

# DRDO

NEWSLETTER



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## ADVANCED TOWED ARTILLERY GUN SYSTEM UNDERGOES SUCCESSFUL ENGINEERING TRIALS



# CONTENTS

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## INNOVATION

07

DRDO conducts Successful Dynamic Firing Trial of ATAGS



Agni-IV tested Successfully

08

DEFENCE CO-OPERATION

13



EVENTS

14

COURSES

18

HRD ACTIVITIES

20

SPORTS ROUND-UP

21

VISITS

22

MAKE IN INDIA INITIATIVE

09

DRDO SERIES

24

TOT

10

RAJBHASHA PAK-WADA

26

FROM LAB TO FIELD

11

T&E FACILITIES

12

DRDO IN PRESS

27



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### FROM THE DESK OF THE CHAIRMAN



#### Dr S Christopher

CHAIRMAN

Defence Research & Development Organisation

&

SECRETARY

Department of Defence Research & Development

### MILESTONES REACHED AND MILES TO GO...

In **Aero Cluster laboratories**, Light Combat Aircraft, Tejas, the flag-ship programme of the cluster, completed major trials during 2016. The Indian Air Force has placed an order worth ₹ 80,000 crore for induction of 83 Tejas adding to a total of 123 aircraft. Real Time Simulator for Tejas has been upgraded to meet all training requirements. Tejas Series Production aircraft, SP-2 and SP-3, had their maiden flights. The Flight Control System of LCA has been cleared after outstation trials. Rustom-2, the Medium Altitude Long Endurance UAV, had its first Design Validation Flight successfully marking a significant milestone in its development. Nirbhay, the subsonic cruise missile, has been put through Ground Vibration Tests for critical Boost and Cruise phases. The missile had a launch in December 2016.

ADRDE has successfully demonstrated its capabilities. Integrated Aerostat Surveillance System, Nakshatra, had trials raising the system up to 1000 m altitude at Agra and at Gurdaspur. Truck-mounted Tactical Aerostat System had trials at high altitude (13,000 ft) and forward areas with COMINT payload. Controlled Aerial Delivery System was successfully tried out in Sikkim and Paratrooper Tactical Assault Parachute has been handed over to the Army for user trials.

The Airborne Early Warning & Control (AEW&C) System, is getting ready for induction into operational service shortly. Ground Exploitation System (GES) for the AEW&C operation has been installed in Bhatinda airbase. IACCS connectivity at Jodhpur has been established. GTRE has made progress with development and testing of Kaveri, Manik engines and testing of the Turbocharger for the MBT and the Sustainer engine of Navy's Uran missile. CEMILAC has supported progress of programmes at Aero Cluster labs as well as HAL and other industries for airworthiness clearance.

The laboratories in the **Electronics and Communication Cluster** have production orders worth ₹ 5,500 crore and programmes worth over ₹ 10,000 crore are on the anvil. Eight Medium Power S-Band Active Aperture Phased Array Radar, Arudhra, worth ₹ 800 crore, 18 Low Level Transportable Radar, Ashwini, worth ₹ 1,200 crore, and 55 S-band 3D Surveillance Radar, Bharani, worth ₹ 500 crore are under production. Three flight-worthy Synthetic Aperture Radar for ground imaging have been qualified. Prototype of AESA Radar for LCA has been validated on roof top. A 2 kW Directed Energy Laser Beam System has been integrated on to a



Arudhra, medium power active aperture phased array radars, worth ₹ 800 crore, are under production

Transportable Shelter and has been demonstrated successfully up to a range of 1 km against moving targets on the ground and in the air. Three numbers of LWIR Type 2 Super Lattice (T2SL) Detectors have been realized through M/s IIMC, Israel, by joint funding between DRDO and MoD, Israel. Based upon this detector, IRDE has realized a Thermal Imager. Laser fence developed by DARE is in operational deployment at its designated location and is working satisfactorily. DLRL has realised the ESM and CSM systems under the Samudrika programme for Navy and Air Force. SDR systems for the Navy has been developed and SDRs for other services are nearing completion.

The cluster of **Life Sciences laboratories** has been engaged in development of defensive and offensive Chemical-Biological systems as well as Life Support gadgets like Anti-'g' suit and Submarine Escape Suit. This cluster has, over the years, developed many systems that help neutralise the effects of the Nuclear-Biological-Chemical (NBC) warfare. Telemedicine programme would help in monitoring and management of health of armed services personnel. The production value of products from this cluster is about ₹ 780 crore with projects amounting to ₹ 3,200 crore in the pipeline.

As far as **Missiles and Strategic Systems** are concerned, while Agni Series missiles, A1, A2, A3, and A4, are already inducted into the Services, the A5 missile is progressing through trials. The Supersonic Cruise Missile, BrahMos, has been tested from INS Kolkata and INS Kochi. Its advanced version, BrahMos



A5 missile is progressing through trials

Land Attack Cruise Missile (LACM), has also been successfully test-fired. Akash, the surface-to-air missile has entered operational service with both Air Force and Army. Astra, a beyond-visual-range air-to-air missile (BVRAAM), is capable of engaging targets at varying range and altitudes allowing for engagement of both short-range (up to 20 km) and long-range (up to 80-110 km) targets using alternative propulsion modes. The missile has been tested from a Su-30 MK I fighter against a simulated live target. Astra uses a smokeless propulsion system. Helina, the 3rd Generation Anti-Tank Guided Missile (ATGM) has a Lock-on-Before-Launch system. The 'fire-and-forget' Helina has already been tested for its seven kilometre range.

The cluster of **Micro Electronic Devices, Computational Systems and Cyber Systems** has accomplished development of a number of Micro Electronic Devices like TWTs for radars, EW systems and MPMs for missiles amongst others. Important among the devices developed by CAIR are Secure Multi-Interface Link Encryptor (SMILE), Geographic Information System (GIS), Multi Agent Robotics System (MARS). SAG has developed and deployed a number of Cyber Security Tools like USB-ACE, IT-AIM, NADS, TILISM, AFITT, and SWIPE. ANURAG's major contributions last year include the High Performance Computing, CHITRA, and the Security-focussed Operating System—a hardened LINUX. MTRDC-developed Coupled-Cavity Travelling Wave Tube (CCTWT) for Weapon Locating Radar has gone into limited series production at BEL, Bengaluru. The lab has also developed and tested lab-level Microwave Power Module (MPM) for EW Pod, MTR-17. SSPL got its Chemical-Warfare Agent Monitor, e-Nasika, qualified for sensitivity levels at TNO, Netherlands, for all warfare agents as per JSQR. The lab has also developed and demonstrated an efficient Blue Laser marine data transmission system for under water applications.

In **Naval Systems and Materials** Cluster, four Naval Systems, viz., Abhay, a hull mounted Sonar for shallow water crafts, Humsa UG, an Upgrade for the





Abhay, a hull mounted Sonar for shallow water crafts, has been inducted into the Navy

Humsa Sonar system, NACS, a Near-field Acoustic Characterisation System and AIDSS, an Advanced Indigenous Distress Sonar System for Submarines, have been handed over to the Indian Navy. DRDO's Sonar has been fitted on three ships of Myanmar Navy. Total production value of products from NPOL is about ₹ 3,000 crore. Varunastra, an advanced heavy-weight anti-submarine torpedo from NSTL, has been inducted into the Navy. Maareech, the Advanced Torpedo Defence System, has also been inducted by Indian Navy. Total production value of NSTL products is over ₹ 2,800 crore. Defence Acquisition Council has cleared 1,500 numbers of BMP-2, the modernised amphibious NBC protection system for the Army at a production value of ₹ 1,265 crore. DMSRDE has developed and qualified Bullet Proof Jackets (BPJ), Multispectral Personnel Camouflage Equipment (MSPCE), NBC Suite, Synthetic Life Jacket and ECW Gloves, etc. The Materials labs have delivered Titanium Sponge, Composite Armour,

Investment Castings, Thermal Protection Shields, Microwave Chaff Cartridges, etc.

For the **Chief Controllers R&D** in the Corporate Headquarters, **CC R&D (SAM)** introduced ARNAV, the Naval Wargame for Tactical Training and Decision Making amongst user groups, Ammunition Tables for Artillery field guns, Training Software at Air Defence College, Gopalpur, Sangram-II War Gaming Infrastructure across various locations and demonstrated SAMAR at Army War College, Mhow.

**CC R&D (TM)** managed the Technology Management tasks in processing of 145 IPR applications and patenting 39 items in India and five items in foreign countries. A total of about 1500 patents have been processed. Towards creation of Centres of Excellence with Academia, Centre of Propulsion Technology (CoPT) at IIT Bombay and Madras, JCB Centre for Advanced Technology (JCBCAT) at Jadavpur University and Joint Advanced Technology Centre (JATC) at IIT, Delhi

were created.

In Technology Development Fund, a Funding System for development of Defence and Dual Use Technologies through industries has been created. Already 67 vendors have been registered under the Scheme. In Directorate of Budget, Finance & Accounts (DBF&A), the Directorate has modified and finalised the Schedule for Delegation of Financial Powers. The Expenditure Status up to Nov 2016 was 64.25 per cent.

For Directorate of Materiel Management (DMM), the Directorate has implemented e-procurement process in the Labs and Establishments. Already 2107 tenders have been processed by 35 labs/estts. Directorate has also drafted and issued a revised Procurement Manual, PM-2016, during the year. The Directorate of Vigilance and Security has processed 1,472 Security Clearances of Foreign Nationals to DRDO Headquarters and Labs, reviewed Security Infrastructure of five Labs and Security Manpower of eight Labs.

Vigilance Clearance of about 100 officials was also carried out.

The Directorate of Rajbhasha and O&M (DRB&OM) carried out Official Language Inspection of 13 Labs, translation of Parliament Matters, CCs Notes and published the journal, Raksha Anusandhan Bharti.

The Directorate of Civil Works and Estates (DCW&E) established Aeronautical Test Range at Chitradurga, Karnataka; Office of the DG (Aero); Civil Works for High Gain Telemetry System at ITR, Chandipur; LED Management and Audio System for Mission Control Centre at ILC, LC-IV, Dhamra; accommodation for Directorate of Contract Material Management at RCI, Hyderabad; Married Accommodation for DSC personnel at R&DE (E), Dighi, Pune; and Technical Accommodation for Centre for Engineering Analysis and Design (CEAD) at CVRDE, Avadi during the year.

The Directorate of Management Services (DMS) achieved the measures towards Cashless Payment System, replacement of old vehicles, conduct of Science Day, Technology Day and other events, Streamlined Foreign Visit formalities and processed over 300 procurement cases during the year.

The Defence Technology Commission Secretariat achieved creation of four posts of IAF personnel for implementation of IAF scheme in DRDO, Restructuring of Organisation of Corporate Headquarters and Renaming of designation of 'DG DRDO' to 'Chairman DRDO'.

The Directorate of Personnel (DoP) implemented the waiving of ACC clearance for Grade Pay of Sc 'F' on promotion to Sc 'G'; strengthening of Grievance Redressal Mechanism; rationalisation of SOP for appointment of laboratory Directors; streamlining of DPCs for Admin and Allied Cadres; recruitment of DRDS scientists for vacancies arising out of VRS and resignations; timely execution of ACC promotions and timely implementation of VII CPC recommendations in DRDO.

The Recruitment and Assessment Centre (RAC) carried out its Recruitment and Assessment duties systematically

**DRDO developed systems attracted attention of the World in many national and international exhibitions and Air Shows. Export potential of DRDO developed systems is increasing. Twenty countries have shown interest in procuring Akash, BrahMos, Sonar, Underwater Acoustic Communication System, Torpedoes, FAE Bomb, Thermobaric & FSAPDS Ammunition, Titanium Sponge, AEW&C System, and BFS Radar systems developed by the organisation.**

and on time. Training programmes were managed judiciously within the resources.

The Directorate of Human Resource Development has made a commendable contribution in processing Cadre Review Structures of various DRDO categories including DRTC, Admin and Allied, etc. The Centre for Personnel Talent Management (CEPTAM) carried out its Recruitment and Assessment duties smoothly. Training programmes were identified, scheduled and conducted. The Institute of Technology Management (ITM)/Defence Institute of Advanced Technology (DIAT), two premier Training Institutes of DRDO, organised over 40 courses with participation of over 740 officers. The Institutes also conducted 46 sessions under the Virtual Training Programme (VIP).

The Directorate of Public Interface (DPI) enhanced digital presence of DRDO through website and social media. About 30 Press Releases were

made on various events and a number of Press Conferences were organised. It participated in more than 19 exhibitions including the Africa Aerospace, Defence Exhibition, AMCDRR and the one in the premises of Indian Parliament House.

The Defence Scientific Information and Documentation Centre (DESIDOC) launched Defence Life Sciences Journal, new Website of DRDO, the E-Learning Portal and books on Dr APJ Abdul Kalam. Centre also designed and printed 200 books, documents, Annual Reports for DRDO, the Services and published DRDO Newsletter, DRDO Samachar, Technology Focus, Pradyogiki Vishesh, Defence Science Journal, and DESIDOC Journal of Library & Information Technology.

As for the Right to Information (RTI), three Workshops on RTI were held at Pune, Bengaluru and Hyderabad. Lectures were organised at ITM, Mussoorie, DL, Jodhpur, CGCRI, Kolkata, and SASE, Chandigarh. 1040 applications/appeals were received and 1017 of them have been disposed off. The rest are under process.

It is heartening to note that export potential of DRDO developed systems is increasing. Twenty countries have shown interest in procuring the following DRDO systems: Akash, BrahMos, Sonar, Underwater Acoustic Communication System, Torpedoes, FAE Bomb, Thermobaric & FSAPDS Ammunition, Titanium Sponge, AEW&C System, and BFS Radar.

DRDO developed systems attracted attention of the World in many national and international exhibitions and Air Shows. Notable among these are the Aero India, Bahrain International Air Show and Africa Aero-space and Defence Exhibition in South Africa.

DRDO has taken major strides over the years to contribute significantly and relevantly to the nation's defence preparedness. DRDO resolves to persist on its mission in the service of the nation in the years to come.

*Jai Hind.*





# DRDO CONDUCTS SUCCESSFUL DYNAMIC FIRING TRIAL OF ATAGS

**D**RDO achieved technological breakthrough by successfully conducting maiden dynamic firing trials of two fully integrated 155 mm x 52 mm calibre Advanced Towed Artillery Gun System (ATAGS). The development of the complex system has been carried out in a very short time of four years. The trials conducted at Proof and Experimental Establishment (PXE), Chandipur, from 13-20 December 2016, successfully met the mission objectives.

Armament Research and Development Establishment (ARDE), Pune, is the nodal lab, which carried out majority of the development work of ATAGS. Sister DRDO labs—Instruments Research and Development Establishment (IRDE), Dehradun; Vehicles Research and Development Establishment (VRDE), Ahmednagar; Centre for Artificial Intelligence and Robotics (CAIR), Bengaluru; Defence Electronics Application Laboratory

**The gun had several significant features such as an all-electric drive, high mobility, quick deployability, auxiliary power mode, advanced communication system, and automated command and control system.**

(DEAL), Dehradun and PXE—chipped in with solutions in specific areas. The in-house development has led to headway in the advanced technologies, which include higher pressure, higher chamber volume gun barrel, breech mechanism, compact recoil system and an efficient

muzzle brake. A very robust yet compact structure, high power compact auxiliary power unit for achieving higher mobility during cross-country, walking-beam suspension for negotiating highly undulating terrains, SDR-based advanced communication, simultaneous voice and data communication, fire control computer, compact thermal imaging sight and surveillance system are some of the advanced features of the gun system.

The ATAGS is configured with all-electric drives to ensure maintenance-free and reliable field operations. The automation ensures five Multiple Rounds Simultaneous Impact (MRSI), automatic shell loading and ramming, higher rate of fire, and fast coming into/out of action in the day/night war scenario. It is equipped with Integrated Fire Control system consisting of INS-based Automatic Gun Alignment and Positioning System (AGAPS), Muzzle Velocity Radar



ATAGS on display in Republic Day Parade 2017

(MVR) and Ballistic Computer to carry out online computations. The system comprises a Tactical Computer (TC) that commands and controls a battery of six to eight guns over radio and line, and has been configured to be integrated as per ACCCS Shakti network protocol of Artillery Regiments.

Dr KM Rajan, DS and Director, ARDE,

Shri R Appavuraj, OS and Director, PXE, and Dr SV Gade, Project Director, ATAGS monitored the firing. Teams from ARDE, VRDE, IRDE, CAIR, and PXE along with Development Partners, Tata Power SED and Bharat Forge Ltd, participated in the trials. Lt Gen JP Singh, Chairman, members of Special Review Committee, officers from School of Arty, Deolali,

also witnessed the trials. Shri PK Mehta, OS and DG ACE, DRDO, expressed satisfaction on completion of this major milestone.

Dr S Christopher, Chairman, DRDO and Secretary, Department of Defence R&D witnessed the remote firing of both the guns. He congratulated all the teams for successful test firing.

## AGNI-IV TESTED SUCCESSFULLY

**A**gni-IV, the long-range surface-to-surface ballistic missile with a range of 4000 km was successfully flight tested on 2 January 2017 meeting all the mission objectives and proving the reliability and efficacy

of the weapon system. The missile was launched from Dr APJ Abdul Kalam Island, Odisha, at 12 hr. Radars, tracking systems and range stations tracked and monitored the flight performance.

Agni-IV is equipped with state-of-the-

art avionics, 5th generation on-board computer and distributed architecture. It has latest features to correct and guide itself for in-flight disturbances.







# INDIA EVOLVING AS A GLOBAL HUB IN DEFENCE MANUFACTURING



**H**on'ble Raksha Mantri Shri Manohar Parrikar congratulated DRDO scientists for the recent successful missions including Smart Anti Airfield Weapon, Long Range Ballistic Missiles Agni-V and Agni-IV, Guided Pinaka and Astra. He complimented the Missile Complex for indigenizing various technology products and strengthening the defence industrial base in the country. Shri Parrikar was on a visit to DRDO's Dr APJ Abdul Kalam Missile Complex.

Speaking on the occasion Hon'ble Raksha Mantri said, "There is lot of knowledge and infrastructure base with the DRDO that if tapped by the Micro

Small and Medium Enterprises (MSME) and private industries would lead to the establishment of a self-reliant defence industrial ecosystem in our country. Today, the industries are significantly contributing in the realization of various defence products with the know-how provided by the DRDO and few of these have even graduated as lead integrators. The partnership between DRDO and industries is transforming our country into a global defence manufacturing hub. This synergy has provided the much needed thrust for exporting our defence products globally. We are taking necessary initiatives in this direction and I am sure that our state-of-the-art

missiles and weapons systems will garner the much needed interest in the global markets and generate foreign exchange."

Shri Parrikar appreciated DRDO for signing MoUs with various universities in diversified research areas and their further strengthening by frequent interactions for realization of futuristic technological products."

Hon'ble Raksha Mantri reviewed ongoing missiles and related programmes. Dr S Christopher, Chairman DRDO and Secretary, Department of Defence R&D along with Dr G Satheesh Reddy, SA to RM and DG (MSS) briefed the Raksha Mantri on various technological developments.

## DLJ SIGNS AGREEMENT OF ToT FOR PCM COOL VEST & CAP

**D**efence Laboratory, Jodhpur (DLJ), signed the agreement documents for ToT of Phase Change Materials (PCM) Cool Vest and Cap with three Indian firms. Dr SR Vadera, OS and Director, DLJ, signed Licensing Agreement with M/s Sure Safety (India) Pvt Ltd, Vadodara on 9 December 2016, and with M/s MKU Pvt Ltd, Kanpur and M/s Vijay Sabre Safety Pvt Ltd, Mumbai, on 23 December 2016.

PCM Cool Vest and Cap reduces heat stress and provides relief from high heat in hot, humid and dry environmental conditions by absorbing excess heat of human body while working in high heat ambient conditions. PCM cool packs absorb large amount of heat in the form of latent heat of PCM during phase change (solid to liquid) and maintains



temperature of less than 30 °C in the vicinity of body. The cool vest consists of specially designed 12 pockets to hold PCM cool packs and cool cap consists of

specially designed 2 pockets to hold PCM cool packs. These packs are easy to use and rechargeable. The weight of vest is 2 kg and that of a cap is 300 g.

## DFRL TRANSFERS TECHNOLOGIES OF HIGH ENERGY & NUTRIFOOD BAR

Defence Food Research Laboratory (DFRL), Mysuru, signed Memorandum of Understanding (MoU) for transfer of High Energy and Nutrifoed Bar Technologies. Dr Rakesh Kumar Sharma, Director, DFRL and Mrs Pallavi Bohra Purohit, Owner M/s Arunima Food Bangalore, signed the agreements on 4 January 2017. DFRL has developed different types of nutritious energy bars to cater to the requirement of Armed forces located at desert and high altitudes. Each bar, targeted with a specific functional ingredient, provides health benefits with calorific value ranging from 400-540 kCal and shelf-life of 6-15 months with good organoleptic acceptance as compared to the bars available in the market with limited shelf-life of 4-6 months.







# RURAL DEVELOPMENT PROGRAMME

Defence Food Research Laboratory (DFRL), Mysuru, along with Spoorthy Janaabhivruddi Samste conducted an awareness programme and one-day workshop for the farmers of Ahalya village on 11 December 2016 to promulgate various tomato processing techniques developed by the laboratory. Dr RK Sharma, Director, DFRL inaugurated the workshop.



DFRL has developed a range of products and processing technologies to reduce the post harvest losses of tomatoes. All these technologies are farm amenable and have been developed keeping in view the traditional Indian taste and palate. The products

developed using these technologies are stable for 6-9 months when stowed at ambient temperature and are available

in ready-to-serve or ready-to-prepare forms.

# FARMERS TRAINING PROGRAMME IN EASTERN LADAKH

A two-day training programme on “Scope of Agriculture in Changthang Valley and Technologies Available” was organized for local farmers of Changthang

Valley at Durbuk village during 17-18 December 2016 by Defence Institute of High Altitude Research (DIHAR), Leh. The programme was organized in collaboration with 16 Garhwal of 14 Corps.

Despite freezing cold, 70 farmers from different villages of Changthang actively participated and were trained to grow vegetables in protected as well as open field conditions during different seasons.



# INSTRUMENTED MECHANISED DROP TEST FACILITY AT TBRL RANGE

An Instrumented Mechanised Drop Test Facility (IMDTF) was made operational at Terminal Ballistics Research Laboratory (TBRL) Range, Ramgarh, on 16 December

2016. The facility conforms to all the drop test requirements for IM compliance and other standards to ensure that unintentional drop of munition/warhead/armament store

does not cause any loss to life. The facility has provision for testing 1.5 ton of ammunition, which can be dropped from a max height of 15 m, and capability to withstand any accidental detonation.



# NUCLEAR EMP TEST FACILITY AT VRDE

Nuclear weapon detonated at high altitude produces a phenomenon called Electromagnetic Pulse (EMP) with an amplitude of 50 kV/m, and between 20 ns to 30 ns. MIL STD 461F/G has specified an EMP pulse width of 28 ns, rise time 2.2 ns and amplitude of 50 Kv/m.

Vehicle Research and Development Establishment (VRDE), Ahmednagar, has developed a Nuclear Electromagnetic Pulse (NEMP) Test Facility to test various shelters and equipment against NEMP threats. The facility has been developed utilizing simulation techniques by simulating EMP with respect to the chamber size and the EUT size to get optimum performance before finalizing the configuration.

The facility is housed inside a Semi-anechoic Chamber and can cater to all types of weapon platforms (wheeled/



tracked) and systems/sub-systems. The antenna of the facility works in a Transverse Electromagnetic Mode (TEM) by generating an electric and magnetic fields simulating EMP phenomena. A

B-dot and D-dot sensors gives feedback of the pulse to generate EMP in close loop condition.

Maj Gen Ajay Gupta, Director, VRDE, inaugurated the facility.





# INTERNATIONAL DEFENCE COOPERATION

A Russian delegation from JSC-RTI, Moscow, visited Institute for Systems Studies and Analyses (ISSA), Delhi, on 9 December 2016 under

the India Russia Inter-Governmental Commission on Military Technology Cooperation to discuss possible collaboration in the field of wargaming.

The delegation presented their capabilities in wargaming. Requirements for collaboration were discussed.



A team of scientists from ISSA, Delhi, visited the Kyrgyz Military Institute, Bishkek, Kyrgyzstan, during 12-16 December 2016 to extend support and share their expertise in the

design and development of wargames for military training. The team held detailed discussions for future collaborations in area of Land and Air Defence Wargame activities. The Kyrgyz

Military Institute showed tremendous interest in the joint development of Company-level Commander Training and Air Defence Software systems.



# DRDO AWARDED EXHIBITOR OF THE YEAR AWARD IN ISC



Indian Science Congress (ISC) is organized every year by the Indian Science Congress Association (ISCA) in different parts of India to inculcate the scientific temper among people and to give young scientists a platform to interact with eminent scientists. ISCA has been organizing annual congress of the scientists and popular science lectures. The 104th Indian Science Congress was organized this year at Sri Venkateswara University, Tirupati, Andhra Pradesh, during 3-7 January 2017.

The Congress this year was inaugurated on 3 January 2017 by Shri Narendra Modi, Hon'ble Prime Minister of India, in the presence of Shri ESL Narasimhan, Governor of Andhra Pradesh; Shri N Chandrababu Naidu, Chief Minister of Andhra Pradesh; Dr Harsh Vardhan, Union Minister of Science & Technology and Earth Sciences; Shri YS Chowdhary, Union

Minister of State, Science & Technology and Earth Sciences; Prof. D Narayana Rao, General President of the Indian Science Congress Association; and Prof. A Damodaram, Vice-Chancellor of Sri Venkateswara University.

A special plenary session titled "Frontiers of Defence Research" was organized on 4 January 2017. Scientific Advisor to Raksha Mantri and DG (MSS) Dr G Satheesh Reddy was the Convener of the session. Shri MD Hafizur Rahaman, Chief Controller R&D (Human Resources & Technology Management) and Dr G Athithan, Director General (Micro Electronic Devices, Computational Systems and Cyber Systems), delivered lectures in the session.

As part of ISC, Women Science Congress (WSC) was inaugurated on 4 January 2017 to showcase the contributions of women in S&T and to inculcate scientific interest and

temper among them. Eminent women scientists presented their views on the Role of Women Scientists in National Development and Career Opportunities for Woman in S&T. Dr Shashi Bala Singh, DG (Life Sciences), DRDO and Dr Tessy Thomas, Director, Advanced Systems Laboratory, Hyderabad, were among the prominent speakers from DRDO in the WSC.

DRDO also participated in the "Pride of India Expo" organised on the sideline of ISC. The Expo displayed the latest innovations, applications and products to the general masses. DRDO pavilion was inaugurated by Shri N Chandrababu Naidu, Hon'ble Chief Minister of Andhra Pradesh, and was a major attraction amongst visitors and students. Forty-six DRDO laboratories showcased state-of-the-art indigenous military systems and technologies portraying India's march towards self-reliance in the cutting-edge defence technologies and realisation





Dr K Nageswara Rao (second from left), Director, Planning & Resources, DRDL, Hyderabad, receiving Exhibitor of the Year Award on behalf of DRDO

of Hon'ble Prime Minister's "Make in India" initiative.

Outdoor exhibits, which included long-range surface-to-surface ballistic missile Agni-V, Akash Weapon System,

Shaurya missile, the mock-up of the BrahMos supersonic missile, remotely operated vehicle Daksh, etc., were the main attractions amongst the visitors.

DRDO was awarded "Exhibitor of

the Year Award" for its products and technologies. Dr K Nageswara Rao, Director, Planning & Resources, DRDL, and DRDO's nodal officer for ISC, received the award on behalf of DRDO.

## DESIDOC PARTICIPATES IN WORLD BOOK FAIR

In its endeavour to promote and popularize science among civil society, Defence Scientific Information and Documentation Centre (DESIDOC), participated in the World Book Fair held during 9-17 January 2016 at Pragati Maidan, New Delhi. Dr S Christopher, Chairman DRDO and Secretary, Department of Defence R&D, inaugurated the DESIDOC stall and appreciated the Centre for enhancing DRDO's visibility among stakeholders and civil society. Shri MD Hafizur Rahaman, DS, Chief Controller R&D (Human Resources & Technology Management) and Shri Gopal Bhushan, Director, DESIDOC were present on the occasion.

DESIDOC displayed its complete array of in-house publications to highlight DRDO's academic pursuit and its determined efforts towards contribution in the knowledge economy of the country

and establishing connectivity with masses, researchers, academicians and

students. The presence of DRDO at the exhibition was appreciated by all visitors.



# RAISING DAY CELEBRATIONS

## DFRL, Mysuru



**D**efence Food Research Laboratory (DFRL), Mysuru, celebrated its 55th Lab Raising Day with grandeur on 28 December 2016. Chief Guest, Prof. B Suresh, Vice-Chancellor, JSS University, Mysuru, presided over the function. Dr RK Sharma, Director, DFRL, welcomed the guests and gave a brief account of R&D achievements of the laboratory in the year 2016. Prof. B Suresh, in his address, appreciated the achievements of DFRL in the area of food products and technologies and its yeomen services to the Armed Forces.

Laboratory-level DRDO Awards, DRTC Awards, Cash Awards and various other awards were presented to the meritorious employees and winners of sports activities.

## DRDE, Gwalior

**D**efence Research and Development Establishment (DRDE), Gwalior, celebrated its Lab Raising Day with gaiety and enthusiasm on 28 December 2016. Dr Lokendra Singh, OS and Director, DRDE, inaugurated the function and presented the significant achievements of DRDE in the year.

Dr Lokendra Singh conferred laboratory-level DRDO Awards to the meritorious scientists and staff and felicitated employees who completed 25 years of service in the organization. Dr Beer Singh, Sc G, Associate Director, presented prizes to the winners of various sport events held to celebrate the Raising Day.

The function concluded with a colourful cultural programme.



## ITR, Chandipur

**I**ntegrated Test Range (ITR), Chandipur, celebrated its 34th Raising Day on 18 December

2016. Dr G Satheesh Reddy, DS, SA to RM and DG (MSS), DRDO, was the Chief Guest at the function. Shri MSR

Prasad, DS, Director, DRDL and Shri MVKV Prasad, DS, Director, ADE, were the Guests of Honour. Dr BK Das,



OS and Director, ITR in his address to the august gathering highlighted achievements of the laboratory and its future programmes. He stressed on teamwork and assured to put all-out efforts towards social activities along with ongoing Range activities.

Dr G Satheesh Reddy in his address emphasised on improvement of Range Capabilities and assured to support the futuristic programmes of ITR for T&E of next generation trials. Various laboratory-level DRDO Awards were distributed to the meritorious employees. Merit and Welfare Scholarships were given to children of ITRians. Prizes were also distributed for various sports and cultural events organised to mark the day. A colourful programme was also organised on the occasion.

## NMRL, Ambernath

Naval Materials Research Laboratory (NMRL), Ambernath, celebrated its 64th Lab Raising Day on 5 January 2017. Dr SB Singh, OS and Director, NMRL, presided over the inaugural function. Dr (Smt) Susan Titus, Sc F, in her welcome address gave the glimpses of NMRL history right from its inception in the year 1953 to the present. Director, NMRL, in his address, highlighted technical achievements of the 2016 and set new targets for the year 2017. He urged the Project Directors to make all-out efforts to complete the projects before time so that their trials can be conducted on time. He also emphasized on the need for maintaining general cleanliness in the lab for pleasant environment. Dr Singh presented awards to the employees for their outstanding



and meritorious contributions and mementos to those who completed 25 years of service in DRDO. The

programme concluded with cultural programme where the employees and their children participated in a big way.



## CAIR, Bengaluru

Center for Artificial Intelligence and Robotics (CAIR), Bengaluru, celebrated its Lab Raising Day and Karnataka Rajyotsava Day with lot of enthusiasm on 22 December 2016.

Invited talks by Prof. (Dr) V

Vijayakumar, former VC, Dr Ambedkar Law University, on "Humanitarian Law" and by Dr VK Aatre, former SA to RM and Secretary DD R&D, on "Outlook on Science & Technology", were the highlights of the day.

A Technical Exhibition was organised to showcase CAIR's products

and technologies. Laboratory-level DRDO Awards were distributed to the meritorious officers and staff by Dr Aatre.

The programme concluded with a cultural programme performed by officers, staff and children of CAIR.

# CBRN DEFENCE TRAINING

Institute of Nuclear Medicine and Allied Sciences (INMAS), Delhi, organized course-cum-CME (accredited by the Medical Council of India) on 'Medical Management of CBRN Emergencies' for medical officers of Delhi Government during 28 November 2016 to 2 December 2016 to make the medical officers aware about

the gravity of CBRN emergencies and to inculcate skills to manage such situations on hospital level. The course curriculum included CBRN detection, protection, decontamination and medical management of CBRN emergencies. Participants were also appraised about the development work being carried out at INMAS for the medical

management of such emergencies.

INMAS has been imparting CBRN Defence Training to various stakeholders since 2010 and has trained more than 5000 responders including medics, paramedics and first responders from the Armed Forces, Paramilitary, elite forces and civilian agencies.



# BIODIGESTER TECHNOLOGY: PERFORMANCE & CHALLENGES

A national workshop on "Biodigester Technology: Performance and Challenges", was organized at Defence Research and Development Establishment (DRDE), Gwalior, on 2 December 2016 to update DRDO's Biodigester Technology holders about the latest developments in the field and to take notice of the difficulties

and challenges faced by them. The workshop was attended by 40 industry partners from all over the India.

Dr Lokendra Singh, Director, DRDE, and Dr DV Kamboj, Sc F, highlighted the various issues pertaining to implementation of the technology aligned with Govt of India's "Swachh Bharat Abhiyan".

The industry partners shared their experiences of technology implementation and accentuated various challenges being faced by them. The necessity for conducting such workshops at regular interval was also expressed by the industry partners so as to get technical support well-in-time.

# TECHNOLOGIES FOR DATA ANALYSIS & VISUALIZATION

ACEP course on "Technologies for Data Analysis and Visualization" was conducted during 14-16 December 2016 at Centre for Artificial Intelligence

and Robotics (CAIR), Bangaluru. The course covered Machine Learning and Data Mining techniques for analysing data of various media types. Speakers from IISc, IIIT's, C-DAC, ISRO,

etc., delivered the lectures.

Twenty participants attended the course. Dr NNR Ranga Suri was the Course Coordinator.



# EMERGING TRENDS IN ELECTRO-CHEMICAL POWER SOURCES FOR DEFENCE APPLICATIONS

A course on “Emerging Trends in Electrochemical Power Sources for Defence Applications” was held under the Continuing Education Programme (CEP) of DRDO during 5-9 December 2016 at Naval Science and Technological Laboratory (NSTL), Visakhapatnam. Dr OR Nandagopan, Director, NSTL, inaugurated the course.

The course covered all aspects of Energy Storage Devices: Past, Present and Future. Eminent speakers from IITs, Universities, DRDO, ISRO and industry delivered talks on various attributes of Lead acid, Silver-Zinc, Li ion batteries, metal air and other metal ion batteries including their safety and quality.



# COURSE ON MICROWAVE & MILLIMETER WAVE RECEIVER APPLICATIONS IN EW

Defence Electronics Research Laboratory (DLRL), Hyderabad, conducted a CEP course on “Microwave and Millimetre Wave Receiver Applications in EW” during

12-16 December 2016. Dr CG Balaji, DS, Director, DLRL, inaugurated the course and released the course material. In his inaugural address, Dr Balaji stressed on the importance of microwaves in the

field of electronic warfare. The course focused on overview of RF/microwaves to latest trends of microwaves. A visit to microwave workcenter and GAETEC lab facility was organized.



# AWARDS

## Best Higher Education Institute Award

**D**efence Institute of Advanced Technology (DIAT), Deemed University, Pune, has been conferred the “Best Higher Education Institute in Maharashtra” under the Innovative Category in the National Maharashtra Education Summit and Awards 2016 organized

by CMAI Association of India. Hon’ble Prof. Anil Saharabudhe, Chairman, All India Council for Technical Education, presented the award to Dr Surendra Pal, Vice Chancellor, DIAT at a function held at the University of Mumbai, Mumbai, on 4 November 2016.

DIAT also got “Education Leadership Award” amongst the Educational Institutes across India at 24th Dewang Mehta National Education Awards at a function held in Mumbai on 25 November 2016. The award was received by Prof. Balasubramanian, Dean, DIAT.



## Distinguished Woman Scientist Award

Dr Tessy Thomas, OS and Director, Advanced Systems Laboratory (ASL), Hyderabad, was awarded “Distinguished



Woman Scientist Award” by Andhra Pradesh Science Congress, Andhra Pradesh Academy of Science, for her lifetime contributions to the field of missile technology.

## Fellow of the Royal Society of Chemistry



Dr Trilok Chand Shami, Sc F, Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur, has been conferred

Fellow of the Royal Society of Chemistry (FRSC), Cambridge University, UK. The membership has been conferred on Dr Shami for his outstanding contributions in the field of

Chemistry/Materials. His key expertise is in Stealth Materials Development and Establishing RCS Measurement Methodologies at DMSRDE for Defence Applications.

## Best Paper Award



Shri Sameer Abdul Azeez, Sc E and Shri Vibin MV, Sc E, Naval Physical and Oceanographic Laboratory (NPOL), Kochi, won the “Best Paper Award in Ergonomic Design” at the International Conference on Management of Ergonomic Design, Industrial Safety and Healthcare Systems held at IIT Kharagpur during



20-23 December 2016.





## Higher Qualifications Acquired



Shri AC Pandey, Sc F, Defence Research and Development Establishment (DRDE), Gwalior, has been awarded PhD by Jiwaji University, Gwalior, for the

thesis titled 'Bio-Informatics of Vectors of Certain Diseases: Development of Vector Database and Predictive Modeling'.



Shri Vijai Pal, Sc D, DRDE, Gwalior, has been awarded PhD for the thesis titled 'Studies on Molecular and Serological Diagnosis of Ganders'.



Smt Bhargavi R Gopal, AD (OL), Defence Food Research Laboratory (DFRL), Mysuru, has been awarded PhD from Dakshin Bharath Hindi Prachar Sabha, Chennai, for the thesis titled 'Application, Implementation and Management of Official Language in Central Government Offices situated at Mysore: A Survey'.

# SPORTS ROUND-UP

## Central Zone Football Tournament

Proof and Experimental Establishment (PXE), Chandipur, organized DRDO Central Zone Football Tournament from 28 November to 2 December 2016. Teams from DLRL, DMRL, DRDL, RCI, ITR, PXE, NSTL and SFC participated in the tournament. PXE won the tournament by defeating DMRL. Two veteran footballers of ITR, Shri PK Singh and Shri SK Jonko were facilitated for their long association with football at the laboratory level. Dr AK Sannigrahi, Sc F, was the Chairman of Organizing Group and Shri C Marandi, TO C, was the Secretary.



## Central Zone Volleyball Tournament

DRDO Central Zone Volleyball Tournament was organised by Integrated Test Range (ITR), Chandipur, during 21-23 December 2016. Teams from ASL, DLRL, DMRL and DRDL from Hyderabad; NSTL, Visakhapatnam; SFC, Jagadapur; and PXE and ITR from Chandipur participated in the tournament. Dr BK Das, OS and Director ITR inaugurated the tournament. NSTL bagged the Tournament Trophy with a win over DMRL. Shri K Srinivasa Rao of NSTL was adjudged the Man of the Tournament.

Dr Das, presented trophy and medals to the Winners and Runners-up and announced the Central Zone Volleyball team.



# VISITORS TO DRDO LABS

## DARE, Bengaluru

Hon'ble Raksha Rajya Mantri (RRM) Dr Subhash R Bhamre visited Defence Avionics Research Establishment (DARE), Bengaluru, on 19 December 2016. Director, DARE, briefed the visitor about EW systems such as Radar Warning Receivers, Self Protection Suites, Radar Warner Jammers, Avionics Computers and Test Facilities. He also briefed about the various DARE developed systems that have been inducted into the IAF. Details of ongoing EW and avionics projects were also presented. Hon'ble RRM visited the Radar Warner Jammer Integration Facility, Digital Radar Warner Development and Evaluation Facility, Cockpit Engineering Simulator, and Darin III MC RiG.



## ISSA, Delhi

A team of officers led by Gp Capt Ajit Singh and Col AK Das, College of Defence Management, Secundrabad, visited Institute for Systems Studies and Analyses (ISSA), Delhi, on 15 December 2016. Team ISSA presented various aspects of defence modelling and simulation with details in various products developed by the institute.

The officers were also briefed about the work done in the area of strategic planning and non-conventional weapon systems, and computerised wargames for Land, Naval and Air systems.



## DIPAS, Delhi

Twelve Probationary IDAS Officers along with IFA R&D, DRDO HQ, visited Defence Institute of Physiology and Allied Sciences (DIPAS), Delhi, on 27 December 2016. Dr Bhuvnesh Kumar, Director, DIPAS, briefed the visitors about the ongoing R&D activities of the institute. The visitors appreciated the contributions made by DIPAS for Armed Forces and society at large.





## CAIR, Bengaluru

Hon'ble Raksha Rajya Mantri (RRM) Dr Subhash R Bhamre, visited Centre for Artificial Intelligence and Robotics (CAIR), Bengaluru, on 19 December 2016. Dr Bhamre was demonstrated technologies developed by CAIR in the area of Maritime Domain Awareness, Maritime Operational Knowledge, Patrol Management, GIS Technologies, Robotics Technologies and Image and Video Analytics for Semantic Sensor Data Processing.



## DIBER, Haldwani

Dr Shashi Bala Singh, DS, DG (LS), DRDO, visited Defence Institute of Bio-Energy Research (DIBER), HQ Haldwani and Field Station Pithoragarh during 27-29 January 2017. Dr Sanjay K Dwivedi, Offg Director, DIBER, briefed Dr Shashi Bala Singh about the R&D activities of DIBER.

DG (LS) reviewed the progress of the ongoing R&D projects and keenly discussed roadmap for future. DG also met officers of 119 (I) Infantry Brigade and State Government Agriculture Departments to understand their requirements and expectations, as well as the support DIBER can provide them. She highlighted the national importance and relevance of bio-fuel programme and need of intense R&D in a larger scale in this field.



## HEMRL, Pune

Dr Subhash R Bhamre, Hon'ble Raksha Rajya Mantri (RRM), visited High Energy Materials Research Laboratory (HEMRL), Pune, on 30 December 2016. An overview of the technical activities including rocket propellants, pyros and flares, gun propellants and insensitive munitions/thermobaric ammunition of HEMRL was presented to the RRM.

Hon'ble Minister inaugurated latest state-of-the-art HD 1.1 Propellant Processing Facility.



# DRDO HARNESSING SCIENCE FOR PEACE AND SECURITY-XII

## CHAPTER 2: TRANSFORMATION — DEFENCE RESEARCH & DEVELOPMENT (1958-1969)

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

### INTRODUCTION

The arming of Pakistan from 1954 with the latest weapons as a result of its signing a military pact with the United States of America and the increased incursions by the Chinese on our north-eastern borders forced the Government of India to reconsider its policies with respect to defence. Right from the time the independent government of the country took charge, Jawaharlal Nehru and other leaders, who had fought for independence gave highest priority for putting country's resources to improve the woefully low standard of living of the people. In their perception, the defence requirements were an unavoidable evil with and as far as possible they kept government investment and spending for defence at the minimum necessary levels. The strength of the armed forces was more or less kept at the same level as at the time of independence and the re-equipping of the army which was by far the largest of the three armed services had been progressively deferred. The Ministry of Defence did not have a full time minister of cabinet rank as it was under the direct charge of the Prime Minister who could not devote full-time for it. In a similar manner, it did not have a full time Scientific Adviser as the incumbent Dr DS Kothari had gone back to his teaching and research at the Delhi University and was available on part time basis. In the words of the

Chief of General Staff, Indian Army had equipment which were 14 to 18 years old and most of it obsolescent, if not obsolete, in the country of their origin. In such a situation, Pandit Nehru in 1957 reached out to one of his close associates, Shri VK Krishna Menon to become the Minister of Defence.

### SHRI VK KRISHNA MENON

According to his biographer, Shri VK Krishna Menon had the required credentials for the job as he had precise ideas about military matters. He had made a thorough study of defence, submitted several papers on it to various authorities and become recognized, particularly by the Left in Britain, as something of a military genius. Shri Krishna Menon who spent most of his lifetime in the United Kingdom during India's struggle for freedom, burst on the Indian political scene after India had attained independence as the first High Commissioner for India in Britain and later as a cabinet rank Minister without portfolio in Nehru's council of ministers. He greatly respected Nehru and accepted his leadership and would be friend those who had the ear of Nehru. He was a many sided personality with the positive qualities of a strong and sharp intellect, an enquiring mind, a hard working nature, a kind, generous, convivial and jovial disposition towards his friends; it was more than balanced

by his coldness, general mistrust of people, domineering attitude, obsessive nature, and unfriendliness. This resulted in his becoming over a period of time, a person surrounded by controversies whether it was at the United Nations or with the top rung officers of the Armed Forces or with his own party colleagues. However, it does not detract from the vital contributions he made to defence production and to defence research and development by kick-starting the process towards the objective of self-supporting defence entity for arms and weapons – a goal that was enunciated by the government in the early years after independence.

### DSO TO DRDO

#### Events Leading to the Formation of DRDO

When he took over the Defence Ministry, Shri Krishna Menon was very much conscious of the need to provide better equipment to the Armed Forces from indigenous production. If the Prime Minister had the vision and the faith that science and technology would serve the cause of Indian defence, it was the conviction and enthusiasm of Shri Krishna Menon, which brought about a sea change in defence production and a complete transformation of the Defence Science Organization. He was a firm believer that Indian scientists, technologists and engineers are second





to none and could achieve any target set in front of them provided they are given opportunities. Therefore, besides strengthening defence production activities, he initiated them over to merge the laboratories engaged in import substitution and in minor changes/development activities mostly under the Army, with the Defence Science Organisation to form the Defence Research and Development Organisation with the Scientific Adviser as the head. The level at which the advice of the Scientific Adviser was earlier sought by the Ministry was raised and the post of the head of the organization was converted into Scientific Adviser to the Defence Minister instead of being Scientific Adviser to the Ministry of Defence. The Directorate of Technical Development and Production (Air) which was concerned with research and development activities related to aircraft as well as the Fire Adviser were also brought into the Defence Research & Development Organisation (DRDO). It appears that even though Shri Krishna Menon had given orders to the Defence Secretary to go ahead with the formation of DRDO in October 1957, this was not given effect to, as "the Chiefs of Staff called for no evidence and, having a preconceived notion on the subject (formation of the DRDO) opposed it and sent a dissenting note to the [Defence] Ministry". On his return from the United Nations by the end of December 1957, the Defence Minister held a meeting with the top civilian and military officers of the Ministry and the DRDO came into being on 1st January 1958 with Dr DS Kothari as the Scientific Adviser to the Defence Minister. The principal functions of the DRDO were defined as:

- Undertaking development and design relating to equipment, including armaments, ammunition, electronics, aircraft, vehicles and engineering stores based on operational requirements defined by the Services
- Carrying out applied research to solve the problems of the Services
- Rendering scientific advice to the Services Headquarters
- Evaluating and carrying out technical

trials of new weapons and equipment or those designed and developed in the country

- Rendering technical assistance to civil trade for the development of new equipment, and
- Standardization of defence equipment and stores.

The Scientific Adviser was assisted by the Chief Controller of R&D (CCR&D), a senior Service Officer and by a Chief Scientist (CS). The CCR&D was mainly responsible for coordinating R&D programmes with the Services and for efficient functioning of research and development activities of the groups of the erst while TDEs which had been merged with the DRDO, general administration of the scientific and technical establishments, and standardization of equipment and stores. The Chief Scientist had the responsibility for coordinating the research carried out in the research and experimental establishments, formulation of training policy and research programmes, to liaise with the universities national laboratories & research institutions, taking care of the scientific interests of the Ministry and Service Headquarters, and also for contacts with the Commonwealth countries in matters of defence research interest. The CCR&D and the CS were required to act conjointly in carrying out their functions and also on matters impinging on defence science.

The Scientific Adviser along with the CCR&D and the CS formed the Management Group, which had the responsibility for policy and control of the DRDO. The Chief Controller R&D was assisted in carrying out his functions by Controllers of Armament Development, Electronics Development, and Vehicles & Engineering Stores Development. Their main functions were, to ensure efficient functioning of the laboratories under their control, to decide in consultation with the laboratories the projects to be undertaken, their priorities and the resources requirement, to facilitate the dialogue between the Services and the laboratories for definition of new weapon systems to ensure that the in-house equipment development meets

the Services' requirements, and to assist the laboratories in the placing of development contracts. The Chief Scientist was assisted in his functions by an Officer-in-Charge, Coordination Division. The first incumbent of the post of CCR&D was Major General BD Kapur and that of the CS was Dr V Ranganathan who was designated as Deputy Chief Scientist (DCS). In addition to these two senior officials, the Director of Technical Development and Production (Air) reported to the Scientific Adviser and was made responsible for coordinating with the respective Controller in matters regarding development of stores for the Air Force, and for coordinating with the Chief Scientist regarding research activities for the Air Force.

The importance attached by Shri Krishna Menon to science and technology for leading India to self sufficiency in defence could also be appreciated by his constituting the Defence Minister's Research and Development Committee which would consider all policy matters affecting the DRDO. The Defence Minister presided over the Committee and had besides the Scientific Adviser, as members, the Chiefs of Staff of the three Services, the Financial Adviser and the senior Secretariat Officers. The composition of the Committee was such that the Defence Minister ensured that all aspects of major policy decisions would be looked into and discussed before decisions were arrived at, and once decisions have been taken, implementation would not require any further concurrence from either the bureaucrats with in the Ministry or from the Services. There was another committee called the Research and Development Advisory Committee with the Scientific Adviser as the Chairman and with distinguished civilian scientists, senior Service Officers and defence scientists as members to assist the Scientific Adviser in the formulation of science and technology policies to meet the needs of the three Services. These two new committees replaced the earlier Defence Research Policy Board and the Defence Science Advisory Committee respectively.

To cover all civilian scientists engaged in research, design, development and inspection in Ministry of Defence, the Defence Science Service was revised and expanded with the creation of an adequate number of posts at the level of heads of laboratories and lower levels for attracting scientists of high calibre to lead research and development efforts. Further, as a fallout of the Science Policy Resolution, the Government of India also sanctioned for the DRDO funds for building residential accommodation for scientific and technical personnel. This paved the way for the first of the laboratory and residential complexes of the DRDO at Pashan, Pune for the ARDE and ERDL and for the Institute of Armament Studies, near Khadakvasla.

It was also realized that lack of adequate scientific and technical personnel could slow down considerably the process of building the organization. Hence, in addition to the recruitment through the Union Public Service

Commission, induction through the Defence Research Fellowship Scheme was also pursued. Accordingly every year a maximum of 50 young scientists and engineers indifferent scientific and engineering disciplines would be selected after a screening process and offered senior and junior research fellowships and would be trained for a period of two years after which those who were successful would be absorbed in the Defence Science Service as Junior Scientific Officer and Senior Scientific Officer Grade II respectively in the different disciplines of interest to the DRDO. The remuneration provided during the training period of two years and the likelihood of absorption after training into DSS was an attractive prospect for engineers and scientists.

In 1958, with the merging of the TDEs with the DSO, ten laboratories came into being under the DRDO and by end 1961, the number had swollen to 21 laboratories. However, in July 1961, the services of Dr

Kothari who had continued as Scientific Adviser to the Defence Minister were requested for taking over as Chairman of the University Grants Commission. Even though the fledgling DRDO needed Dr Kothari to direct and shape its destiny for some more time to come, the Defence Minister agreed to release him from his post. In his letter to Dr Kothari, he stated that “No one knows better than you how much I know I value your services and your near indispensability for Defence Science. However, there can be no defence without proper education...I am glad that you have acceded to my request to continue as Chairman of the Research and Development Advisory Committee. I feel sure that I can leave it to your judgment to meet both our needs and availability of your time and energy to give what best you can to defence science without defaulting on your duties to the University Grants Commission.”

*To be continued...*

## RAJBHASHA PAKHWADA

The Centre for Advanced Systems (CAS), Hyderabad, organised Rajbhasha Pakhwada conclusion function on 7 December 2016.

Dr V Venkateswara Rao, OS and Director, CAS, presided over the programme. Dr M Venkateshwara, formerly Prof. Osmania University, and Shri Ch V Subbarao, Hindi Officer, CSIR-National Geophysical Research Institute (CSIR-NGRI), Hyderabad, were invited as the Chief Guest and the Special Guest.

Dr V Venkateswara Rao called upon all the officials of CAS to propagate and promote Hindi. Col Vikhyat Marwah, DOMS, CAS, talked about future plans to propagate and promote Hindi in CAS. The guests shared their long experiences pertaining to implementation of official



language. For encouraging the staff, prizes were given away to the winners of

various competitions organised during the Pakhwada.





# INDIGENOUSLY DEVELOPED PROTECTIVE COVERING FOR T-72 TANKS OF INDIAN ARMY

As many as 2,500 T-72 tanks of the Indian Army will soon be equipped with an indigenously developed protective covering to ensure safety from enemy tank fire. Top Defence Research and Development Organisation (DRDO) officials told TOI on Friday that the tanks will be equipped with the advanced version of Explosive Reactive Armour (ERA) Mk-II for effective protection. “Besides, this will also result in saving of huge foreign exchange,” they said.

Presently, the T-72 tanks of the Indian army are fitted with ERA Mk-I. To get better protection for the tanks, the Indian Army had put forth its demand for advanced version of the ERA in 2010 to the DRDO.

The development of ERA Mk-II was thus undertaken by the DRDO in 2011 with High Energy Materials Research Laboratory as a nodal lab in association with the Combat Vehicles Research and Development Establishment and the Defence Metallurgical Research Laboratory.

The DRDO officials said the user trials of the ERA Mk-II were carried out in four phases from November 2015 to January 2016. “During these trials, ERA Mk-II was evaluated against 84 mm heat, 125 mm heat, Milan warhead and AMK-339 ammunition,” they added. The officials said, “With improved explosive properties and armour materials, the performance of ERA Mk-II against shaped charge warheads and kinetic



T-72 Ajeya with ERA Mk-I

energy projectiles was excellent and better than ERA Mk-I.”

“Army officers have also evaluated various performance parameters, like mobility, turret traverse, gun stabilisation among others as per the trial directives. All the requirements were met during the user evaluation,” the officials added. A top DRDO official, who did not wish to be named, told ToI, “Adoption of ERA Mk-II will significantly enhance the protection level of tanks. Thus, the Army wants advanced version for T-72 first and they will equip this system to their T-90 and Arjun MK-II in the near future.”

The official said the weight of reactive panel is similar of ERA MK-I. It means, it will not put any additional weight on the tank. Commenting on ERA’s role, a senior army officer said, “The main task of the ERA is to reduce the

penetration of shaped charge warheads and KE projectiles, thereby, ensuring the non-perforation of tank armour and protection of the crew within. Positively, the newly developed ERA has achieved all necessary requirements during the trials.”

The DRDO aims to start the mass production of the ERA after Transfer of Technology (ToT) to private defence manufacturers. “We will complete the process once we finalise manufacturers in the next few months,” sources from the DRDO said.

*Courtesy: Times of India; Jan 07, 2017*

# AFTER AGNI-V, INDIA TO TEST ANOTHER NUKE-CAPABLE BALLISTIC MISSILE, THE K-4

*India is likely to test K-4 SLBM from an underwater pontoon.*

There is reason now for China and Pakistan to be sore with India as the latter is expected to test launch K-4, a submarine-launched ballistic missile (SLBM) from an underwater pontoon on January 31, 2017.

The K-4 SLBM has a strike range of around 3,500 km and is said to be weighing 17 tonne. The missile can carry warhead of two tonne and is powered by a solid rocket propellant. The K-4 has been compared with Agni-III in terms of range. Submarine-launched missiles are miniaturised to fit the nuclear missile silos.

This is not the first time India is testing the K-4 SLBM. Last year, in March, India tested the missile from depth of 30 m, with “roaring success,” the New Indian Express reported.

The January-end test is expected to be fired from a depth of 20-30 m,

though the missile is designed to be launched from depth of 50 m. The K-4 is a combination of cruise and ballistic missile. It uses multiple stage rockets to exit the atmosphere and re-enters in a parabolic trajectory. India has already inducted an indigenously built nuclear submarine, INS Arihant that could eventually host the K-4.

Along with the K-4, an intermediate range missile, India is also developing a smaller 700 km missile K-15 (B-05). India has also tested the K-15. Apart from the K-4, K-15, New Delhi is said to be working on K-5, a 5000 km SLBM.

All the K-series of missiles will eventually make their way into India's Arihant-class submarines. The report also claimed that the K-series of missiles are faster, lighter and stealthier.

New Delhi needs to have effective defences against a nuclear Pakistan.

Pakistan grew stronger with recent successful tests of Babur-3, its first submarine-launched cruise missile (SLCM), that was fired from an underwater platform. Babur-3 is said to have the capability to carry both nuclear and conventional warhead.

For India, it is paramount strategically, to have credible minimum deterrence against a nuclear Pakistan and China. India also needs to have the capability of a second strike as India has voluntarily proclaimed a “No First Use” policy.

India also has a good track record when it comes to nuclear proliferation and safeguards unlike Pakistan. New Delhi wants to march ahead and seal its status as a responsible nuclear-triad nation.

*Courtesy: International Business Times; Jan 23, 2017*

## DRDO OUTLINES FUTURE MBT REQUIREMENTS

*Further details have emerged about India's plans for the main battle tank (MBT) element of the Future Ready Combat Vehicle (FRCV) programme.*

Requirements for the main armament, power pack, and mission systems have been revealed by the Defence Research and Development Organisation (DRDO).

Speaking at the International Armoured Vehicles 2017 Conference in London, Dr U Solomon of the DRDO's Combat Vehicles Research and Development Establishment (CVRDE) highlighted some of the new requirements for the MBT design, which is intended to replace the Indian Army's fleet of T-72 M1 'Ajeya' MBTs and is scheduled to enter service from the early 2020s.

Previously identified as having a requirement for a 120 mm main gun, the MBT is now set to be armed with a 125 mm gun, third-generation anti-tank

guided weapon (ATGW), and an air-defence machine gun. It is planned that the main gun will have the capacity to fire guided munitions, with these understood to be Israel Aerospace Industries' Laser Homing Attack or Laser Homing Anti-Tan (LAHAT) missile. Other ammunition will include programmable airburst munitions and armour-piercing, fin-stabilised discarding sabot (APFSDS) nature. The turret design will be unmanned, with the three-person crew seated in suspended seats below the turret - a configuration that is intended to enhance protection against underbelly blasts from mines or improvised explosive devices (IEDs).

The Bharat power pack—set to replace

the existing power packs of the Arjun Mk I and Mk II MBTs, as well as power the future MBT—is identified as a 2,200 kg unit powered by DHPP-A fuel. This is intended to operate at altitudes of up to 16,400 ft and temperatures as low as -20° Celsius. This requirement is likely a reflection of the Indian Army's need to operate in mountainous areas, particularly when deployed along India's border with Pakistan. A dynamic track tension adjuster will also enable the MBT to maintain ground traction when crossing obstacles and soft or rough terrain.

*Courtesy: IHS Jane's 360; Jan 23, 2017*