to duty/distinguished service. He is a member of the Society of Automotive Engineers (India) and the Indian Institute of Welding. He has guided more than 10 student projects.

AWARDS

MRSI Medal



Dr AR James, Sc 'F', Defence Metallurgical Research Laboratory (DMRL) has been conferred MRSI Medal in recognition of his contributions to the field of Materials Science and Engineering by the Materials Research Society of India, Bengaluru.

GS Tendolkar Award



Dr Manoj Kumar Jain, Sc 'G', DMRL, and co-authors have been conferred the GS Tendolkar Award for their paper presented in the International Conference on Powder Metallurgy and Particulate Materials and 44th Annual Technical Meeting of Powder Metallurgy Association of India (PMAI) held at CIDCO Exhibition Centre, Navi Mumbai.

Life Fellow of IPE



Shri Srinivas Rao Nandam, Sc 'E', DMRL, has been elected as Life Fellow of the Indian Institute of Production Engineers (IPE), Bengaluru, for his contributions in the field of Manufacturing Engineering.

National NDT Award



Dr Sony Punnose, Sc 'E', DMRL, received National Non-Destructive Testing (NDT) Award under the R&D Category-2017 in recognition of her contributions towards R&D in the field of Non-Destructive Engineering by the ISNT, Chennai.



HIGHER QUALIFICATION ACQUIRED



Shri Parikshit Premchand Vadhe, Sc 'E', High Energy Materials Research Laboratory (HEMRL), Pune has been award-

ed PhD (Chemistry) by Savitribai Phule Pune University, Pune for the thesis entitled "Development and Studies on High Density, High Performance Castable Plastic Bonded Explosive (PBX) Formulations."

Shri Ganesh Shankar Dombé, Sc 'E', HEMRL, has been awarded the PhD (Applied Chemistry) by Defence Institute of Advanced Technology



(DIAT) Deemed University, Pune, for the thesis entitled "Studies on Twin Screw Continuous Mixing and Rheology of Concentrated Suspension for Application in Composite Propellants."

SOCIAL ACTIVITIES

GREEN BHARAT PROGRAMME

As a part of Green Bharat Programme, Defence Metallurgical Research Laboratory (DMRL), Hyderabad, organised a tree plantation programme by planting the saplings in the area opposite to the entrance of Powder Processing Group (PPG) building.

The campaign was led by Dr Vikas Kumar, OS and Director, DMRL, along with officers and staff of who enthusiastically participated in the programme.



CAIR ORGANISED BLOOD DONATION CAMP

Centre for Artificial Intelligence and Robotics (CAIR), Bengaluru, celebrated Bharat Ratna Baba Saheb Dr BR Ambedkar's 127th Jayanthi by organising a blood donation camp with Bangalore Medical Service Trust, Rotary Bangalore Blood Bank. Forty CAIR employees and their family members donated blood. Rotary Blood Bank thanked all the donors, volunteers, management for helping the blood donation camp.



VISITORS TO DRDO LABS/ESTTS

CAIR, Bengaluru

A team from Advanced Defence Technology Centre (ADTeC), Acquisition, Technology and Logistic Agency, Ministry of Defence, Japan, visited Centre for Artificial Intelligence and Robotics (CAIR) on 16 and 17 April 2018 for technical discussion. There was a briefing by Director, CAIR followed by demonstration of technologies developed by CAIR.

DARE, Bengaluru

AVM MSJ Pai, VM, Commandant, Software Development Institute (SDI), AF, visited the facilities at DARE on 4 April 2018 and different project teams gave an overview of the projects.

DIHAR, Leh

Vice Admiral AR Karve, PVSM, AVSM, FoC-in-C (S), visited Defence Institute of High Altitude Research (DIHAR) Leh on 20 April 2018. He was briefed about the various R&D activities and services being extended by DIHAR to the 14 Corps and local population.

DL, Jodhpur

Lt Gen RK Jagga, AVSM, VSM, GOC HQ 12 Corps, visited Defence Laboratory (DL) on 11 May 2018. Lt Gen Jagga discussed the specific requirements of Armed Forces stationed at the Thar Desert and discussed their issues related to water purification and desalination, soil stabilisation, Camouflage Patterns software and PCM Cool Vest technologies.

DLRL, Hyderabad

Vice Admiral SN Ghormade, AVSM, NM, DG (Naval Operations), visited Defence Electronics Research Laboratory (DLRL), at its ELSEC campus on 23 April 2018. Dr Anil Kumar Singh, OS and Director, DLRL briefed the visitor about the various technical activities, ongoing projects, achievements and infrastructure of the laboratory.



AVM MSJ Pai, VM, Commandant (SDI), AF, being briefed at DARE



Lt Gen RK Jagga, AVSM, VSM, GOC HQ 12 Corps, being briefed about DLJ technology



Vice Admiral SN Ghormade, being briefed about DLRL technology



DRDO HARNESSING SCIENCE FOR PEACE & SECURITY- XXVI

CHAPTER 3: OVER TO SYSTEMS DEVELOPMENT (1970–1982)

The article is 28th 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).

HEADQUARTERS REORGANISATION

In December 1971, the Functional Chart of the DRDO Headquarters was published. It got first revision in May 1973 with the strengthening of the Headquarters by the appointment of an additional Chief Controller (R&D), re-designation of the Chief Scientist as Chief Controller (R&D) and with a Joint Secretary working full time for the DRDO. In his communication to the DRDO the Scientific Adviser stated, "... the needs of the Defence Services are getting more and more sophisticated day-by-day. But the resources placed at the disposal of the Defence Research & Development Organisation are limited. In order to optimise the resources, the R&D Headquarters has to play a significant role in the process of analysis and decision-making and in the allocation of tasks. It has also to monitor progress and remove difficulties of laboratories/establishments and assist these in all possible ways to speed up the progress of assigned tasks. It has to systematically analyse the need and to delegate authority to the laboratories/establishments in various matters and to review the manner in which the delegated authority is being used so that corrective action where necessary can be taken with quickly on time. In addition, the Headquarters must periodically forecast technological development areas, collect, collate and disseminate information so that development programmes are consistent with current and future trends and do not significantly fall behind." The role of

Headquarters, as spelled out by the Scientific Adviser, was one of support to the laboratories who would be the backbone of the Organisation and monitor their performance for rendering service. The functional chart as well as the duties and responsibilities of the three Chief Controllers, one Joint Secretary, and the directorates under each of them were laid out in detail. The Scientific Adviser also stipulated that the three Chief Controllers and the Joint Secretary would not only be responsible for the activities in their own areas but will work as a team and help each other in all important, technical, scientific, personnel and administrative matters". The three Chief Controllers, the Joint Secretary and the Director of Administration reported directly to the Scientific Adviser. The distribution of responsibilities and duties of the three Chief Controllers was such that one Chief Controller had the technical directorates and the laboratories/establishments primarily oriented to Army projects under his jurisdiction, the second one had technical directorates and laboratories oriented to Naval and Air Force tasks, while the third Chief Controller had the Headquarters directorates and laboratories involved/working in applied sciences and the Directorate of Personnel. The duties of the Joint Secretary were to interact with the Ministry and pilot the paper work for all schemes and proposals requiring Government approval /sanction. He was to be associated from the early stages of the proposals. The Director of Administration had the responsibility on all administrative matters such

as planning and preparation of budget, interacting with Ministry for foreign exchange allocation, and ensuring progressive allocation to the laboratories, processing papers on procurement of stores sent by the laboratories for approvals at DRDO Headquarters at Delhi, planning and implementation of civil construction to meet residential and laboratory needs, security and vigilance. Three Committees were formed for taking decisions on all important technical and administrative matters and they would meet periodically to review the progress made in the major areas of activities. The Technical Committee 'A' consisting of the SA to RM, three CCR&Ds, Joint Secretary, and Director of Administration would meet every alternate Monday to consider all policy and important matters. Technical Committee 'B' with SA to RM, three CCR&Ds, Director of Administration, Director of Personnel and other technical directors (on need basis) would review the progress on all important projects, consider all other technical and administrative matters related to specific projects, and would need detailed consideration at higher levels.

The third committee called the Capital Equipment and Procurement Committee, would comprise the three CCR&Ds, Director of Administration, and technical directors (on need basis). The work of the Committee was to scrutinize the need for the procurement of all stores requiring foreign exchange, capital equipment and creation of major facilities. The duties of the



technical directors at the Headquarters were divided into four broad categories-general duties, staff functions, technical functions and line functions. In the category of technical functions, the work involved arranging and reporting on prototype trials of equipment/ systems developed by the laboratories, keeping a watch and progressing development-to-production and induction into services of equipment to safeguard R&D interests, and writing position papers in their field on various subjects, upgrading these from time-to-time and anticipating advancing technologies and techniques. These three Committees would synergise the capabilities of the top management to resolve difficult issues. The reorganisation laid in clear terms the duties and responsibilities with little or no overlap up to the level of Headquarters directors so that confusion was minimised and accountability was enhanced. It was effective in reducing the delays within the DRDO. However, the technical functions of writing position papers on various subjects was, by and large, not carried out by the technical directors with the exception of a few.

DELEGATION OF POWERS TO THE LABORATORIES

As the laboratories were well spread out geographically and these also dealt with a wide spectrum of science and technology fields, the Scientific Adviser expressed that there should be more autonomy than hitherto by delegating more powers to them. This measure would cut out considerable paper work on matters which could be dealt at the laboratory level. Thus in June 1971, the Defence R&D Organisation issued letters enumerating the delegation of financial powers to establishments/ laboratories. In some cases, these orders enhanced the powers of the heads of the laboratories to the extent held by the Scientific Adviser and in others additional powers earlier held by the Scientific Adviser were delegated down. Similar action was taken in

respect of extending the financial powers of the heads of the laboratories. It was later found that in effect it reduced the correspondence between the laboratories and the Headquarters by about 25 per cent to 30 per cent.

STORES PROCUREMENT PROCEDURES

The procedure followed for the purchase of test equipment, machinery, or any other sophisticated facility that would enhance the capability of the laboratory was antediluvian because the Government rules that were applied, were by and large framed by the colonial rulers at the beginning of the 20th century. The expansion of the infrastructure in the thrust areas was hampered by the elaborate procedure of the Government which required as many as 82 complicated and time-consuming steps involving diverse agencies like the DGTD (Director General of Technical Development), DGS&D (Director General of Supplies and Disposal), India Supply Mission, Department of Electronics, and so on. In view of the enormous administrative burden that would be imposed on DRDO if it took over procurement from DGS&D, it was decided not to disturb the present arrangement. However, in special cases recommended by the Organisation, DGS&D was persuaded to permit DRDO to purchase directly. The uncertainties and delays in procurement of equipment/machinery, either from indigenous sources or foreign imports, continued throughout the 1970s.

GOVERNING COUNCILS

Governing councils had been constituted in the 1960s for the laboratories with participation from academies and industry to provide independent expert opinion on technical as well as other matters to the scientists of the laboratories. The contributions and the impact of the governing councils on the laboratories varied considerably

from negligible to significant. In the case of the governing council dedicated to one laboratory and the activities of the laboratory led to new processes, materials and devices, the impact was, by and large, significant. However, for equipment-oriented laboratories, the contribution of the governing councils was negligible. Most of their input and decisions came out of the development panel meetings where DRDO interacted with the User and associated production agencies. Similarly in the case of governing councils constituted for multiple institutions, the contributions were not significant. In the light of these it was decided to discontinue the practice of constituting governing councils for DRDO laboratories. Instead, the development panels and the Project Steering Committees were found to be better and true mechanisms for monitoring and reviewing the work carried out by the laboratories.

IMPACT ON THE ORGANISATION

Four years to the day, on 1st July 1974, Dr BD Nag Chaudhuri moved out of South Block where he had been the Scientific Adviser to Raksha Mantri, and donned the mantle of an academician by becoming the Vice Chancellor of Jawaharlal Nehru University in Delhi. In that short period, he set the DRDO for the new direction or vision of contemporary system development for the Services. He created the department of personnel to look into the problems of recruitment, promotions and career prospects of the personnel and initiated a sequence of actions which would ultimately take DRDO out of the purview of UPSC. He also decentralised the decision process by initiating the delegation of powers of the Scientific Adviser to the Directors of the laboratories.

To be continued...



DEFENCE AVIATION POST

Sat, 05 May, 2018

DRDO handovers ground-based Mobile elint system to IAF

Ground-Based Mobile ELINT System handed over to the Indian Air Force The Ground-based Mobile Electronic Intelligence (ELINT) System (GBMES) was handed over to the Indian Air Force (IAF) at the BEL, Hyderabad Unit on 18 March 2018. DRDO's Defence Electronics Research Laboratory (DLRL), Hyderabad, is responsible for the system design, development of critical sub-systems, and realisation of engineered version of truncated GBMES systems as successfully proved in the field. BEL, Hyderabad is the production agency for GBMES.



- SALIENT FEATURES**
- Wide Frequency coverage from 70 MHz to 40 GHz and COMBAT segment 30-1000 MHz
 - Quad Repeated Receiver Front-End Technology
 - Quad Digital Receiver Technology
 - Built-in Radar Finger Printing System (RFPFS)
 - Location Fixing (LF) using triangulation

BW BUSINESSWORLD

Fri, 11 May, 2018

Drdo is taking new challenges in AI and Robotics that will act as force multipliers'

BW Business world's Manish Kumar Jha catches up with DRDO Chairman and Secretary, Department of Defence R&D, S. Christopher, for an exclusive interview
By Manish Kumar Jha

The Defence Research & Development Organization (DRDO) is an apogee among institutions under the government's Department of Defence Research and Development. It has since 1958, been indigenously developing military technology, weapons and equipment for the Indian Armed Forces. It has received both bouquets for India's home-grown missiles technology (Agni-V, NAG and the long-range LRSAM), rocket systems (Pinaka) and platforms with DRDO Chairman and Secretary, Department of Defence R&D, S. Christopher, for an exclusive interview.

Next generation technology is going to influence warfare in the future. Please tell us about these new developments

War is serious business, as it tends to drain the economy, development and social fabric of any nation involved. Future wars would be short, swift, accurate and gain an upper hand during bargaining. That brings us to the importance of technology in futuristic wars affecting military doctrine and strategy. New dimensions of threat are posing radically new questions, demanding fundamentally new answers, buttressed by unconventional mindsets and integration of methods that facilitate both. The DRDO has identified specific technologies for low level of readiness and high strategic value, where scientific investigations are urgently required in laboratories, through modeling and simulation.

In the future, Artificial Intelligence (AI), cyber elements, smart materials, smart ammunition, Soldier as a System, Military Robotics and Unmanned Systems, Network Centric, surveillance, long-range accurate weapons and systems, mobile launch pads and stealth technology will incapacitate the enemy, even before a full-scale war begins. They would also play a pivotal role in safeguarding our own assets. The aim would be to create an effect, without sending a soldier to a hostile land. Joint initiatives are on between the DRDO and academia at various Centres of Excellence for multi-institutional collaborative and directed research under technology verticals, like Directed Energy Technologies, Secure System and Cognition, Unmanned Systems and Robotics Technologies, Quantum Computing, Photonics, Plasmonics and Smart and Intelligent materials. These areas have been identified based on the requirements of future defence systems and where further scientific investigations are required to enhance indigenous capabilities.



FINANCIAL EXPRESS

Thu, 10 May, 2018

Make in India boost: Indian army may procure more Akash missile systems from DRDO

Akash missile is a medium-range surface-to-air missile which can simultaneously engage multiple targets in all kinds of weather conditions. The Akash system features a launcher, a missile, an integral mission guidance system, autopilot system, C/I centres, and also multifunctional radar.

The Indian Army is likely to order another batch of Akash missiles, India's first indigenously built surface-to-air missile developed by the DRDO. The Indian Army, which has shown immense interest in the Akash missile system, is very satisfied with its operational capabilities and performance, reported The Hindu. Speaking to the media Lt Gen Parminder Singh S Jaggi, Director General, Army Air Defence had said that the defence forces were fully satisfied with the performance of Akash system and that they were also intending to enhance its performance.

the pioneer

Mon, 07 May, 2018

BrahMos likely to attain 75% localisation in six months

BrahMos, the world's fastest supersonic cruise missile, will be achieving 75 per cent localisation in six months from the current 65 per cent domestic components that goes into its production, a top Aerospace official has said. "As of on Sunday 65 per cent of the value (in BrahMos) is created. We started with a very low 10-12 per cent indigenisation and today we have reached 65 per cent. In six months, we would be close to 75 per cent." BrahMos Aerospace managing director and CEO, Anand Mishra said at the handing over ceremony of the prototype Quad launcher manufactured by Larsen & Toubro (L&T) here over the weekend. "Last March, we flight-tested the defence arm of BrahMos, a smart seeker, and booster also would be shortly tested in about two months. We would be achieving a localisation of about 85 per cent in this," he said.

The quad launcher is designed for supersonic cruise missiles in an inclined configuration on-board a ship. The launcher provides superior firepower as compared to the twin canister, deck mounted launcher and has the capability to support and launch four missiles in a single or salvo mode. The new Quad launcher, suitable for warships which have space constraints to accommodate a vertical launch module, can launch smart launcher, eight missiles (four on the right and four on the left side of the ship) simultaneously. Though we are yet to get the order from the navy we have started work. We have the technology, knowledge and future business. We are just waiting for the order," Mishra said.

indiatoday

Wed, 02 May, 2018

As Tejas Inches Towards Final Clearance, DRDO Chairman Explains Why the Fighter Jet Programme Was Delayed

By Sudhi Ranjan Sen

In an exclusive interview to India Today, Dr S Christopher, chairman of Defence Research and Development Organisation (DRDO) clarified that it would be wrong to say that the Tejas Light Combat Aircraft (LCA) was made in a span of three decades. He explained that that it was only in 1998 that the government decided to go for full-scale production of Tejas and allocated money for it. Crossing yet another milestone last week, Tejas, for the second time, fired an Israeli Derby Air-to-Air Beyond Visual Range (BVR) missile successfully. The Tejas is now a step closer to getting its final operational clearance (FOC) from India's Aeronautical Development Agency (ADA).

US sanctions hurt India

Accepting that the Tejas LCA could have been rolled out much earlier, Dr Christopher said that "sanctions imposed on India" that denied India access to technology after the atomic test in 1998 "affected the development of the fighter." Soon after the 1998 explosions the United States imposed sanctions on India. Referred as the Glenn Amendment to the Nuclear Non-proliferation Act of 1994, as many as 200 Indian organisations like the DRDO and Defence Public Sector companies like Hindustan Aeronautics Limited (HAL) and Bharat Earth Movers were bludgeoned with sanctions.

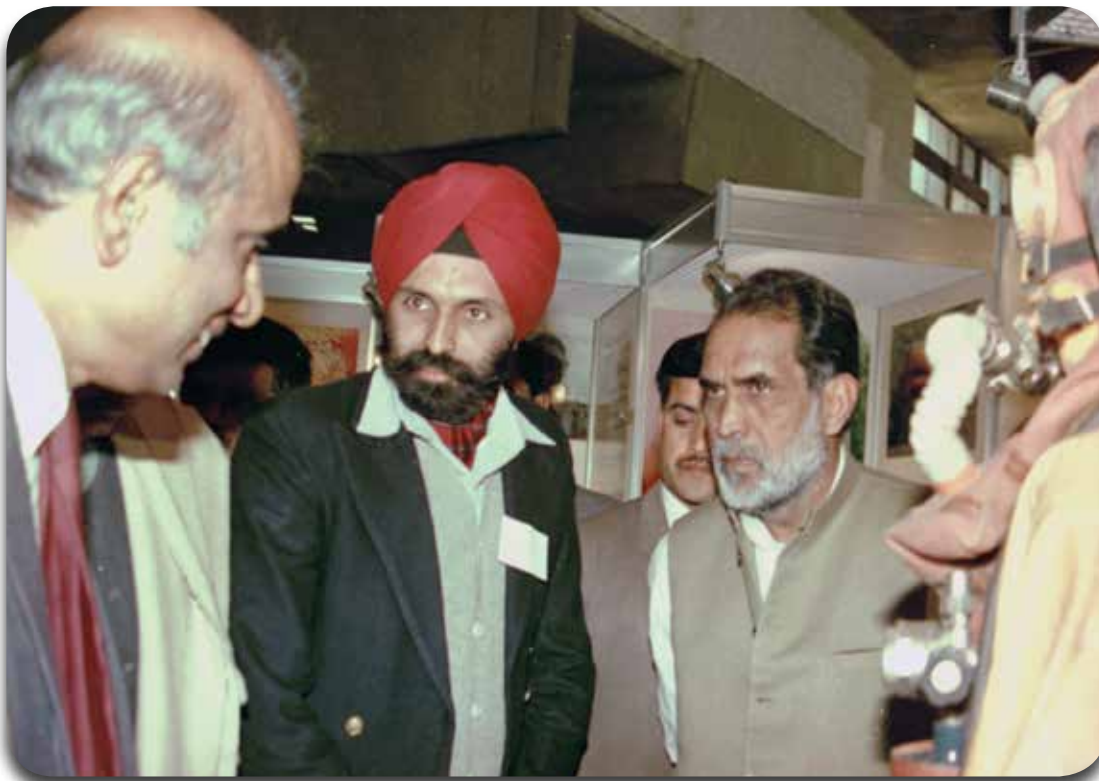


Indian air force too responsible

DOWN THE MEMORY LANE



Former Prime Minister Shri Chandra Sekhar with then SA to RM Dr VS Arunachalam.



Shri Chandra Sekhar being briefed about DRDO products by Dr VS Arunachalam.