

DRDO CONDUCTS SUCCESSFUL TEST OF BALLISTIC MISSILE INTERCEPTOR AAD



Dr G Satheesh Reddy is
the new DRDO Chief



CONTENTS

SEPTEMBER 2018
VOLUME 38 | ISSUE 9
ISSN: 0971-4391

COVER STORY 04

Dr G Satheesh Reddy, Distinguished Scientist and SA to RM takes over as the Secretary DDR&D and Chairman DRDO

Ballistic Missile Interceptor AAD Flight Tested Successfully 05



INNOVATION 06

TOT 06



TD PROGRAMME 07

EVENTS 11



INFRA DEVELOPMENT 15

HRD ACTIVITIES 16

SOCIAL ACTIVITIES 25

FOCUS 26

VISITS 29



DRDO SERIES 30

DOWN THE MEMORY LANE 32

38th Year of Publication

Editor-in-Chief: Dr Alka Suri
Managing Editor: B Nityanand
Editor: Manoj Kumar
Editorial Assistance: Biak Tangpua
Multimedia: RK Bhatnagar
Printing: SK Gupta, Hans Kumar
Distribution: Tapesh Sinha, RP Singh



Website: <https://www.drdo.gov.in/drdo/pub/newsletter/>

Please mail your feedback at:
director@desidoc.drdo.in

Contact: 011-23902403; 23902474
Fax: 011-23819151

LOCAL CORRESPONDENTS

Ahmednagar: Lt Col. AK Singh, Vehicles Research & Development Establishment (VRDE); **Ambernath:** Dr Susan Titus, Naval Materials Research Laboratory (NMRL); **Chandipur:** Shri Santosh Munda, Integrated Test Range (ITR); **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 (CEMILAC); Smt Josephine Nirmala M, Defence Avionics Research Establishment (DARE); Shri Kiran G, Gas Turbine Research Establishment (GTRE); Shri Venkatesh Prabhu, Electronics & Radar Development Establishment (LRDE); Dr Vishal Kesari, Microwave Tube Research & Development Centre (MTRDC); **Chandigarh:** Dr HS Gusain, Snow & Avalanche Study Establishment (SASE); Dr Prince Sharma, Terminal Ballistics Research Laboratory (TBRL); **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); Ms Bidisha Lahiri, 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); **Panagrah:** Shri Anjan Kumar Das, DRDO Integration Centre (DIC); **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)

Dr G Satheesh Reddy, Distinguished Scientist and SA to RM, takes over as Secretary DDR&D and Chairman DRDO

Dr G Satheesh Reddy graduated in Electronics and Communication Engineering from JNTU, Anantapur and received his MS and PhD from JNTU Hyderabad. He joined Defence Research and Development Laboratory (DRDL), Hyderabad, in the year 1986. He later joined Research Centre Imarat (RCI), the brain child of Dr Kalam and a premier DRDO laboratory responsible for R&D of missile systems, guided weapons and advanced avionics for the Indian Armed Forces.

Dr Satheesh was elevated as Distinguished Scientist in September 2014 and was later appointed as Scientific Adviser to Raksha Mantri (SA to RM) and Director General, Missiles and Strategic Systems (MSS). He is well known for his significant contributions towards indigenous design, development, deployment of diversified Missiles and Strategic Systems, Guided Weapons, Avionics Technologies and for sustained efforts in advancement of Aerospace technologies and Industries in India.

As SA to RM, he significantly contributed towards the formulation of many national policies and was pivotal in evolving roadmap for self-sufficiency in missiles. As Director General (MSS), he spearheaded Dr APJ Abdul Kalam Missile Complex, cluster laboratories and technical facilities. He led the design and development of a wide range of tactical and strategic missile systems to attain complete self-sufficiency in missiles and initiated many new projects to equip Armed Forces with state-of-the-art weapons and technologies. He invigorated the Ballistic Missile Defence (BMD) programme and developed the mission critical technologies for Long



Russia. He is an Honorary Fellow of CSI and Project Management Association of India, Fellow of Indian National Academy of Engineering, IET (UK), Associate Fellow of American Institute of Aeronautics and Astronautics, USA and many other academies/scientific bodies in the country and abroad.

Dr Satheesh is the recipient of several prestigious international and national awards, which include the Indian Science Congress Association Homi J. Bhabha Memorial Gold Medal, National Aeronautical Prize, National Design Award, National Systems Gold Medal,

DRDO WILL STRENGTHEN THE DEFENCE OF OUR NATION BY MAXIMISING THE INDIGENOUS CONTENT

DRDO has achieved significant milestones in our deterrence and defence capabilities. Eliminating the need for import of foreign equipment is a priority, said Dr Satheesh Reddy on taking over as new DRDO Chief.

Our focus will be on design and development of indigenous futuristic technologies and systems and ensuring that DRDO continues to be a leading technology generator. We will harness the capabilities of our Academia and Industry in realizing the state-of-the-art products, create an enabling environment and ensure that in the next five years majority of the systems inducted into our Armed Forces are indigenous products and also India exports defence systems in a big way, he further added.

Range Agni-5 missile. As Director, RCI, he led many Programmes, Projects and steered the development of advanced Avionics Technologies.

He is a renowned navigation and avionics expert and has been elected as the Fellow of Royal Institute of Navigation (FRIN), London, Royal Aeronautical Society, UK (FRAeS) and the Foreign Member of the Academy of Navigation and Motion Control,

the first IEI-IEEE (USA) joint award for Engineering Excellence and was conferred with the Silver Medal of Royal Aeronautical Society, London. He is also the recipient of Dr Biren Roy Space Science Design Award, Astronautical Society of the India Rocketry and Related Technologies Award and has been conferred with Honorary Degrees of Doctor of Science by many leading universities in the country.

BALLISTIC MISSILE INTERCEPTOR AAD FLIGHT TESTED SUCCESSFULLY

DRDO conducted successful test of the Advanced Area Defence (AAD) Ballistic Missile Interceptor at 1130 hr on 2 August 2018 from Abdul Kalam Island, Odisha. The endo-atmospheric missile, capable of intercepting incoming targets at an altitude of 15 to 25 km, was launched against multiple simulated targets of 1500 km class ballistic missile.

One target among simultaneously incoming multiple targets was selected on real time, the weapon system radars tracked the target and the missile locked on to it and intercepted the target with a high degree of accuracy.

The complete event including the engagement and interception was tracked by a number of electro-optical tracking systems, radars and telemetry stations. All the mission objectives were met successfully.

Chief of the Air Staff, Air Chief Marshal BS Dhanoa, witnessed the flight test along with other senior officials.

Hon'ble Raksha Mantri Smt Nirmala Sitharaman congratulated DRDO on the successful flight test and for further boosting the defence capabilities of the country.

The endo-atmospheric missile is capable of intercepting incoming targets at an altitude of 15 to 25 km.



INDIAN ARMY IMPLEMENTS SIZE INDIA COMBAT UNIFORM SETS

Size Roll as sets of shirt and trouser for uniform of Indian Army, developed and proposed by Defence Institute of Physiology and Allied Sciences (DIPAS), Delhi, has been accepted for implementation by the Master-General of the Ordnance (MGO). This is the first of its kind Size Roll in India with 12 sizes recommendation of combat uniform for male soldiers. The Size Roll has been extracted from the anthropometric database of around 8,000 soldiers of the Indian Army generated using India's first 3D whole body scanner.

An extensive anthropometric study of the Army was undertaken by DIPAS



for scientific study of best combination of sizes for the Indian Army. Earlier,

the shirt and the trouser of the combat uniform were provided from two different sources leading to mismatch and fitments disturbing uniformity of the uniform, which affected troops' combat preparedness.

DIPAS recommended a combination of four sizes in shirts and five in trousers with 12 combinations to attain maximum coverage of the users in minimum number of sizes. After successful human trials of the uniform, sets in different units along with UN Mission troops from the Armed Forces, its extensive provisioning has been undertaken by MGO as per revised Size Roll from financial year 2019-20 for induction in the Indian Army.

TOT

DLJ SIGNS LATOT FOR MULTI SPECTRAL CAMOUFLAGE PAINTS

Defence Laboratory, Jodhpur, (DLJ) signed License Agreement for Transfer of Technology

(LATOT) of Multi Spectral Camouflage Paints (MSCP) with Marudhar Paints and Polymers, Jodhpur, and Prolite

Paints and Chemicals, Kolkata, on 13 June 2018 in the presence of Dr SV Kamat, DS and DG (NS&M),





DRDO. Shri Vijay Kumar Sharma, Proprietor, Prolite Paints and Chemicals, and Shri Ashish Mathur, Partner, Marudhar Paints and Polymers, signed LATOT with Dr SR Vadera, OS and Director, DLJ. Dr SV Kamat handed over the ToT documents to the representatives of

the two firms and received the Demand Drafts of ToT fees.

The MSCP coatings have been developed by DLJ to provide cover to combat vehicles/installations in visual, near-IR, and thermal infrared spectral regions. The MSCP coatings are specially designed for low gloss, and colour

matching with the natural surroundings such as sand and vegetation. In addition, the near-IR reflectivity of the various shades are matched to corresponding terrain features like vegetation, sand, etc. They also have low emissivity for moderation of thermal infrared signatures.

DMSRDE TRANSFERS TECHNOLOGY OF HIGH PRESSURE HYDRAULIC FLUID-PEGCOL 113

Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur, transferred the technology of High Pressure Hydraulic Fluid,

PEGCOL 113 to M/S Protochem Industries Pvt Ltd, Navi Mumbai, on 2 July 2018.

PEGCOL 113 is a new product developed by DMSRDE on the urgent

demand of Programme ATVP. The hydraulic fluid would be used in steering gear system of underwater platforms.

TD PROGRAMME

MOBILE FOOD MICROBIAL ANALYSIS LABORATORY, PARAKH, LAUNCHED

Mobile Food Microbial Analysis Laboratory, Parakh, developed by Defence Food Research Laboratory (DFRL), Mysuru, for detection and identification of food and water borne pathogens was launched by Dr Rakesh Kumar Sharma, Director, DFRL, in the presence of Dr Upendra Kumar Singh, OS and Director, Defence Bio-engineering and Electromedical Laboratory (DEBEL), Bengaluru, on 31 July 2018. Dr MM Parida, Sc 'G', Head, Food Microbiology, and his team, who contributed in the development of the facility, were present during the launch.

This readily deployable laboratory can be used for rapid detection and characterization of pathogen and toxins in food and water. The laboratory is an autonomous 20 feet container mounted



on Ashok Leyland 1618-2C-4700 cabin chassis. It adheres to class ISO 7 and operated with negative pressure to handle clinical, food and environmental samples during biological emergency without any risk to personal and environment.

It is equipped with a dynamic pass box for transferring the samples directly inside the class III bio-safety cabinet for safe handling of samples. Parakh is capable of identifying select food borne pathogen and toxins (Anthrax, Brucellosis, Salmonella, Shigella, E.

Coli, Listeria, Yersinia, Botulinum, Staphylococcal Enterotoxin, Afla toxin, Ochra toxin, etc.) using both immunological and molecular test. The end user of Parakh includes ASC-CFL's, RVC, AFMC and Government Organisation like NDMA, FSSAI, etc.

MODULAR & CUSTOMIZED RATION STORAGE SYSTEM SILO INAUGURATED AT 102 INFANTRY BRIGADE

A modular and customized ration storage system, Silo, developed at Defence Food Research Laboratory (DFRL), Mysuru, under Young Scientist Project Soldier Assist System for Difficult Areas, installed at 5102 Coy ASC Comp, Khalsar, Nubra Valley, J&K, was inaugurated by Brigadier Bhupesh Hada, SC, Commander 102 Infantry Brigade, on 3 July 2018. Dr Rakesh Kumar Sharma, Director, DFRL, and Dr OP Chaurasia, Director, Defence Institute of High Altitude Research (DIHAR), Leh, were present on the occasion.

The issue of freezing of fresh fruits, vegetables, special ration items such as juices, chocolates amongst others is a dampener to morale of troops deployed at high altitude. The options of resuscitation of freshness by means of boiling the vegetables, exposure to limited sunlight available in the area and use of additives for tenderizing and thawing have not delivered satisfactory results.

To address the problem, DFRL developed this customized Silo System. The aspect of camouflage, concealment, ruggedness, transportability, need for

modular structure and easy operability and its functioning on solar power was kept in mind at the design stage.

The system caters to two segments, namely, commodities like rice, pulses, sugar and salt, and commodities like spices, condiments, oil hydro, tea rations, perishable fresh items, etc. The present modular and expansible structure was envisaged for minimum 3 tons of rations during land locked periods at Siachen. The Silo will be under trial for another one year for its on ground efficiency particularly during peak winters.



DRDO GEARING UP FOR PRODUCTION OF INDIGENOUS DEFENCE EQUIPMENT

Envisioning Hon'ble Prime Minister's 'Make-in-India' initiative, DRDO has set its sight on indigenous production of several weapon systems accepted by the services.

The projects completed by DRDO during the last three years, which find merit for indigenous production through various partner agencies include: 46 m Inflatable Radome; Medium Size Integrated Aerostat Surveillance System Nakshatra; 16 Ton Heavy Drop System; Enhanced Range Rocket Pinaka Mk-II; Sub-munition Warheads for Pinaka; 250 kg Pre-fragmented Bomb; Air Bursting Grenades for individual weapons; Penetration-cum-Blast (PCB) and Thermobaric (TB) Ammunition for 120 mm MBT Arjun Gun; Multi Calibre Individual Weapon System (MCIWS);

Minefield Marking Equipment Mk-II; CBRNe Remotely Operated Platforms (CBRNeP), Barmine Layer; Mountain Foot Bridge; Water Mist System for Fire Protection in naval ships; Electro-optical Fire Control System for naval ships; Commander's Non-panoramic TI Sight for Armoured Fighting Vehicles T-90, T-72 and BMP-II; Medium Power Radar for IAF; Anti-Torpedo Decoy System Maareech; High Speed Heavy-weight Ship Launched Torpedo Varunastra; Multi-influence Ground Mine (MIGM), etc.

The information was given by Hon'ble Raksha Mantri Smt Nirmala Sitharaman in a written reply to Dr Vinay P Sahasrabudhe in the upper house of the Parliament on 6 August 2018.

She also informed the house that the total Budget of Department of Defence Research and Development (DDR&D) for the Financial Year 2018-19 is Rs 17861.19 crore with manpower of approximately 24224 including 7354 scientists.

A total of 13 research projects in Technology Development (TD) and Science & Technology (S&T) category have been taken up by the DRDO in the year 2018-19 in the broad areas of hybrid power system, advanced materials, CBW Defence technologies, laser diode technology, technologies for insensitive munitions etc., and since these are in design phase, outcome of research projects will be seen in the coming years.



Some of the ready for indigenous production defence products developed by DRDO

SKILL DEVELOPMENT PROGRAMME ON MUSHROOM CULTIVATION & USER WORKSHOP ON DRL TECHNOLOGIES

A two-day training course on 'Mushroom Cultivation at High Altitude' was conducted at Twang by Defence Research Laboratory (DRL), Tezpur, under the Arunodaya Programme of DRDO. Twenty-five local farmers and 19 army personnel attended the programme. The participants were informed about the nutritional benefits of mushrooms and their economic importance as an alternative source of income especially for rural self-help groups. Hands-on training on preparation of mushroom bags and on other aspects of oyster mushroom cultivation were given to the participants. Mushroom spawn packs of 250 gm were distributed to each farmer and army personnel along with

substrate (buckwheat agro residue), so that they can continue with the endeavour on their own. A mushroom technology calendar was also provided to each participant. Shri Ashok Naglor, Sc 'D', Shri Utsab Deb, Sc 'C', Shri Vijay Pal, STA 'B', and Shri Arpan Sarkar, STA 'B' conducted the programme.

DRL also organised a one-day Users' Workshop on DRL Products and Technologies on 11 July 2018 under the Arunodaya Programme. Dr SK Dwivedi, Director, DRL, in his welcome address, described Arunodaya a platform for the Services wherein the technical problems faced by the soldiers in day-to-day functioning in the inhospitable regions can be addressed by DRL through the scientific pool of DRDO and

through DRDO developed products and technologies.

Brig T Jaggi, BGS (IS), HQ 4 Corps, the Chief Guest of the inaugural function, appreciated the initiatives taken by DRDO Life Sciences laboratories for the troops stationed at high altitude areas under 4 Corps.

Guest of Honour Brig Jaspal Singh, Brig Med, HQ 4 Corps, lauded DRDO efforts in establishing the medical oxygen plant at Khirmu and providing other biomedical devices developed by DRDO.

Thirty-four participants including 17 Service officers from different formations/units of HQ 4 Corps participated in the workshop.





RAISING DAY CELEBRATIONS

DESIDOC, DELHI

Defence Scientific Information and Documentation Centre (DESIDOC) celebrated its 48th Raising Day on 30 July 2018. Dr G Satheesh Reddy, DS and DG (MSS), DRDO, and SA to RM, was the Chief Guest of the inaugural function. Directors of the Delhi-based DRDO labs and HQ, former Directors and employees of the DESIDOC, and families of the DESIDOC employees were present on the occasion. To mark the occasion, Dr Reddy planted a sapling in the premises of the DESIDOC.

Dr Alka Suri, Director, DESIDOC, welcomed the august gathering and presented the achievements of the centre during the year 2017 and thanked all the employees for working tirelessly for accomplishing the tasks set for and by DRDO HQ. She expressed her gratitude to all the former Directors and employees for their outstanding contributions for the progress of the DESIDOC. A short film on the evolution of the DESIDOC since its inception along with DRDO in 1958 and its growth as a centre of excellence in the field of knowledge management and dissemination was screened on this occasion.

Dr Satheesh Reddy in his address praised DESIDOC for knowledge generation and for providing latest S&T information to the scientific community of DRDO. He extolled publications brought out by DESIDOC for highlighting the latest news and development in DRDO and thereby image building of DRDO to a whole new level.

Exuding confidence in DESIDOC's abilities Dr Reddy said: "There is plethora of books and information available, it is sometimes difficult to precisely tell what is needed. DESIDOC, thus, should continue to synergise, integrate and disseminate information among DRDO labs and provide the right information at the right time and



at the right format. It should always live up to the saying "Connect, Collaborate and Communicate." Adding further he said, "There is a need for directional change of research areas in the ensuing years wherein DRDO would focus more on futuristic research areas, and sophisticated technologies. DESIDOC should live up to its name and should gear up for providing services according to the changing need."

Dr Reddy released a monograph brought out by DESIDOC on 'Principles of Radar Electronic Warfare' and centre's Hindi Patrika 'Gyandeeep'. He also presented various laboratory-level DRDO Awards to the meritorious

employees and mementos to the retired employees and the employees who completed 25 years of service in DRDO.

A scintillating cultural programme was organised by the DESIDOC's talented employees. Dr Alka Suri and former Directors of DESIDOC gave away DESIDOC Annual Sports Awards and gifts to artists. Smt Vinod Kumari Sharma, Sc 'G', presented the vote of thanks.

MSC, PUNE

Mobile System Complex (MSC), Pune, observed its 17th Raising Day on 17 July 2018 amid the honourable presence of Shri Pravin K



Mehta, DS and DG (ACE), DRDO, as the Chief Guest and Dr MRM Babu, DS and Programme Director, Agni, as the Guest of Honour, and other senior dignitaries. As part of the lined-up events, MSC organized a 'Tree Plantation Drive' at DRDO's Transit Facility. An 8 km 'Walk for Green India' with banner conveying the message, was also part of the celebration events. Lab-level DRDO and Cash Awards to meritorious personnel for their excellence in service were conferred by the Chief Guest.

Ex-DRDO personnel, Shri VV Ghorpade, Shri S Karmakar, and Shri Y Hemade were also felicitated with a token of appreciation by Shri Pravin K Mehta. Personnel who completed 25 years service and winners of the various sporting events conducted to celebrate the Raising Day were felicitated by Dr MRM Babu. The gathering also enjoyed cultural programme executed by MSC's personnel and their family members. The Chief Guest appreciated

the Centre and wished MSC the very best. The event culminated with release of MSC's Mission Statement, 'Together Towards System Innovation on Rail'.

MSC also organised a technical symposium on the occasion on the topic, 'Innovation and Future Trends of Rail System for Defence Application'. The symposium was chaired by Dr MRM Babu, who accentuated the need of conducting such symposiums and enlightened the gathering with his commentary on the topics.

INTERNATIONAL DAY OF YOGA

ADE, BENGALURU

As part of yoga awareness among Aeronautical Development Establishment (ADE) employees, various videos on yoga were uploaded in ADE Intranet. Yoga charts were distributed to all the divisions of the lab for awareness on importance of yoga. An essay competition on topics such as Yoga and Lifestyle, Relevance of Yoga in Modern Life was conducted for all the employees. Mass demo of yoga was conducted on 21 June 2018. Shri Ramanuj Gautam, STA 'B', Shri Ajay Kumar Thakur, STA 'B' and Smt Uma K, Steno I helped in performing yoga exercises. Shri MVKV Prasad, DS and Director, ADE, and other senior scientists participated in the programme. Tree saplings were planted in ADE campus to mark the occasion. A lecture on 'Relevance of Yoga in Modern Society' was delivered by Shri Bhakthi Vinodha Swami, Director, Turiya Academia, Coimbatore.

DEAL, DEHRADUN

International Day of Yoga (IDY) was celebrated at Defence Electronics Applications Laboratory (DEAL), with great enthusiasm and fervour. The event was inaugurated by Dr RS Pundir, Director, DEAL. Experts from Bhartiya Yoga Sansthan and DEAL conducted the camp. Around 200 persons participated in the event.



IDY celebration at ADE (top) and DEAL

MSC, PUNE

MSC celebrated the IDY with the objective of sensitising the officials to the need,

importance and positive effect of yoga. A lecture-cum-demonstration programme on 'Experiential Learning of the Science of Yoga', with special emphasis on yoga for working



executives, was arranged in coordination with the world-renowned Kaivalydharm Yoga Institute and Research Centre, Lonavala. The yogacharyas from the centre apprised about the benefits of Yoga and demonstrated various yoga mudras. All the attendees, including Shri Sangam Sinha, OS and General Manager, MSC, performed yoga asanas during the session. The event was attended by Capt (IN) Sudhish Kamath, Director (SSQAG), Cdr R Vineeth Krishnan, Joint Director (SSQAG), Lt Col GS Yadav, all the MSC employees, and a few Army personnel. The event concluded with GM, MSC, advocating the need for frequent sessions of yoga for the benefit of one and all.

NPOL, KOCHI

International Day of Yoga (IDY) was celebrated with programme focusing on the significance of yoga for healthy and happy life. Shri S Kedarnath Shenoy, OS and Director, Naval Physical Oceanographic Laboratory (NPOL), elucidated how the holistic approach of yoga aims at harmonising the physical, mental and spiritual strength of human beings. Shri Kaithapram Vasudevan Namboothiri, eminent Yoga Guru and Chairman, Patanjali Yoga Training and Research Centre, Kochi, conducted a workshop on yoga. He stressed the need of practicing yoga, which serves as a mechanism for wellness of human beings by the combination of physical, mental, social and spiritual enrichment. The workshop had yoga demonstrations by a regular practitioner. All officers and staff performed breathing exercises.

NSTL, VISHAKAPATNAM

International Day of Yoga (IDY) programme was conducted at Naval Science and Technological Laboratory (NSTL) with enthusiasm. Officers and staff of the NSTL, office of the DG (NS&M), AO (R&D), PINA, Defence Standardization Cell, DSC, MKM members, family members and children of NSTL fraternity participated in the programme. Director, NSTL, Dr OR Nandagoan, the Chief Guest of the programme, along with 75 personnel performed common yoga protocol in

the morning session. Amrutha Aharam was served to the participants. In the afternoon session, Swami Guneshanada, delivered an enlightening speech on "Science of Yoga and its Implementation in day-to-day Life." Dr SV Kamat, DS and DG (NS&M), the Chief Guest of

the session, in his address, explained the influences of regular practice of yoga on performance improvement and uplifting of the organization. Dr Nandagoan briefed about the benefits of yoga and encouraged regular yoga practice in NSTL campus.



IDY at MSC (top), NPOL (centre) and at NSTL

FIRE SERVICE CAMPAIGN

DEAL, DEHRADUN

A mock fire drill was organised at Defence Electronics Applications Laboratory (DEAL), by the officers of Opto Electronics Factory. Large number of employees attended the drill. The employees were apprised about different type of fires and various type of fire-extinguishers used to tackle it. Mock fire drill was carried out and the employees were asked to extinguish the fire.

SFC, JAGDALPUR

Safety Engineering Division, SF Complex (SFC), conducted Fire Safety Campaign. The General Manager, Shri JC Chaudhary, Sc 'G', addressed and motivated the employees to be pre-active to prevent incidents like fire. Induction of 25 T GVW 6X4 multi-function advanced fire-fighting trucks was also done on the occasion.

Safety Engineering Division also conducted Environment Protection Campaign 2018 themed "If You can't Reuse it, Refuse it and Beat Plastic Pollution" during 5-30 June 2018. Shri JC Chaudhary inaugurated the campaign by planting a tree sapling at the premises.



Fire Drill at DEAL



Newly acquired GVW 6X4 Multi-function Advanced Fire-fighting Trucks at SFC

VARUNA MERIT DAY 2018

Naval Physical and Oceanographic Laboratory (NPOL), Kochi organized NPOL-Varuna Merit Day 2018 on 27 June 2018 to felicitate and honour the students and teachers of Bhavan's Varuna Vidyalaya (BVV), a joint venture of NPOL and Bharatiya Vidya Bhavan, on their excellent academic achievements. Smt Rani Gopakumar, Sc 'F', Chairperson, School Management Council (SMC), welcomed the gathering and highlighted the consistent academic excellence of

BVV over the years. Shri S Kedarnath Shenoy, OS and Director, NPOL, lauded the remarkable achievements of the students and emphasized the necessity of holistic education, with equal thrust to science, arts and their application in daily life.

The Chief Guest of the function, Shri C Radhakrishnan, renowned Malayalam Author, Physicist, Researcher, Film Director and Media Person, inaugurated the function and presented trophies and merit certificates

to the stream toppers and students who secured A1 in all subjects in the CBSE XII Board Examination. Through his humorous anecdotes and experiences, he stressed upon the critical role of parents and teachers in the success and achievements of the students. Ms Sreelakshmi G, national topper in X CBSE was also honoured on the occasion. Shri E Ramankutty, Director, Bharatiya Vidya Bhavan, Kochi Kendra, and Smt K Usha, Principal, BVV, offered felicitations on the occasion.



Meritorious students of Bhavan's Varuna Vidyalaya at NPOL-Varuna Merit Day

INFRA DEVELOPMENT

DG (NS&M) INAUGURATES INFRA FACILITIES AT DLJ

Distinguished Scientist and Director General (NS&M), DRDO, Dr SV Kamat inaugurated a Reverse Osmosis (RO) Plant on 14 June 2017 at Defence Laboratory Jodhpur (DLJ). The plant, established jointly with the local MES authorities, has capacity of purifying 2 lakh litre of underground water and would help in resolving the water crisis in the laboratory premises to certain extent.

DG (NS&M) also inaugurated renovated 'Admin Block' and an 'Engineering Workshop' at the laboratory. The Admin Division located at a far off distance from the main laboratory premises, will now be shifted to the New Technical Complex of the laboratory. It will not only resolve the



issue of extreme heat conditions faced by the Admin staff during the summer but will also be easily approachable for other employees. The Engineering Workshop building is well equipped

with all latest engineering machines required for carrying out R&D projects at DLJ.

NATIONAL SEMINAR ON R&D CHALLENGES IN DESERT WARFARE & OPERATIONS

A National Seminar on 'R&D Challenges in Desert Warfare and Operations (WARCODE-2018)' was organised at DLJ, during 14-15 June 2018 under the Chairmanship of Shri Ravindra Kumar, Sc 'G'. The aim of the seminar was to have interaction with the Services for understanding their requirements and their perspective on R&D activities.

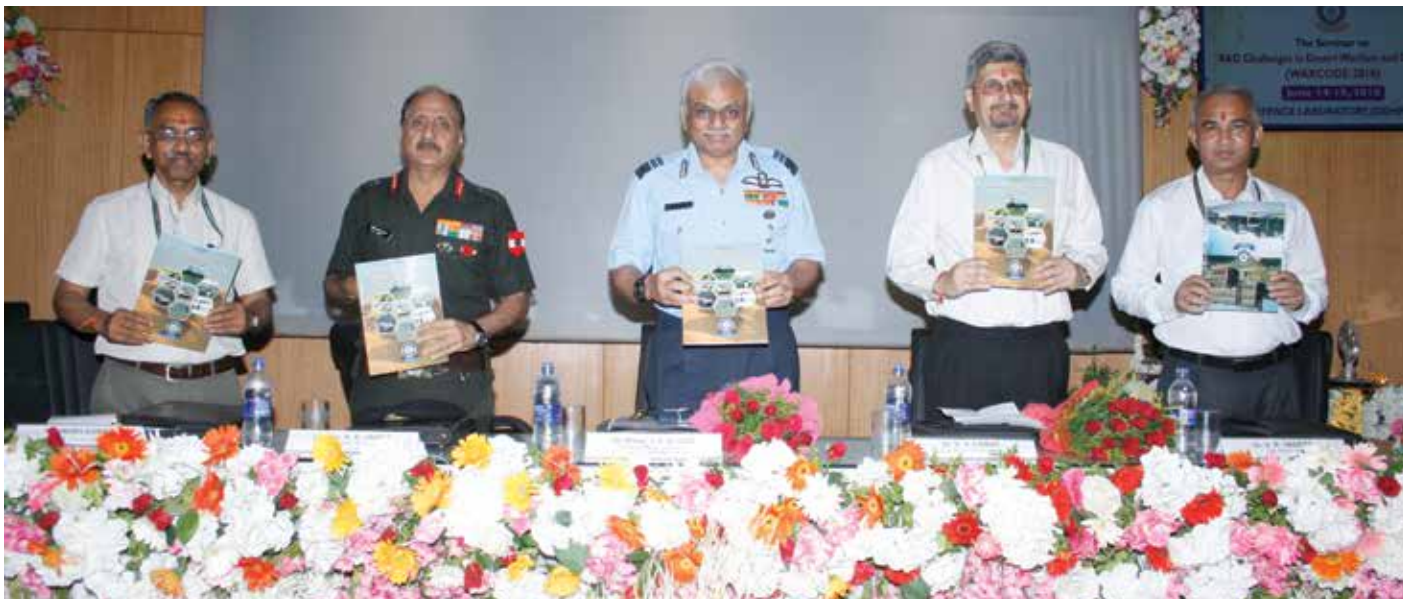
Air Marshal SB Deo, PVSM, AVSM, VM, VSM, AOC, Vice Chief of Air

Staff, the Chief Guest of the function, inaugurated the seminar. Dr SV Kamat, DG (NS&M), DRDO, presided over the inaugural function. The keynote address was delivered by Lt Gen RK Jagga, GOC, 12 Corps, Jodhpur.

Four invited talks and 20 oral presentations were made in four technical sessions by speakers from Services, former Directors of DLJ, and senior scientists from INMAS, DMSRDE, DIPAS, DRDE, DFRL and

DLJ. The participants discussed the issues related to R&D Challenges in Desert Warfare and Operations.

Dr PK Mehta, DG (ACE), DRDO, the Chief Guest of the valedictory function, chaired the panel discussion. Maj Gen AS Chauhan, GOC, JOSA, was also present on the occasion. One hundred and sixty-five delegates from Services, DRDO and industry partners attended the seminar.



Release of Seminar Souvenir

INFORMATION SECURITY OFFICERS MEET 2018

Directorate of Information Technology and Cyber Security (DIT&CS), DRDO HQ, organized an Information Security Officer (ISO) Meet during 12-13 July 2018 at DRDO HQ. More than 70 Information Security Officers (ISOs) from various labs and workcentres of DRDO attended the meet. The primary objective of the meet was to make the ISOs aware of

the practical aspects of cyber security, DRDO Information Security and Data Protection Policies and operational aspects of DRDO's air gapped network DRONA. The sessions were planned on various topics on cyber security including practical demonstration of indigenous and COTS security products.

The inaugural speech was given by Dr G Athithan, DG (MED, COS & CS),

on 'Concepts and Technologies for Cyber Defence.' Dr SK Pal, Director, DIT&CS, delivered a talk on 'Security of Air Gapped Networks.' The meet had presentations from subject experts from BARC, CAIR, DIT&CS, JCB, SAG and SPIC.

Shri CP Kulkarni, Associate Director, DIT&CS, was the coordinator of the meet.



Participants at Information Security Officers Meet 2018

ZONAL WORKSHOP ON STREAMLINING PROJECT MANAGEMENT IN DRDO

A two-day workshop on 'Streamlining Project Management in DRDO' was organized by Directorate of Planning and Coordination (DP&C), DRDO HQ, during 19-20 July 2018 at Targeted Training Center (TTC), Raja Ramanna Complex, Bengaluru. Forty senior scientists from various south zone labs and offices of DG MSS, ECS, Aero and NS&M clusters participated in the workshop in addition to south-based DRDO labs of other clusters.

Aim of the workshop was to improve project management in DRDO, to share tacit knowledge related to project management gained from various completed and ongoing projects and to come out with possible measures for further streamlining project execution.

Prof. S Chandrashekar from National Institute of Advanced Studies (NIAS), Bengaluru, delivered the keynote

address in which he emphasized on the need for developing a strategic vision through radical innovation. Prof. L Prasad from Indian Institute of Management (IIM), Bengaluru, in his talk on 'Grooming of Project Leaders: An interactive Session' laid emphasis on creation, nurturing and delivering of values related to products and services. Prof. PR Mahapatra from Indian Institute of Sciences (IISc), Bengaluru, in his talk on 'Enhancing Value and Outcomes of DRDO Projects: A Ringside Perspective' emphasized on need to take more number of Mission Mode projects by DRDO. Shri Sanjay Tandon, Director, Institute of Technology Management (ITM), Mussoorie, provided an insight into best practices in 'Time Estimation and Risk Management.'

The second day was devoted to talks by Directors from DRDO HQ. Director, Planning & Coordination, Smt Nabanita

R Krishnan, and her team deliberated on 'PPFM and Case Studies of DRDO Projects.' Smt Chandrika Kaushik, Director, Interaction with Services for Business, delivered a talk on 'Service Interactions and Para-72 linkage to DRDO Projects' and Dr AK Bhateja, Director, Finance and Materials Management, spoke on the 'Impact of DFP and PM-2016 on DRDO Projects'.

An important session was steered by Financial Advisers of the Office of the DG (MSS), DG (ECS), DG (NS&M), and CDA, Bengaluru, on 'Role of Finance as Enabling Partners in DRDO Projects', which turned out to be both informative and highly interactive.

The workshop concluded with an excellent panel discussion chaired by the DG (ECS) and DG (Aero), with Directors of ADE, CABS, GTRE and LRDE as panellists. The discussion brought out a number of action points.



Participants at Zonal Workshop on Streamlining Project Management in DRDO

WORKSHOP ON PULSED POWER TECHNOLOGY FOR EM LAUNCHER AND OTHER APPLICATIONS

Armanent Research and Development Establishment (ARDE), Pune, with the aim of bringing together experts from the challenging area of Pulsed Power Technology, conducted a two-day workshop on 'Pulsed Power Technology for EM Launcher and Other Applications' during 4-5 July 2018. Scientists, Engineers, and Professors from all over India working in the field were invited as participants. The workshop received an overwhelming response and participants from organizations such as BARC, Mumbai, BARC, Vizag, IIT Delhi, IPR, Ahmedabad, IISc, Bengaluru, and CDAC, Thiruvananthapuram, along with participants from ARDE, TBRL, RCI, MTRDC, R&DE (E), attended the

workshop. A total of 60 participants took benefit of nearly 20 talks by experts during the two-day course.

A panel discussion was held on 'Existing Technological Challenges and

Future Roadmap' with emphasis laid on developing all the enabling technologies in India.

A visit to the ARDE Rail Gun Facility was also organized.



Workshop on Pulsed Power Technology for EM Launcher and Other Applications



COURSE ON NDE OF COMPOSITE STRUCTURES

Advanced Systems Laboratory (ASL), Hyderabad, organized a course on 'NDE of Composite Structures' under the continuing education programme (CEP) of DRDO, during 16-20 July 2018. The course provided an insight in NDE technologies keeping in view their

practical applicability to the composite structures. Adequate exposure on these emerging technologies along with their new possibilities and approach was given to the participants. Shri MSR Prasad, DS and Director, ASL and DRDL, inaugurated the course and addressed the participants.

Forty participants from various DRDO labs and Indian Navy attended the course. Experienced guest faculties from DRDO, ISRO and IIT Madras delivered lectures along with internal faculty. Shri J Dhanasekaran was the Course Director. Dr K Srinivas was the Course Coordinator.



Participants of Course on NDE of Composite Structures

COURSE ON EXPLOSIVE SAFETY AND ACCIDENTAL HAZARDS

Centre for Fire, Explosives and Environment Safety (CFEES), Delhi, is the secretarial body of Storage and Transport of Explosives Committee (STEC), which regulates storage, transport, manufacture and handling of ammunition/explosive besides being the certifying authority. As Armed Forces hold and handle huge quantity of ammunition, the centre

works in very close coordination with all the three services.

Explosive safety with respect to storage, its transport, inspection, repair and eventual disposal is a very risky and technical operation that requires special skills and enhanced safety. CFEES organized a CEP course on 'Explosive Safety and Accidental Hazards' during 7-11 May 2018 to familiarize the Services

officers with explosive safety aspects and to understand their requirements through interaction

The course provided exposure on how to hold and handle huge quantity of ammunition. Thirty-three Service officers, 13 from Army, 12 from Navy and 8 from Air Force, attended the course.



Participants of Course on Explosive Safety and Accidental Hazards

COURSE ON INFORMATION SECURITY AND WEB-BASED-SERVICES

Defence Scientific Information and Documentation Centre (DESIDOC), Delhi, organised a three-day CEP on 'Information Security and Web-based Services' during 9-11 July 2018. Dr Rajeev Vij, Course Coordinator,

elaborated the need 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: Development of Web Applications, ISMS and ISO 27001,

Role of Cryptography and Information Security in Web Services, etc. The course comprised lectures, demonstrations, hands-on training and visit to Data Centre. Twenty-six participants from various DRDO labs/estts attended the course.

USERS AWARENESS PROGRAMME

DESIDOC organised a Training-cum-User Awareness/Interaction Programme at Defence Food Research Laboratory (DFRL), Mysuru, on 18 July 2018 to increase user awareness of the various services provided by the DESIDOC. Ninety-four scientists/officers from DFRL participated in the programme.

Dr Rajeev Vij, Sc 'G', organiser of the event, briefed the participants about various services provided by DESIDOC. Dr Alka Suri, Director, DESIDOC, apprised the participants about the new initiatives taken by the centre and its future roadmap. Dr Rakesh Kumar Sharma, Director, DFRL, exhorted DFRL scientists to benefit from the

scientific services being provided by DESIDOC.

An exhibition of DESIDOC products and services of relevance to DFRL was inaugurated jointly by Dr Rakesh Kumar Sharma, and Dr Alka Suri. Four publishers displayed their products and services.

COURSE ON E-PUB DESIGNING

DESIDOC conducted a three-day CEP course on 'Designing for E Publications' during 23-25 July 2018. Dr Rajeev Vij, Course

Coordinator, welcomed the participants and briefed them about the objectives and purpose of the course. Smt Vinod Kumari Sharma, Course Director,

explained how the course will improve the quality of future publications and increase their circulation.

Dr Alka Suri, Director, DESIDOC,



inaugurated the CEP and stressed on the need for automation and explained how by bringing out e-publication, there will be considerable improvement in the

quality and delivery of the publications. The topics covered during the course were: Basics of Designing, Artwork, E publications, Online Editing: Tools and

Techniques, E Publishing Software, Digital Printing, etc.

Twenty-five participants from eight DRDO labs/estts attended the course.



Participants of Course on E-pub Designing

ANNUAL MEET OF HRD COORDINATORS

Annual Meet of HRD Coordinators was organized at DFRL, Mysuru, during 16-17 July 2018. Dr Hina A Gokhale, OS and DG (HR), DRDO, inaugurated the event. Dr Rakesh Kumar Sharma, Director, DFRL, was present during the inaugural. Dr Farhath Khanum, HRD Coordinator, DFRL, welcomed the participants.

In her inaugural address, Dr Hina A Gokhale spoke about the importance of human factor in bringing laurel to the organisation. She asked the participants to utilize this meet to find out solutions for HRD related issues in their routine activities of lab. HRD Coordinators from 30 laboratories participated in the workshop. Shri Ashok Kumar, Director, DHRD, DRDO HQ, spoke about the objective of the meeting.



Dr Hina A Gokhale addressing HR Coordinators

CLUSTER COUNCIL MEETING

The Cluster Council Meeting of Naval Science and Materials (NS&M) cluster was held at DLJ on 13 June 2018 under the chairmanship of Dr SV Kamat, DG (NS&M), DRDO. The meeting was attended by Director, Defence Metallurgical Research Laboratory (DMRL), Director, Naval Materials Research Laboratory

(NMRL), Director, Naval Physical and Oceanographic Laboratory (NMRL), Director, Defence Materials and Stores Research and Development Establishment (DMSRDE), and senior officers from the NS&M cluster.

Dr SV Kamat welcomed all the members and briefed them about the objectives and charter given by DRDO

HQ to discuss the manpower, material management, budget and finance, and other issues related to the cluster laboratories.

Presentations covering status of current projects and future projects were made by the cluster Directors.



NS&M Cluster Council Meeting in progress

COURSE ON COMMUNICATION AND INTERPERSONAL SKILLS

Institute of Technology Management (ITM), Mussoorie, conducted a five-day course on 'Communication and Interpersonal Skills' during 9-13 July 2018. The course was designed to enlighten the participants with the concepts and importance of

effective communication skills. Shri Sanjay Tandon, OS and Director, ITM, inaugurated the course and deliberated upon the importance of effective communication skills for achieving professional excellence. Lectures on topics, viz., Communication

Process and its Importance, Assertive Communication, Effective Presentation Skills, Power of Non-Verbal Communication, Managing Stress, etc., were delivered during the course. Exercises were also conducted on communication and listening skills and stress release.

COURSE ON GROUP DYNAMICS & TEAM BUILDING

A five-day course on 'Group Dynamics and Team Building' was conducted by ITM, Mussoorie, during 16-20 July 2018. Shri Sanjay Tandon, in his welcome address explained the role and responsibilities of team in projects. The objective of the

course was to make participants aware about the concept of a team, explain the major theories of team development, describe methods for identifying team problems and develop appropriate strategies for their resolution (critical thinking), effective communication

and decision-making skills in team settings and also to identify issues in team dynamics, such as group norms, structures, leadership, authority, membership, cultural sensitivity, etc.

Lectures on various topics, viz., Fundamentals of Group and



Team Dynamics, Analysis of Team Development Stages, Effective Communication in Team, Interpersonal Effectiveness with Exercise, Team

Attributes and Characteristics, Cross Functional Team: Characteristics, Management Game, were delivered. A video on 'Team Development

Stages' was shown to the participants. Some exercises related to team and stress management were also conducted.



Participants of Course on Group Dynamics and Team Building

COURSE ON ADVANCED COMPUTER NETWORKING

A CEP course on 'Advanced Computer Networking' was organized at Integrated Test Range (ITR), Chandipur, during 23-27 July 2018. Dr BK Das, OS and Director, ITR, inaugurated the course.

The course aimed to upgrade the knowledge and practical exposure of the

participants on the recent technology concepts on computer networking. Various topics related to computer networking, e.g., Switching, Routing, Infrastructure services, Network Security, etc., were covered in the course. Faculties and experts from Adroit Information Technology Academy,

Kolkata, and ITR Chandipur, delivered the lectures. Thirty participants from ITR and other labs of DRDO attended the course.

Shri Pradip Saha, Sc 'F' and the Course Director, and his team organised the course.



Participants of Course on Advanced Computer Networking

COURSE ON OCEAN DATA PROCESSING TECHNIQUES, TOOLS AND SOFTWARE FOR SCIENTIFIC PURPOSES

A CEP course on 'Advancement of Ocean Data Processing Techniques, Tools and Software for Scientific Purposes' was conducted by Naval Physical Oceanographic Laboratory (NPOL), Kochi, during 25-29 June 2018. The course aimed to update the knowledge of the participants on the state-of-the-art techniques and

tools in ocean data processing and its applications for scientific use.

Shri S Kedarnath Shenoy, OS and Director, NPOL, inaugurated the course. The topics covered during the course included: Advancements in Ocean Observation Techniques, Advancements in Satellite Oceanography, Computational and

Statistical Techniques and Tools in Ocean Data Analysis, Artificial Neural Network and Fuzzy Logics for Marine Applications, etc.

Twenty-two participants attended the course. Shri Anand P, Sc 'E', and Dr Maheswaran PA, Sc 'D', were the Course Coordinator and the Deputy Coordinator, respectively.



Participants of Course on Advancement of Ocean Data Processing Techniques, Tools and Software for Scientific Purposes

INCOME TAX AWARENESS PROGRAMME

Smt Sheetal Sarin, Deputy Commissioner of Income Tax, Visakhapatnam, and team participated in an interactive awareness programme on 'Submission of TDS Returns' organized by the Department of Income Tax for the benefit of officers and staff of Naval Science and Technological Laboratory (NSTL), Visakhapatnam, on 10 July 2018.

Welcoming the IT team, Dr OR Nandagopan, OS and Director, NSTL, appreciated the Department of Income Tax for organizing the programme and hoped that this initiative would help NSTL employees in hassle-free submission of IT returns.

The session featured live demo of the e-filing website, and talks on provisions relating to taxation of salary

and perquisites, provisions relating to taxation of income under house property and capital gains. The IT team addressed all relevant queries of the audience and also briefed them on the various grievance redressal mechanisms—ASK Centers, e-Nivaran, e-Scrutiny and limited scrutiny.



COURSE ON SOLID MODELLING

Research and Development Establishment (Engineers), [R&DE (E)], Pune, organized a three-day CEP course on 'Solid Modelling' during 9-11 July 2018. The course was inaugurated by Shri AK Patel, Associate Director, R&DE (E).

The topics covered during the course included: CAD/CAM Product Cycle, Design Automation using CAD, Future of Making Things, Introduction and Advanced Features of Solid Works, Gateway to Design using CATIA, New Paradigm in Design using Unigraphics/NX, etc. The case studies of modelling of

R&DE(E) projects were presented.

Fifty-seven participants attended the course. Shri Kumod Kumar Sharma, Sc 'D', was the Course Director.



Participants of Course on Solid Modelling

DR APJ ABDUL KALAM MEMORIAL SCIENCE COUNCIL

Research Centre Imarat (RCI), Hyderabad, organised Dr APJ Abdul Kalam Memorial Science Council on 27 July 2018. Shri Sriganesh

S Prabhu and Prof. A Venugopal from TIFR, Mumbai delivered lectures on Modified Bulk Surface and Antennas Structure for Terahertz Spectroscopy

and Meta Materials and their Applications, respectively. Shri BHVS Narayana Murthy, DS and Director, RCI, presided over the function.

SOCIAL ACTIVITY

DMSRDE ORGANISES BLOOD DONATION CAMP

A blood donation camp was organized at Defence Materials Stores and Research and Development Establishment (DMSRDE), Kanpur, in association with Amar Ujala Foundation on 3 July 2018. A team of doctors from Ursala Blood Bank helped in organising the camp. Forty-seven volunteers donated blood. Eye and Diabetes check-up of the DMSRDE employees were also done in the camp.



LAND-BASED PROTOTYPE FOR AIR INDEPENDENT PROPULSION

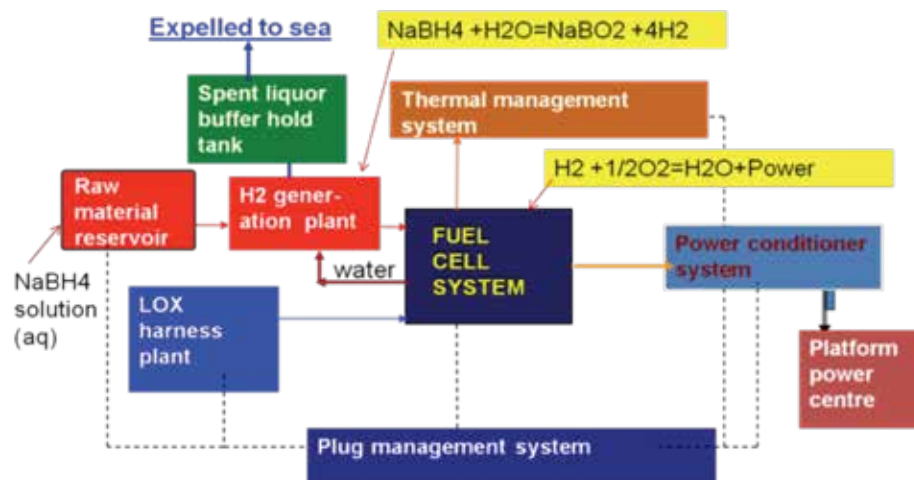
This column covers the pathbreaking and successful projects and programmes of the DRDO.

Lethality of a submarine owes a lot to its underwater endurance. Unlike nuclear powered submarines, lethality of a conventional diesel or electrical submarine depends on energy stored in rechargeable batteries for their propulsion power when submerged. Depending on the mission profile, the typical endurance can range between 1 to 2 days of continuous submergence. As the energy of the battery get depleted, submarine is forced to surface to snorkel level and run the diesel generators for charging the batteries; oxygen needed for combustion being drawn from the atmosphere. This probably is the most vulnerable phase during an operational mission, since acoustic, radar and satellite signature of the vehicle will be high under this condition. Air Independent Propulsion (AIP) systems are envisioned to alleviate this handicap by enhancing the underwater endurance of a submarine to about 12 to 14 days.

Submarine designers have tried different power trains starting from closed cycle diesel (CCD) with mode advanced steam-based power train like MESMA and external combustion engine like Sterling engine. Among all the fuel cell-based AIP systems, power train developed by German submarine manufacturer M/s HDW with Polymer Electrolyte Membrane Fuel Cell (PEMFC) and metal hydride storage for underwater hydrogen provision is the most successful AIP system. However, the system needs extremely pure hydrogen of the order of 99.9995 per cent purity.

Project AIP at NMRL

Basic R&D on fuel cell technology was started at Naval Materials Research



AIP Configuration Conceptualized and Implementation by NMRL

Laboratory (NMRL), Ambernath, a marine materials laboratory of DRDO, in early 1990s. The focus has been always on phosphoric acid fuel cell (PAFC) owing to its long operational life with fault tolerant characteristics. Besides, indigenous material development provides complete control over technology with minimum dependency on foreign countries. Unlike the development projects where a system is developed, proven, subjected to trials and then inducted and then installed on platforms, AIP system forms an integral part of the main platform itself.

System development is of no practical relevance unless the user is fully convinced and confident. Therefore, the Indian Navy was approached at the highest levels right at the beginning.

Feasibility Study & Technology Selection

The idea of an indigenous AIP was welcomed by the then Chief of the Naval Staff, though there were genuine apprehensions about its realisation. A

core team was formed with scientists from NMRL, technical Directorates of Integrated Headquarters Minister of Defence (Navy) and representatives of DRDO HQ. The core team brought out a comprehensive and professional comparative analysis of possible technologies and in the end an innovative configuration was conceived based on hydrogen provision through alkali borohydride hydrolysis and PAFC as power generation unit for integrating the system on Indian submarines.

Technology Implementation

The technology demonstration project was initiated in later 2010 with about 30 per cent funding from IHQ MOD (Navy) to develop the AIP technology, industrialize the same and to develop a Land-Based Prototype (LBP) in same form and fit of a representative submarine platform. Naval support further continued in the form of issuing of NSQRs to test the LBP system, which allows equipment rating in the beginning itself.



AIP Technology Definition

The AIP configuration, as drawn from the feasibility study, has advantage of no gaseous by-product allowing zero bleed at full diving depth, compact size, meeting the space constraints of submarine, and the simple process yielding high reliability. The primary chemical fuel—sodium borohydride (NaBH₄)—is carried in the form of aqueous solution with stabilisers. Hydrogen is generated on-board by catalyst-based hydrolysis of NaBH₄. The hydrogen generated is highly pure and after removal of carry over mist is fed directly to the PAFC stacks hold inside a Fuel Cell (FC) tower box. Oxygen is carried in cryogenic liquid form inside specially designed cryo tanks and is vaporised on-line to form gaseous oxygen. It is fed to the PAFC stacks as well. The PAFC stacks oxidise hydrogen into water through electrochemical route and in turn generates DC power with high efficiency. The raw DC power from fuel cell is fed to a power conditioner to boost the voltage so that the power can be injected to the submarine power centre, which in turn charges the submarine battery or could be directly used for its propulsion and hotel loads.

The user advocated NMRL to ensure performance and safety guarantee of the indigenous AIP system from a foreign

submarine designer through a MoU in 2012 to undertake ‘preliminary phase acceptance study’ on no-cost basis. The study was completed successfully in 2013.

A concurrent development plan was decided to reduce the time lag. Two types of approaches were adapted: the first was to develop the AIP hardware (prototype) with many interfaces hypothesised, and the second was to conduct a systematic design and safety study for the submarine version. Development of the sub-systems level technologies like PAFC stacks, hydrogen generators and power conditioners, through NPOL-CDAC route, along with relevant safety studies were taken up simultaneously. This was made possible owing to the modular nature of the technology where inter modular interfaces could be decided owing to the clarity of performance requirements and interface restrictions provided by the foreign submarine designers.

Issue of low manpower resources and skill sets was handled by identifying industrial partners for the sub-technologies in the initial phase and by engaging the resources of the same to realize the experimental assemblies while NMRL scientists worked for the primary development of fuel cell (PAFC stacks) and the hydrogen generator technologies.

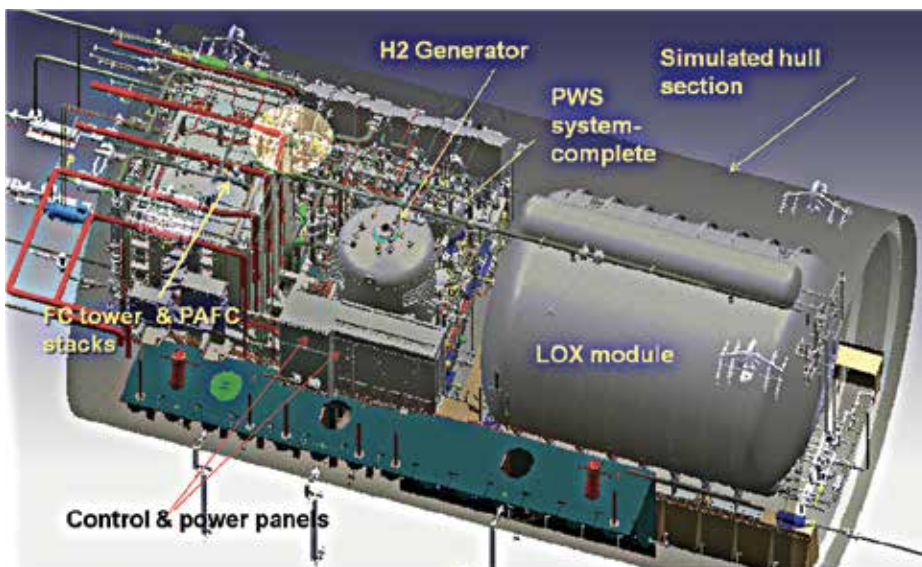
The safety study requirements were flagged vis-à-vis performance requirements of sub-systems and the technologies developed were put to test in an integrated manner through a pre-production floor model (PPFM)—a full scale AIP plant with open architecture. The PPFM set-up was used for testing the performance, reliability and other safety issues by NMRL and was later demonstrated to IN. Based on the learning from the PPFM, the AIP design was upgraded both for the LBP as well for the submarine version under the definition phase study with the submarine designer. The definition phase study was successfully concluded in early 2017 and the upgrades, particularly related to safety adaptations, were incorporated in the LBP hardware.

The LBP contains the primary AIP energy module mounted on a skid, called cradle, and the same was kept outside the simulated submarine hull initially. After setting to work, the LBP was trialed by the user from September 2017 to January 2018. The performance of the LBP was found satisfactory. Certain peripheral components were identified during the trials, which required modifications. The plant was operated in presence of IN representatives who in turn operated part of the system and expressed satisfaction towards its operability and safety. The primary power train of integrated AIP was, therefore, successfully tested through the LBP. In the final phase, the energy module cradle is being shifted inside the simulated submarine hull for user trials by the end of 2018.

Technology Challenges & Innovations

Introducing a new system concept built on home grown technologies, and engineering such a system to suit the form and fit of a submarine section posed several challenges. Analytical thinking and innovative problem solving skills resulted in as many as a dozen patents. A few indicative examples are:

A robust electrode system crafted from graphitic mesoporous carbon supported electrocatalyst allows flexible



Land-based Prototype LBP General Arrangement



User Trial

operation of the fuel cells and simple spring-based clamping technique maintains stack integrity under variable temperature conditions. Cascade regime of fuel flow map introduced in the tower ensures maximum fuel economy even while maintaining a fuel rich operating condition. Dual purpose embedded planar coil plate exchangers developed for heat transfer from/to cells improved the generator mode and sleep mode operation of stacks.

Designing of hydrogen generator on a novel principle of pulsed fuel injection with recirculation system allowed load independent control of hydrogen generation. Integrating the gas liquid separation and heat exchanger operations within the reactor itself resulted in a highly compact system that meets the space constraints. Fluid choke systems introduced in the hydrogen feed manifolds make controlled feed rates to the different stacks in the fuel cell tower.

Industrialization of the AIP Technology

To reduce the AIP technology development time, industry partners were involved at the early stage of development and their expertise was utilised to expedite the scale up process. In this venture, PAFC technology—the heart of the AIP

system—was industrialized through technology transfer to M/s Thermax, Pune, while the AIP system engineering design and prototype realization was done through M/s L&T Defence. The power conditioner development was outsourced to CDAC, Trivandrum for faster realization. The approach created the AIP production agency consortium at the end of the development phase.

Upshot

In the year 2010 when serious activities on the project was started, the Technology Readiness Level (TRL) was just about 2 to 3. As the endurance

trials in form and fit prototype get completed in January 2018, the TRL has risen to 7. Looking at the complexity of the product and the diversity of technologies associated, the task has been a great challenge. Systematic process development strategy starting with laboratory scale experiments to bench scale data generation and then to pilot plant scale up followed by scaled up prototypes has resulted in elegant equipment design and piping. Process intensification through innovative hybridization of unit operations has not only made the lay out compact, but also enhanced reliability.

Safety, reliability followed by efficiency, was the hierarchy of priorities targeted at all stages of design. Telescoping of development models using industry partners' expertise, leveraging of collaboration opportunities, partnership with other laboratories, multiple workcentres concept, designing to outsource, systematic experimentation for data generation, transparent review mechanisms, continuous user participation were the crucial factors that led to the development and proving on ground of the strategically significant and technologically complex prototype in a record time of around eight years. The first submarine grade AIP is scheduled for integration to a suitable Indian Naval submarine under retrofitment mode.



PPFM plant

VISITORS TO DRDO LABS/ESTTS

DFRL, Mysuru

Shri Sonam Wanchuk, Founder Member, Himalayan Institute of Alternative (HIAL), Ladakh, Leh, visited Defence Food Research Laboratory (DFRL), on 7 July 2018. Shri Dev Kumar Yadav, Sc 'D' made presentation on the recently established Silo at Ladakh, developed under Young Scientist Programme. Shri Wanchuk assured cooperation and support for collaborative research activities in the field of conventional energy sources between DFRL and HIAL.



Shri Sonam Wanchuk being briefed about DFRL products

DIPR, Delhi

Air Vice Marshal VR Chaudhari, AVSM, VM, ACAS (PO), and Gp Capt Manish Sabharwal, DPO-3, visited Defence Institute of Psychological Research (DIPR) on 4 July 2018. The ACAS (PO) reviewed various projects associated with Indian Air Force. He appreciated the research work being under taken in DIPR and looked forward for more association.



AVM Chaudhari interacting with the officers of Group Testing Officers Course at DIPR

IRDE, Dehradun

Shri V Balamurugan, OS and Director, Combat Vehicles Research and Development Establishment, Chennai, visited Instruments Research and Development Establishment (IRDE) on 25 July 2018. Shri Benjamin Lionel, OS and Director, IRDE, briefed him about IRDE and its various products.



Cmde Manish Chadha interacting with Director NPOL

NPOL, Kochi

Cmde Manish Chadha, Naval Attaché (Designate), Russia, visited Naval Physical Oceanographic Laboratory (NPOL), on 20 June 2018. He interacted with Shri S Kedarnath Shenoy, OS and Director, NPOL, and senior scientists and visited major facilities of the laboratory.

NSTL, Visakhapatnam

Vice Adm P Ajit Kumar, AVSM, VSM, VCNS, visited Naval Science and Technological Laboratory (NSTL), on 14 July 2018.



DRDO HARNESSING SCIENCE FOR PEACE & SECURITY

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

The article is 31th 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).

PERSONNEL POLICY REFORMS

The more than doubling of the DRDO budget from Rs.17.52 crore in 1970-71 to Rs 40.00 crore in five years had resulted in expansion of facilities and manpower in the laboratories of thrust areas like radar, communication, electronic warfare, guidance and control, aerospace where the additional scientific/technical and industrial manpower approved for the projects became comparable to their PEs. Since Finance officials targeted higher scientific posts (Scientist E equivalent and higher posts) for drastic reduction, the hierarchical structure was needle-like at higher levels, with a bulge at Scientist B and C equivalent levels and tapered-off upwards at Scientist D equivalent and downwards at Junior Scientific Officer. In the NGO (scientific assistant/foreman) and industrial categories, there was also significant expansion compared to the original strength in the PE. The scientists were mostly recruited through UPSC to whom the vacancies were released twice a year on a regular basis. The delay in filling up the posts varied from eight months to two years. Since the qualifications for the recruitment to the NGO category included Master's degree in science or a BE/B.Tech degree in engineering, and since the recruitment could be done at the laboratory, these posts for technicians were filled up by young engineers and scientists, a significant percentage of whom worked for two to three years to enhance their market value and left the Laboratory

for better prospects. Those who had met with success when UPSC interviews were held and it was not unusual to find a number of them jumping two levels to become Scientist B equivalent from Assistant Foreman, and laterally from one laboratory to another in a matter of three to four years. The picture was not as bright for scientists working in the non-thrust areas or in the inspection organisation where the opportunities for promotion were limited and were through departmental promotion committees which met not so regularly or as frequently. These factors led to unequal career opportunities and unhappiness among the scientists within the organisation, and tension between DRDO and the inspection organisations. The younger and brighter scientists and engineers, and also those who had joined DRDO at the level of technical assistants, moved from one laboratory to another as the project posts for Scientists B or C equivalent were advertised and selections were made. Teams broke up as skilled personnel migrated on promotion or through direct recruitment and affected the system development programmes of the laboratories.

The vexing question of DRDO getting out of the UPSC for recruitment and promotion required a lot more attention from the Scientific Adviser. He held a number of meetings with the Chairman UPSC and these were followed up by one of the Chief Controllers and the Director of Personnel. Concessions like DRDO sending the list of vacant posts for recruitment twice a year, having a say in

the screening of candidates to be called for interview, nomination of specialists for serving on the panel of experts for examination of the candidates, and inclusion of a representative from the laboratory to serve on the selection boards for the posts advertised by the laboratory, were made but the basic problems of uncertainty and delay in recruitment and promotion of scientists continued. The publication of the Third Pay Commission Report in which the Pay Commission recommended flexible complementing scheme for scientists and technologists provided the trigger for DRDO to get out of the inflexible and static personnel policy. The Scientific Adviser pursued it vigorously, by first getting the approval of the Minister for Science and Technology to include DRDO as a scientific department. Next, he utilised the recommendation of flexible complementing for scientific services to get the application of flexible complementing to DSS accepted and approved at a high level meeting of the Secretaries and the Chairman UPSC. The DRDO would no longer be bound by vacancy-constrained promotion which had caused so much unhappiness and migration of scientists from DRDO. Even after the approval Ministry of Finance, the flexible complementing scheme could not be implemented during Professor Menon's tenure as the Scientific Adviser because the details of bifurcation of the common cadre of scientists between the DRDO and DGI organisations, the circulation of the new rules to the scientists etc., had to be completed first.



CONSOLIDATION OF DELEGATION OF POWERS

The shift of DRDO from short-term responses to contemporary system development meant that the number of large projects with significant investments would be on the rise and there would be a greater need for taking decisions closer to the point of action. In effect, it would mean more decisions would have to be taken at the level of the heads of the laboratories for which powers of the Scientific Adviser and the Director General R&D would have to be delegated. Accordingly, Professor Menon delegated some more of the financial powers of the SA to RM and that of DGR&D to the heads of the laboratories in July 1975 and followed it up with a consolidated list of such powers delegated to heads of laboratories in April 1976. For example, full powers of the Scientific Adviser were delegated down in the case of placing of indents, disposal of surplus stores through the central purchase organisation like DGS&D, ISM London/Washington, placing of purchase orders on firms who have a DGS&D rate contract, purchase of material under limited tenders, direct purchase of materials/equipment not handled by central purchase organisations or not covered by DGS&D rate contract, advance payment on orders, sanction of expenditure for airlift of materials/equipment, contingent and miscellaneous expenditures. These steps reduced the paper work at the DRDO Headquarters and also eliminated one of the irritants that had bedevilled the working relationship between the laboratories and the Headquarters.

REFORMING DRDO HEADQUARTERS

The Scientific Adviser took the step of having an Internal Financial Adviser (IFA) attached to the DRDO so that most of the files with respect to revising the peace establishment of the laboratories,

financial approval for projects, foreign visits, equipment purchase, would be processed and scrutinized in-house through the office of the IFA before these were sent outside the Department for sanction, concurrence, and other related activities. This avoided the repetitive movement of files to and from the department and reduced the delays in getting approval of the higher authorities.

The Scientific Adviser who was not fully convinced of the necessity for DRDO Headquarters to grow to the numbers it had, constituted a committee under JP Kaicker, who was Additional Secretary Defence Supplies, to examine the duties and activities of Headquarters personnel versus their growth in numbers. He found that the special allowance paid to personnel serving at DRDO Headquarters might also have provided incentive for personnel from the laboratories to move to Headquarters. Kaicker's committee's recommendations reduced the number of personnel at Headquarters significantly and also cut out the special allowance. In this way the number of personnel available at the laboratories increased to the extent it was reduced at DRDO Headquarters.

FOREIGN DEPUTATION & VISITS

Unlike other science and technology departments of the Government of India, the scientists of DRDO found it very difficult to travel abroad on Government account even for presentation of papers or for attending important international seminars. While foreign visits by the personnel from the Ministry of Defence for purchase of arms or for training on arms and weapons were accorded permission, scientists and technologists of the DRDO were routinely denied permission as it was considered by financial officials that these visits were not necessary. Professor Menon

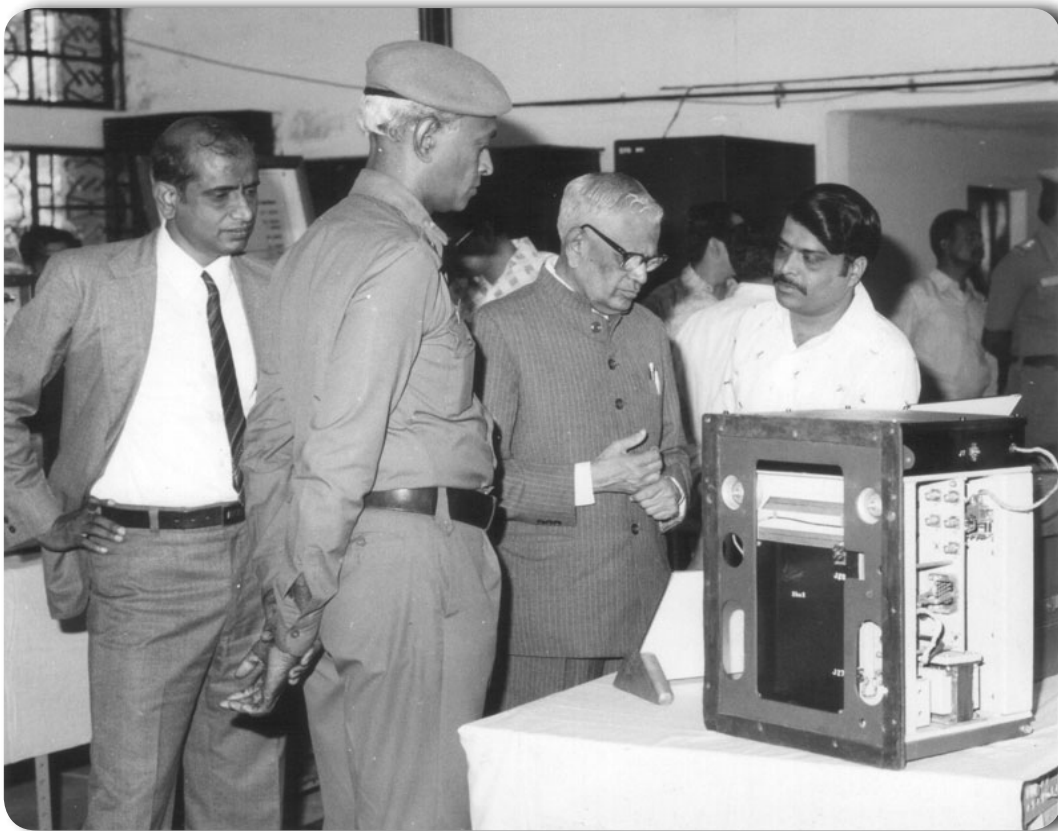
convinced the Expenditure and Finance Secretaries of the Government of India, the necessity for scientists and technologists of DRDO to attend such important international conferences and seminars and visits including stays at laboratories abroad for exchange of information about the latest trends in techniques and technologies, and the benefits that would accrue to the Country. Thereafter, the situation eased for visits abroad for DRDO scientists.

IMPACT ON THE ORGANISATION

Professor Menon's main contributions were two fold. The first contribution was giving thrust to projects where DRDO could contribute effectively and make a significant impact. Typical examples would be, the MBT 80 tank project which he put in shape, the Indra Radar, the microwave component development effort and stress on electronic warfare systems, and the Plan AREN communication projects, which he actively encouraged and supported, the projects of DMRL and the activities in the area of missiles including the strategic perspective on the new technology of missile warfare. The other contribution was in disentangling the sorry state of affairs in personnel policy of the DRDO and putting it on the correct path so that the rigidity and inflexibility by which they were earlier characterised, was eliminated and a methodology for an enlightened and flexible policy could be put in place. This came about in the years after he had left notably under the leadership of Dr Ramanna.

To be continued...

DOWN THE MEMORY LANE



The then Raksha Mantri R Venkataraman at Metcalfe House and showing keen interest in DRDO product (top).