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DEFENCE RESEARCH AND DEVELOPMENT



Third Generation Anti Tank Missile- Nag in flight

HISTORICAL BACKGROUND

- 8.1 The Defence Research and Development Organisation (DRDO) was formed in 1958 by amalgamating the then existing Defence Science Organisation (DSO) and the Technical Development Establishments (TDEs). A separate Department of Defence Research and Development was formed in 1980 to improve administrative efficiency in the sanction and management of complex high technology projects for design, development and production of state-of-the-art weapon systems, equipment, platforms and sensors, undertaken by DRDO. In addition to DRDO, the Department also administers and funds a society, Aeronautical Development Agency (ADA), engaged in the development of Light Combat Aircraft (LCA).

MISSION

- 8.2 The Department of Defence Research and Development is dedicated to the mission of progressive enhancement of self-reliance in defence systems and state-of-the-art defence technologies. To facilitate accomplishing this mission, there is a mission-mode structure headed by the Scientific Adviser to Raksha Mantri, who also functions as Secretary, Department of Defence Research & Development and Director General, Research and Development.

PROGRAMMES AND PROJECTS

- 8.3 The Department undertakes programmes/projects either in response to the expressed requirements of the Armed Forces for design

and development of a major weapon system (staff projects) or for competence build-up in emerging technologies that may be required for systems to be developed in future (technology development projects). These programmes/projects are undertaken in wide ranging disciplines, such as, aeronautics, armaments, missiles, combat engineering, advanced computing, electronics, life sciences, advanced materials and composites and naval R&D. The Department also supports extramural research on defence related problems in academic institutions and other national R&D laboratories, through grants-in-aid projects, which are approved and monitored by various R&D boards.

PROGRAMME EXECUTION

- 8.4 The programmes/projects undertaken by the Department are executed through a network of 49 defence R&D laboratories/establishments and the Centre for Military Airworthiness and Certification (CEMILAC). These laboratories/establishments are situated all over the country from Tezpur in the East to Jodhpur in the West and Leh in the North to Kochi in the South. The programmes/projects are executed by a workforce of about 30,000 including more than 6000 scientists and engineers, supported by a budget of the order of Rs 3000 crore and with adequate delegation of financial and administrative powers to programme/project leaders.
- 8.5 The programmes/projects are executed in close partnership with the Services, defence

public sector undertakings, academic institutions, national research laboratories and private enterprises, to harness optimally the best available national resources and expertise. The 'concurrent engineering' approach is being followed in case of high technology projects to reduce the time lag between design, development and production.

REVIEW MECHANISM

- 8.6 There are institutionalised programme/project monitoring and review mechanisms in the Department. At the apex level, Defence Research and Development Council under the Chairmanship of Raksha Mantri with the three Service Chiefs as members, carries out periodic review and provides directions for policy and planning. There is an in-house apex level body called 'DRDO Council', chaired by the Scientific Adviser to Raksha Mantri, to review the progress of major projects of all the laboratories. In addition, Corporate Reviews covering techno-managerial aspects are also carried out by a high level committee. The staff projects for the Army are being reviewed by the Vice Chief of Army Staff (VCOAS), twice a year. For all major programmes/projects, there are multi-tier 'Programme Management Boards', having representation from the Services, defence R&D laboratories/establishments, production agencies, quality assurance agencies and in some cases from academic institutions and other national research laboratories, which periodically monitor and review the programmes and give mid-course directions.



Avalanche Control Structures installed at an avalanche site on NH-1A (Jammu-Srinagar Highway)

DRDO DEVELOPED ITEMS LED TO PRODUCTION

- 8.7 The limited series production of Pilotless Target Aircraft (PTA) - Lakshya, a reusable aerial target system, remotely operated from ground to provide training to gun and missile crew and to air defence pilots is in progress for all the three Services. The first batch of Lakshya has already been delivered to the Air Force and inducted. The balance quantity is expected to be delivered during the year.
- 8.8 Bulk production of illuminating ammunition having improved luminosity and duration for 105 mm field gun, has been established. The illuminating ammunition plays an important role during night warfare, both in offensive and defensive operations, for locating the targets.
- 8.9 After extensive user trials, including the recently held armour trials, an indent for manufacture of 124 Nos. of the Main Battle Tank (MBT) Arjun, has already been placed by the Army on the Ordnance Factory Board. The state-of-the-art 155 mm Self Propelled Gun, a variant of MBT Arjun, developed by integrating South African T-6 turret with MBT Arjun derivative chassis, has been recommended for introduction into service by the trial team.
- 8.10 Bulk production clearance for production of Data Concentrator has been given. Limited series production order for ACCCS (Artillery Combat Command and Control System) has already been placed and the production model is under testing and getting ready for field evaluation. Production order

for integrated laser-cum-night vision gap measuring device has been placed by the users.

- 8.11 The intelligent sea mine, processor based ground mine and processor based moored mine, have been cleared for production. These mines can be actuated by acoustic, magnetic and pressure signatures. These sophisticated mines have capability of identifying enemy targets and are activated at a predetermined distance. To enable the Navy to carry out training on mine operation, an exercise version of these mines has also been developed and evaluated successfully.
- 8.12 The improved Immersed Current Cathodic Protection (ICCP) system for protection of hull of surface ships of the Navy has been successfully tried out and cleared for production. This system has extended life of 10 years.
- 8.13 Two sets of containerised Operation Theatre Complex on Wheels and container based ward, for providing immediate medical treatment and emergency operation on war casu-



Processor Based Ground Mine

alties in the forward areas, are planned to be delivered to the Army during the year.

- 8.14 A light weight small capacity bridge, using fibre reinforced plastic composite material, developed to overcome the crevasses crossing problems faced by the troops at glacier regions, has been recommended for introduction into service with minor modifications. The bridge has modular construction and takes approximately two hours for launching by six persons.
- 8.15 Bulk production of various NBC protection systems such as, Integrated Field Shelter, small and large Respirator, Leak Tester, Integrated Hood Mask has been initiated.

PROGRESS MADE IN MAJOR R&D PROGRAMMES / PROJECTS DURING THE YEAR

- 8.16 The first Technology Demonstrator (TD1) Light Combat Aircraft (LCA) was flight tested for the first time on January 4, 2001. Subsequently, several flights of the aircraft have been successfully undertaken. Earlier, a major milestone was achieved by successfully conducting High Speed Taxi Trials on the aircraft. Prior to these trials, integration tests on all the on-board state-of-the-art systems had been completed. These systems had also been tested for Electromagnetic Interference/Electromagnetic Compatibility, by conducting 714 tests.
- 8.17 The second LCA Technology Demonstrator aircraft TD2 is in the final stage of system integration tests. After completion of these tests, structural coupling tests will be conducted and the first flight of TD2 is ex-

- pected during the second quarter of 2001. Fuselage coupling of the third aircraft, LCA Prototype Vehicle (PV1), has been completed and the aircraft is undergoing equipping. The fourth aircraft LCA PV2 is in 'parts fabrication' stage. In addition to these four aircraft, approval to build three more prototypes PV3, PV4 and PV5 (LCA Trainer) was accorded by the Government during this year. The programme has been delayed primarily due to technological complexities and lately due to sanctions imposed by the advanced countries.
- 8.18 Under the Kaveri programme for development of engine for the LCA, six prototypes (C1, C2, K1, K2, K3 and K4) have undergone extensive ground testing for a total of about 1000 hours so far. The first flight standard engine (K4) developed vibration problems which have been successfully addressed to, and the engine is now performing quite well. The Kaveri core has been successfully tested at high altitude test facilities of Central Institute of Aviation Motors (CIAM), Moscow. Further tests on engine and components are progressing. The official altitude tests and flying test bed trials are planned around the end 2001 and would continue upto first quarter of 2002. After completion of design work on marinised Kaveri engine, development work (Phase-I) has commenced.
- 8.19 The second flight test of long range surface-to-surface missile Agni-II, was conducted on 17 Jan 2001 in its final operational configuration. Agni-II is a two stage missile using solid propulsion system, having a range of about 2000 km with a payload of one ton and is launched from a rail mobile launcher. The flight test results indicated that mission objectives were met satisfactorily.
- 8.20 Three guided flights of short range surface-to-air missile Trishul (naval version) were conducted in May 2000, against simulated target Chukar, and in an anti-sea-skimmer role, from INS Dronacharya. Three flight trials of Trishul (Army version) were conducted against aero-model and Lakshya targets, using Trishul Combat Vehicle (TCV) - II.
- 8.21 Three flight trials of Akash, medium range surface-to-air missile, were conducted in July and September 2000. During these trials, communication system between battery controlled centre (BCC) and Akash self propelled launcher (ASPL) has been successfully evaluated.
- 8.22 Two guided flights of Nag, third generation anti-tank guided missile, were conducted in July 2000, with a day version seeker in top attack and fire and forget mode. During the last flight, a target at a range of 4.18 km was hit in top attack mode, achieving a technological breakthrough with the potential of developing the first missile in the world to achieve fire and forget and top attack capability at this range. Performance of tandem shaped warhead has been successfully demonstrated and performance of Nag Missile Sighting System (NAMITIS) was proved during limited field trials. Re-powering of Nag Missile Carrier (NAMICA-I) has been done.
- 8.23 Demonstration launch of surface-to-surface missile Dhanush (naval version of Prithvi) was conducted from a moving ship in April 2000. One test each of Prithvi submunition warhead test vehicle (WHTV) for incendiary, bomblet and runway denial penetration system were conducted successfully. One flight trial of Prithvi (Air Force version) was undertaken in June 2000.
- 8.24 Under Electronic Warfare (EW) programme 'Samyukta' for the Army, the Core System Demonstration (CSD) of communication segment is in the final stages. Out of five EW systems envisaged under 'Sangraha' programme for the Navy, one system has been fully flight tested on two airborne platforms and another system has been installed on-board surface platform. The other systems are in advance stages of development and integration.
- 8.25 All design work for the technology demonstrator of Futuristic Infantry Combat Vehicle (ICV) Abhay, under development for replacement of BMP-II vehicles, has been completed. Fabrication of hull and turret for the first mild steel prototype is under progress.
- 8.26 The first airborne sonar MIHIR has successfully completed all aspects of user evaluation except the active track function.
- 8.27 Sea evaluation of the light weight torpedo, Advanced Experimental Torpedo (AET), which can be launched from ship and helicopter for anti-submarine warfare, has been completed. Five Designed & Engineered models of AET, under fabrication by Bharat Dynamics Limited (BDL), Hyderabad, will be subjected to further trials, after which it will enter production phase.

8.28 A Material and Transducers Simulated Test (MATS) facility has been created to undertake static and dynamic measurement on material and transducers at different sea conditions of temperature and pressures simulating ocean depths. This is the only facility of its kind in the Asia Pacific region and one of the very few in the entire world.

8.29 A wargaming software package at infantry division level, Sangram, has been developed and is undergoing rigorous testing at the user premises.

TECHNOLOGY DEVELOPMENT/ INNOVATION

8.30 A new light weight shoulder fired 84 mm Rocket Launcher, which provides anti-tank capability to the infantry, has been developed, reducing the weapon weight from 16.5 kg to 10.5 kg. The barrel has been made of 'hoop over winding' of carbon-epoxy composite over thin rifled steel liner. The technology of a composite gun barrel has been developed for the first time in the country.

8.31 Technology for manufacture of low vulnerability ammunition (LOVA) gun propellant, based on cellulose acetate and fine RDX as main ingredients, has been developed indigenously. In addition, composite modified double base (CMDB) propellant incorporating new energetic plasticisers replacing conventional inert plasticiser, has been developed in order to achieve superior performance with improved specific impulse, to meet the futuristic challenges.

8.32 A new technique, called explosive welding/cladding technique, having great potential

in industrial scale manufacture of heat exchangers, has been established and evaluated.

8.33 The 0.5 micron monolithic microwave integrated circuit (MMIC) technology has been developed and implemented at gallium arsenide enabling technology centre (GAETEC). GAETEC has produced and delivered MMIC amplifier modules, operating in diverse frequency bands, for use in various defence systems.

8.34 The hottest chilli variety in the world so far, was thought to be 'Red Savina Habanero' from Mexico, having pungency of 5,77,000 Scoville Heat Units (SHU). DRDO scientists have discovered that a chilli variety grown in Tezpur in Assam is having one and half times more pungency (8,55,000 SHU) than the Mexican variety. The extract of chilli known as 'oleoresin', being a natural product, is more environmental friendly than synthetic analogues. This has potential for use as a riot control agent and for personal defence.

8.35 The usefulness of breathing Carbogen - a gas mixture of 95% oxygen and 5% carbon-di-oxide - in preventing the loss of hearing as a result of noise, has been demonstrated. Carbogen can be used for prevention of noise induced hearing loss, in all kinds of noisy environments where it is not possible to control the noise by other means.

8.36 High pressure compressor discs of titanium alloy for the Adour engine were manufactured for the first time in the country, achieving a significant milestone in self-reliance in the area of critical aeronautical components.

8.37 The extraction of titanium metal from its ore,

already proven at 3 ton per batch level in the pilot plant facility, continued with trouble-free batch operation during this year. The product consistently met the international specifications. Only five countries in the world manufacture titanium commercially.

8.38 Hydro-gel, as water retaining polymer for agriculture use, has been developed. The parameters of 500 gm to 1 kg batch are under optimisation.

8.39 During the year, 45 patent applications were filed in India, covering inventions/innovations made by DRDO laboratories/ establishments in the fields of materials, engineering, electronics, food technologies, biomedical science etc. One application was filed for copyright registration. Two applications were filed in India and five in other countries for registration of designs. Ten Indian patents were granted and 19 patent applications were accepted for grant of patents.

BASIC RESEARCH

8.40 To provide thrust to basic research, DRDO has already constituted four Research Boards viz., the Aeronautics Research & Development Board (AR&DB); Armament Research Board (ARMREB); Naval Research Board (NRB) and Life Sciences Research Board (LSRB). These Boards promote research in collaborative mode with academic institutions and other national R&D laboratories through funding of grants-in-aid projects. The AR&DB is currently funding 140 projects at about 25 institutes. The ARMREB has sanctioned 22 projects costing Rs 2.70 Crore in the fields of high en-

ergy materials, sensors, ballistics and other armament related fields. Under the NRB, presently 28 projects are being pursued by the academic institutions in five technology areas. Under LSRB, 18 research projects are being pursued at 9 institutes covering areas in biological and bio-medical sciences, psychology, physiology, bio-engineering, specialised high altitude agriculture, food science and technology etc.

SUPPORT TO SERVICES

- 8.41 The indigenous brake parachute for SU-30 aircraft has been successfully developed and five such parachutes have been delivered to the Air Force against their first indent.
- 8.42 Six types of life saving power cartridges have been developed, produced and supplied to the Air Force.
- 8.43 Various types of vehicles were tested for their suitability for the Army. These include Maruti Gypsy King MP-1 with multi point fuel injection system; LPT 713/32 4x4 t and 1210 SD/36 4x4 fitted with cummin engines; Armada Grand 4x4; and Tata Sumo 4x4.
- 8.44 Consequent to wide acceptance of meals-ready-to-eat (MRE) ration among the troops, an order has been placed for supply of 50,000 MRE rations, out of which 30,000 rations have already been supplied.
- 8.45 The efforts of DRDO at Partapur, in the Nubra valley of Ladakh region, have resulted in monthly supply of 10,000 litres of milk, 2,500 kg of fresh vegetables and 250 kg of chicken to the Siachen Brigade.
- 8.46 A number of Defence personnel who suffered facial injuries during 'OP VIJAY' were rehabilitated, using the devices developed by DRDO at Srinagar, Udhampur and Delhi. The cost of the kit having bone plates and screws is approximately one-sixth of the imported devices.
- 8.47 The below-knee artificial limbs, developed by DRDO and produced by 515 Army Base Workshop, Bangalore, have been fitted on amputees by the Artificial Limb Centre (ALC), Pune.
- 8.48 A two phase selection system, developed by DRDO, has been introduced at the Service Selection Boards and Air Force Selection Boards. The new system reduces the workload on the assessors and allows them to spend more time and effort on a candidate in the second stage of selection, thereby bringing more objectivity in the system.
- 8.49 A new airmen selection software has been developed and handed over to the Air Force and has been implemented for selection and trade allocation of IAF personnel at eight centres all over the country.
- 8.50 Avalanche forecast warnings were issued with good accuracy for the areas of J&K including Siachen, Kargil and Mushkoh valley. Three new state-of-the-art automatic weather stations (AWS) were installed in J&K (including Siachen), HP and UP and certain existing stations damaged in adverse weather conditions were made functional. With this, all the 18 Automatic Weather Stations are fully functional in the Western and Central Himalayas. The data received from the AWS are being used in developing avalanche forecast models and in improving the avalanche forecast accuracy.

8.51 Avalanche control and wind drift structures were installed on one of the avalanche control sites on the Jammu-Srinagar highway. Controlled release of avalanches with the help of explosives by using the device known as Avdhav Visphotak Vahan was extensively used on national highway, resulting in total elimination of major avalanches on south and north portal of Jawahar Tunnel. The efficacy of this technique has been demonstrated to the troops, who have been also trained to use the technique during movement through avalanche prone areas.

- 8.52 Selection, characterisation and analysis of landslides of National Highway-31 A and North Sikkim Highway has been done and terrain information has been provided to Border Roads Organisation, to keep these strategic highways open throughout the year.
- 8.53 25 Nos. of NBC suit Mk-II, having disruptive printed flame retardant and water repellent cotton top layer, have been fabricated and sent for trials. These are reusable and can be decontaminated.

SOCIETAL MISSIONS AND SERVICES

- 8.54 DRDO rendered services to restore agro-animal activities and eco-system in super cyclone ravaged Chaluni gaon Panchyat, Orissa. The farmers were provided high yielding seeds and fertilisers alongwith improved technology for vegetable and paddy cultivation. To improve animal health, a total of 3954 animals were examined/ treated and 1350 animals were vaccinated for foot and mouth disease. In addition, one lakh fingerlings of adapted species of fishes were provided for revival of pond fishery.

- 8.55 Sustainable development of Sil village in Kanalichhina block of Pithoragarh district has been carried out by DRDO by way of tree plantation, construction of water harvesting structures and demonstration cultivation of wheat, paddy and soyabean.
- 8.56 To assess the post - traumatic stress disorder cases in the super cyclone affected Orissa, services of psychologists, psychiatrists and medical specialists were rendered by DRDO team. The DRDO team provided the much needed immediate psychiatric medication and individual and group counselling to the affected population.
- 8.57 DRDO developed an innovative technique for fabrication of FRP (fibre reinforced plastic) railway sleepers for the railways. The technology transfer document has been issued to the Research Design and Standards Organisation (RDSO) of the Indian Railways.
- 8.58 A number of hyperbaric chambers have been developed to treat the Army troops deployed at altitudes above 4000m, suffering from High Altitude Pulmonary Oedema (HAPO) or to treat decompression sickness prevalent among divers. One such two bedded chamber has been commissioned for civil application at Indraprastha Apollo Hospital, New Delhi, for carrying out hyperbaric oxygen therapy.

ENVIRONMENTAL PROTECTION AND AFFORESTATION MEASURES

- 8.59 During the year, 32000 trees were planted at various locations of the DRDO in different terrains. In addition, 46000 shrubs and

18.57 acre of ground cover was provided to make a total of approximately 12.32 lakh trees, till date.

QUALITY IMPROVEMENT INITIATIVE

- 8.60 Four DRDO laboratories received ISO-9001 Certification and one lab has been accorded accreditation by National Accreditation Board for Testing and Calibration Laboratories (NABL). So far, 11 DRDO laboratories have been certified for ISO-9001 and 3 laboratories have been accredited by NABL.

DRDO - INDUSTRY INTERACTION

- 8.61 Eight DRDO laboratories were opened to the industry during the last year. A very simple, cheap and easy to use method for assessment of contamination in drinking water, based on the detection of hydrogen sulphide producing organisms, developed by a DRDO laboratory, is under marketing by a private firm. In addition, several technologies have been transferred to private industry such as of Scara Robot, used for assembly jobs, and articulated robot, used for material handling, welding, spray painting etc. In the field of material science, the technologies transferred include : Boropak - chemical mixture to impart surface hardness and reduce wear and tear of ferrous and some non-ferrous metals; non spark tools from copper titanium alloy; gigly saw for use by orthopaedic surgeons; rust converter for protection of ferrous metals against corrosion, moisture resistant corrugated fibre board box as an alternative to timber for packing and

glacier tents for protection in sub-zero temperatures.

HUMAN RESOURCE DEVELOPMENT

- 8.62 Under Research and Training Scheme, a total of 197 personnel, including officers from the three Services and other organizations, were selected to undergo ME/ M. Tech courses in various disciplines at IITs and other National Institutions. This is in addition to the candidates sponsored by Directors of the laboratories under the delegated powers. Under the Continuing Education Programme, 140 courses were organised with participation of 3500 personnel. In addition, a number of specialised courses were conducted both by the Institute of Armament Technology and the Institute of Technology Management. A total of 13 courses were conducted for the three Services and 35 courses for DRDO scientists/engineers.

PARTICIPATION IN REPUBLIC DAY PARADE 2001

- 8.63 Several DRDO developed systems found a place of pride in the Republic Day Parade - 2001. The items displayed included : Main Battle Tank Arjun; Surface-to- Surface Missile Prithvi; Pilotless Target Aircraft Lakshya; Surveillance and Ultra/Very High Frequency (U/VHF) Jamming Vehicle SUJAV; Remotely Controlled Improvised Explosive Device Jamming System SAFARI and a float showing naval system. In addition, support provided by DRDO to the Services in the area of Life Sciences was also displayed.