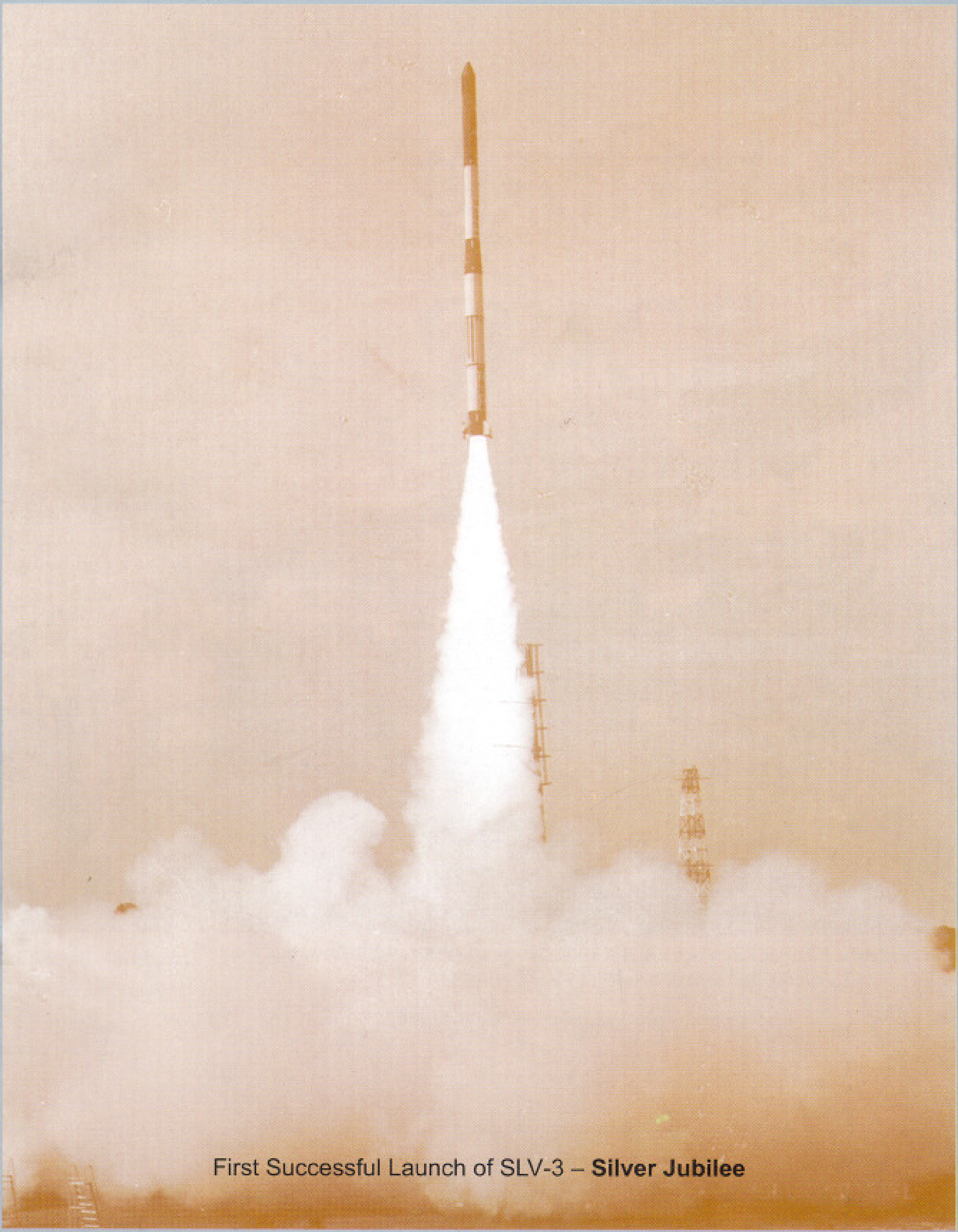
जुलाई - सितम्बर 2005
July - September 2005

अन्तरिक्ष भारत

SPACE india



भारतीय अन्तरिक्ष अनुसंधान संगठन

INDIAN SPACE RESEARCH ORGANISATION

Cautious Steps: Mr A P J Abdul Kalam (left) and Prof Satish Dhawan accompanying SLV-3 to its launch pad

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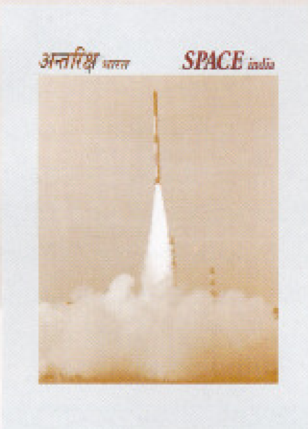

Cover Page: SLV-3 lift-off
July 18, 1980

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International Conferences on Planetary Exploration and Space Law Held in Bangalore

A twin-event — IAA Asia-Pacific Regional Conference on "Advances in Planetary Exploration" and the International Institute of Space Law (IISL) Space Law Conference - 2005 on "Bringing Space Benefits to the Asian region" was held at Bangalore during June 26-29, 2005. ISRO and Antrix Corporation sponsored the conference which was organised by Astronautical Society of India (ASI) in association with International Academy of Astronautics (IAA) and IISL.

The International Space Law Conference 2005 was the third in a series of regional space law conferences, initiated in 2001 by the IISL. These regional IISL Conferences bring space law and policy specialists on to a common forum to discuss legal and policy topics of particular interest to those regions. The meeting addressed the scenario of international space law and the regional perspectives of national space policies, broadcasting, remote sensing and geographical information, disaster management and other areas.

"Advances in Planetary Sciences" was one of a series of regional workshops that are periodically organised in different regions by IAA. The meet at Bangalore addressed the scientific, technological and future perspectives of planetary exploration by different nations. Of special interest was the discussion on "Interest in the Moon" by India, USA, China, Japan

Mr G Madhavan Nair, Chairman, ISRO addressing the delegates and Europe. The sessions covered the challenges and results of outreach to Mars, Jupiter, the past SOHO mission and also extra-solar objects.

A section of the delegates

IAA, founded in 1960, has 1200 members and is the world's premier professional body of space and astronautics experts. The Academy focuses on exploring and discussing cutting-edge issues in space research and technology and the ongoing exploration of the solar system. IISL is the premier professional body of legal experts that addresses legal and policy issues related to space and articulates the perspectives of space activities and their legal implications through special Space Law meets. ASI is the premier national professional body of space and astronautics experts that brings focus on space technology and applications.

A presentation in progress

Mr G Madhavan Nair, Chairman, ISRO inaugurated the twin-meet on June 27, 2005. Director General of European Space Agency, Mr R Jean Jacques Dordain was the Guest of Honour. President of IISL, Mr N Jasunthliana and former President of IAA, Dr Michael Yarymovych delivered opening addresses. For the first time, the twin-meet brought together two cadres of space professionals – scientists who address Planetary Exploration issues and the legal professionals who address policy and legal frameworks of space. The meet was held in parallel sessions with a joint opening and closing plenary sessions.

Question time: A delegate seeking clarification on a subject

The two international events were attended by 250 delegates from India and about 75 from USA, China, Japan, Canada, France, Malaysia, Sri Lanka, Indonesia and others. The conference was significant in the context of India playing a significant role in the international arena on space related issues as well as in the context of important scientific missions like Chandrayaan-1 and ASTROSAT taken up by ISRO recently.

Telemedicine on Wheels

A unique project for Distance Healthcare Advancement (DISHA) has been launched in Madurai District of Tamil Nadu in August 2005. Jointly undertaken by ISRO, Philips India, Apollo Telemedicine Networking Foundation (ATNF) and the Madurai based NGO, namely, Development of Human Action (DHAN), DISHA is a novel telemedicine initiative to provide distance healthcare to the under-served population. It is specifically aimed at providing healthcare to vulnerable groups at affordable cost.

Under DISHA Project, a tele-clinical van, equipped with diagnostic equipment provided by Philips India travels through Teni District in Tamil Nadu. The van has an ultrasound machine, an X-ray, a defibrillator and an ECG machine along with dedicated doctors and other para-medical staff.

ISRO is providing the connectivity through VSAT and allocating the required bandwidth free of cost on its INSAT for tele-consultation with Apollo Specialty Centre at Madurai, which will be the referral hospital for DISHA. Apollo has also deputed doctors and paramedical staff in the van and made available specialist doctors and operational staff at its hospital to facilitate multi-specialty consultations for patients visiting the mobile tele-clinical vans.

DHAN foundation is playing a key role in building trust and credibility for the project by interacting with the local community.

DISHA will travel to identified locations once a week and is expected to cover a population of 7,50,000. This pilot project will be evaluated and the results used to build a business model for

The well equipped tele-clinic van of DISHA healthcare delivery system including the pricing for such facility. Support of NGOs will also be sought to strengthen the interaction between the patients, doctors and the facilities.

Launching DISHA at Madurai, Mr G Madhavan Nair, Chairman, ISRO, said in his address from Bangalore via INSAT "with the objective of taking the benefits of space technology to the rural and remote area population, ISRO undertook the initiative to establish space-based telemedicine network in 2001. ISRO's Telemedicine network has now expanded to connect 26 specialty hospitals in major cities to 87 hospitals in rural and remote areas including the Andaman and Nicobar, Lakshadweep and J&K. ISRO has been working with other departments of Government, NGOs and private entrepreneurs in its various space application programmes to ensure that the benefits of high technology reach the underprivileged. DISHA is another example of the unique combination of a Government Organisation (ISRO), an NGO (DHAN) and private enterprises (Apollo and Philips India) joining hands for a common purpose of serving the society at large in this very important area of healthcare".

Commenting on the new foray by Philips, Mr K Ramachandran, CEO, Philips India said "Philips is a Healthcare, Lifestyle and Technology company. Our vision is to be able to improve people's quality of life through the products we offer and the markets we serve. Our challenge lies in expanding our scope to new markets and new business opportunities with sustainability as the key driver."

"Today, the population growth is highest in emerging markets, especially in the mid and low ends of the economic pyramid. Technology can help drive sustainable solutions that bridge the divide between the privileged and lesser privileged sections of society and improve the quality of life at all levels. However, new value delivery models need to be created to make this happen and this strategic partnership is a step in that direction".

"Philips' approach has been to embark on pilot projects to test new ideas and strategies, in this case remote access healthcare through the launch of DISHA in Teni. This pilot project will allow us to assess the project's viability and gain consumer insights".

Dr. T. Varghese George, Director, ATNF said, that Apollo hospital, which is the third largest healthcare provider in the world, is committed to provide specialised healthcare to the rural poor as a part of its corporate social responsibility. "Through telemedicine, we transfer the knowledge and not the patients, who are then treated at their respective villages" he said.

Chandrayaan-1 to Carry European Instruments

ISRO and the European Space Agency (ESA) have signed an agreement for flying European instruments on board India's first scientific mission to moon, Chandrayaan-1. Mr G Madhavan Nair, Chairman, ISRO and Mr Jean Jacques Dordain, Director General, ESA signed the agreement to this effect on June 27, 2005 at Bangalore, under the already existing umbrella agreement for cooperation between ISRO and ESA.

The European instruments are:

- Low energy (0.5-10 keV) X-ray spectrometer called Chandrayaan Imaging X-Ray Spectrometer from Rutherford Appleton Laboratory, UK, to measure elemental abundance distributed over the lunar surface using X-ray fluorescence technique. It will also include an X-ray solar monitor to record the incident solar X-ray flux
- Near Infra-Red (IR) Spectrometer from Max Planck Institute of Aeronomie, Germany, to detect and measure lunar mineral abundances and
- Sub keV Atom Reflecting Analyser from Swedish Institute of Space Physics, developed in collaboration with Vikram Sarabhai Space Centre, Thiruvananthapuram, India, to measure volatiles generated due to solar wind impacting on lunar surface and determine the surface magnetic field anomalies.

Europe will also contribute to the Indian experiment, namely, High Energy X-ray Spectrometer. The above European instruments will complement the main Indian experiments on Chandrayaan-1, namely, Terrain Mapping Camera with stereo imaging capability operating in panchromatic band with 5 m spatial resolution and 20 km swath; Hyper-Spectral Imager operating in 400-900 nm band with a spectral resolution of 15 nm, a spatial resolution of 80 m and 20 km swath; Lunar Laser Ranging Instrument with a vertical resolution of better than 5 m and High Energy X-ray (10-250 keV) spectrometer with a footprint of 20 km to detect radio nuclei. As per this agreement, Indian and ESA scientists will share the data from the European instruments.

An Impact Probe has also been added to the basket of instruments for proving technological elements required for possible future landing missions.

Chandrayaan-1 is planned for launch by 2007-08 onboard India's Polar Satellite Launch Vehicle. The 590 kg satellite will be placed in 100 km polar orbit around the moon and it will have a life time of two years.

Mr G Madhavan Nair, Chairman, ISRO (left) and Mr Jean Jacques Dordain, Director General, ESA signing the agreement

Satellite Users Meet on Interference Reduction

ISRO cohosted the Annual Meeting of Satellite Users Interference Reduction Group (SUIRG) held in Bangalore during September 19-22, 2005. Experts from about 40 satellite operators including those from Intelsat, PanAmSat, NSS, SES Global, EUTELSAT, INMARSAT, AsiaSat, Arabsat, SatMex of Mexico, NahuelSat of Argentina, Star One of Brazil, CSS of Japan, Thuraya, Singapore Telecom, besides INSAT, participated in the three-day meet. Experts from industries that develop equipments and technologies for interference detection and analysis, also participated in the SUIRG meeting which was inaugurated by Mr G Madhavan Nair, Chairman, ISRO on September 20, 2005.

Today, there are about 220 commercial communication satellites in orbit delivering a range of services including international and intercontinental telecommunications, TV broadcasting and distribution, Direct-To-Home TV, VSAT networks and broadband data communications. According to market research conducted by Northern Sky Research of UK, there are 6700 equivalent 36 MHz bandwidth transponders in C-band and Ku-band frequencies. Of these about 4,100 transponders available are leased to various service providers and approximately 60 percent of the leased satellite bandwidth and transponders are used for TV services in different regions of the world. The major commercial satellite transponder providers include Intelsat, PanAmSat, NewSkies Satellites, SES-Americom and EUTELSAT, who

Formal inauguration: Mr G Madhavan Nair, Chairman, ISRO inaugurating the Annual Meeting of SUIRG by lighting the traditional lamp operate their satellites globally. In addition, there are a number of regional satellite operators providing services either within a country or within a region. It may be noted that ISRO's Indian National Satellite (INSAT) is a strong domestic satellite system in the Asia Pacific region with eight communication and meteorological satellites in operation located in five geostationary orbital slots. With 150 communication transponders and three sets of meteorological payloads, INSAT provides a number of services for Indian users.

Mr G Madhavan Nair, Chairman, ISRO, (second from left), and other dignitaries during the inaugural session

ISRO plans to increase its operational satellites and on orbit capacity in the next few years to meet the increasing domestic demands of India and surrounding regions.

Satellite Radio Frequency Interference (RFI) ranks today as one of the leading challenges of the satellite industry. The International Telecommunication Union worked out a number of technical recommendations to analyse and mitigate satellite interference issues in the last four decades. However, satellite interference problems have been on the increase in the last decade. As a result, it has become critical to appropriately characterise the extent of interference problem, understand its causes and identify practical solutions that would assist satellite operators and users in minimising its occurrences.

Experts from leading global and regional Satellite Operators formed an informal professional group twelve years ago to address interference issues and its effects on efficient utilisation of on orbit bandwidth capacity. Subsequently incorporated in 2003 as the Satellite Users Interference Reduction Group (SUIRG), members meet annually to share experiences of interference incidents and their analysis techniques in solving the interference problems. At its previous Annual Meetings (Singapore 2002, Bariloche, Argentina 2003 and Florida, USA 2004), SUIRG established working groups to address interference source locator capabilities, databases, training and certification, tools and regulatory matters. The group also has cooperative working agreements with other industry and professional forums such as the World Broadcasting Union/International Satellite Operators Group (WBU/ISOG), World Teleport Association (WTA), Global VSAT Forum (GVF), Communications and Satellite Broadcasting Association of Asia (CASBAA) and the Pacific Telecommunications Council (PTC).

The Bangalore meeting was important to review the working of different groups and share the experiences of experts to overcome interference problems.

India-US Joint Working Group Meeting on Space Held

The India-US Joint Working Group on Civil Space Cooperation held its first meeting at Antariksh Bhavan, the headquarters of ISRO at Bangalore during June 29-30, 2005. This Joint Working Group, constituted recently, is a follow up of the India-United States Conference on Space Science, Applications and Commerce held in Bangalore during June 21-25, 2004.

The Joint Working Group (JWG) deliberated on exploring the potentials and possibilities of cooperation in earth observation, satellite communication, satellite navigation and its application, space science, natural hazards research and disaster management support and education and training. These topics were identified based upon the vision document on strengthening India-US cooperation issued at the end of the June 2004 Bangalore Conference.

Dr P S Goel, Co-chairman, JWG, Mr G Madhavan Nair, Chairman, ISRO and Mr Anthony F Rock, US Principal Deputy Assistant Secretary of State, Co-chairman, JWG, during the meeting

Dr P S Goel, Member, Space Commission and Director, ISRO Satellite Centre and Mr. Anthony F. Rock, Principal Deputy Assistant Secretary of State, Washington, co-chaired the JWG meeting, which was inaugurated by Mr. G Madhavan Nair, Chairman, ISRO. In all, 25 US delegates representing Department of State, National Aeronautics and Space Administration (NASA), Department of Transportation, Department of Commerce, US Geological Survey and National Oceanic and Atmospheric Administration, universities and industry attended JWG meeting. Senior officials of India's Department of Space, Ministry of External Affairs, ANTRIX Corporation and other Government of India Departments/ Agencies concerned with applications of space technology took part in the meeting.

The two delegations agreed that India's Chandrayaan-1 lunar mission offers an outstanding opportunity to begin cooperation in space exploration. Cooperation on this mission will further both countries' goals in space. NASA believes that US participation in this Indian programme will be an important contribution to the Vision for U.S Space Exploration announced by the President of the United States in January 2004.

JWG noted that significant progress has been made in the U.S. GPS, the U.S Wide Area Augmentation System (WAAS) and the Indian GAGAN space-based Positioning, Navigation and Timing Systems (PNTS). Both sides have a shared interest in promoting interoperability among existing and future civil space based PNTS to create a Global Navigation Satellite System (GNSS). This area is ready for expanded bilateral cooperation.

JWG expressed the intent to collaborate on a variety of earth observation projects. It was agreed to investigate the comparability and complementarity of data from U.S. Landsat and Indian IRS satellites and establishing an earth reception station in India for the U.S. National Polar-Orbiting Operational Environmental Satellite System (NPOESS).

JWG's meeting has given further impetus towards strengthening and expanding the cooperation between India and the United States in the area of space exploration.

Prime Minister Unveils Satish Dhawan's Bust at Sriharikota

The Prime Minister Dr Manmohan Singh unveiled the bust of Late Prof Satish Dhawan at Satish Dhawan Space Centre SHAR, Sriharikota on September 21, 2005. Prof Satish Dhawan, after whom the space centre at Sriharikota is named, steered the Indian Space Programme as Chairman, ISRO during 1972-1984. He was a multi-faceted personality and truly one of the most distinguished Indians of our times - a brilliant aeronautical engineer, an outstanding space scientist, a philosopher, a humanist, and above all, a great visionary. Prof Dhawan's stewardship of ISRO was distinguished by his keen sensitivity to the true needs of a developing nation, a confident appreciation of the ability of ISRO's scientists and engineers, and the involvement of Indian industry, both public and private. But what was striking about Prof Dhawan was his deep commitment to human values and the use of science and technology for development. The space community in India owes deep gratitude to Prof Dhawan for imbibing in the community an abiding sense of technological excellence, human values, and social commitment.

(From L to R) Mr Raghuveera Reddy, Minister for Agriculture, Government of Andhra Pradesh, Mr Sushil Kumar Shinde, Governor of Andhra Pradesh, Dr Manmohan Singh, Prime Minister, Mr G Madhavan Nair, Chairman, ISRO and Mr Annamalai, Director, SDSC, SHAR, during the function

Satish Dhawan Space Centre SHAR (SDSC SHAR), is located at Sriharikota, about 80 km north of Chennai. So far, four SLV-3 launch vehicles, four Augmented Satellite Launch Vehicles (ASLV), nine Polar Satellite Launch Vehicles (PSLV) and three Geosynchronous Satellite Launch Vehicles (GSLV) have been launched from this Centre. The facilities at SDSC include solid propellant production plant, rocket motor static test facility, launch complexes for a variety of rockets, telemetry, telecommand, tracking, data acquisition and processing facilities, and other support services. A state-of-the-art Second Launch Pad was established recently to cater to more frequent launchings and offers ability to accommodate both present launch vehicles as well as those planned in the coming decade.

Additional facilities are being set up at SDSC for supporting GSLV Mk III programme including a new plant to process heavier class boosters with 200 tonnes of solid propellant and a static test complex for qualifying the S-200 boosters.

It is indeed very apt that a major centre of ISRO and the spaceport of India has been named after Prof Satish Dhawan.

Address of the Prime Minister during his visit to the SDSC, SHAR, September 21, 2005:

I am delighted to be amongst you at the Satish Dhawan Space Centre in Sriharikota. This is a special place as it commemorates the efforts of generations of India's most accomplished scientists to create a world class space port. It is also a particular pleasure to unveil a bust of that great pioneer of India's space programme, Prof Satish Dhawan, after whom this Centre is named.

Prof Dhawan was an outstanding scientist and a memorable personality. I cherish my long personal association with him when I was a Member of Space Commission. He was one of the most distinguished men I have known – a brilliant aeronautical engineer, an outstanding space scientist, a philosopher, a patriot and above all, a great humanist. He combined great personal charm with a deep commitment to social values and an extraordinary objectivity in management. He inspired *several generations of students, scientists and administrators to make unceasing efforts, and to refuse to accept failure. Prof Dhawan's concern for the environment and ecology and his keen interest in all living beings was all-encompassing. I deem it a privilege to have known and worked with Prof Dhawan.*

Standing here, I pay tribute to Prof Dhawan's visionary leadership which helped transform this otherwise isolated island into India's space port. This Indian window to space now has the capacity to launch spacecraft into orbit and around the Earth, and will soon take us to the moon. This we hope will be a precursor to exploring other planets as well.

Prime Minister addressing the audience

Ladies and Gentlemen,

My association with the ISRO family and our space programme gives me a special sense of pride today. In the last three decades, beginning with modest sounding rockets, such as the one I saw being launched today, ISRO has gone on to record many giant leaps. You have now mastered the design, development and launch of powerful and complex rocket systems. Your capabilities now include Polar Satellite Launch Vehicles and Geosynchronous Satellite Launch Vehicles. You have proven that you are equal to the finest in the world, and second to none, in developing complex technologies and using them to serve our development goals. Moreover, you have achieved these milestones with a high success rate. I am told that the last 11 major launches from this Centre have all been highly successful.

It is a matter of particular pride that international technology denial regimes have not impeded your efforts – in fact they have spurred you to greater heights. I am proud to note that among the 16 satellites recently launched by ISRO, four have been from other countries. We have proven to the world that India is a leader in advanced technologies. Your achievements have drawn upon the wealth of talent, skills and sheer brain power in India, and you have remained undeterred by misplaced and anachronistic restrictions. ISRO has indigenously developed an array of sensitive and advanced technologies while maintaining an unblemished record as far as non-proliferation is concerned. This record deserved greater recognition within India and abroad.

Ladies and Gentlemen,

A short while ago, I went around the premises and the facilities that have been created. I was impressed by the level of skills that have been mastered and applied here. I have also seen some of the hardware that testifies to the achievements of our space programme, and to your talent, determination and dedication. The country salutes your contribution. This launch center has great significance. From a small beginning it has become one of the major state-of-the-art satellite launch centres in the world. The excellent infrastructure here meets our national requirements and also provides adequate facilities for us to work with international partners.

I am also proud that India has established the largest constellation of remote sensing satellites in the civilian sector. These satellites provide valuable data on natural resources, not only domestically, but also to more than a dozen countries across the world. We also have one of the largest domestic communication satellite systems in the Asia-Pacific region. We make use of our space assets and the most advanced technologies to meet the needs of many national developmental tasks. These include a number of socially beneficial purposes such as tele-education and tele-health, meteorology, natural resources management and disaster warning. Taken together along with other programmes, such as the novel scheme of Village Resource Centres, we can help farmers by providing them data on land use, water resource management, agriculture and weather forecasts. All of these are examples of an innovative approach to using advanced technology for improving the quality of life of the common man in the country.

Ladies and Gentlemen,

The future evolution of nations and economies will be determined not only by possession of technology but also in its effective application to meet developmental needs. We *must continually aim at the stars if we are to succeed in meeting our ambitious national goals on the ground. One such grand programme is our Moon mission - Chandrayaan-1.*

I look forward to this successful launch of this unmanned Moon-shot from this Centre, using our Polar Satellite Launch Vehicle. Chandrayaan-1 will enable our scientific community to embark on more ambitious plans of exploring the universe. The implementation of this programme will add to the international profile of our space community. Not only Chandrayaan, but our other programmes are now eliciting positive responses from international partners. I therefore reiterate India's commitment to international cooperation in the scientific exploration of outer space for the benefit of humankind.

Ladies and Gentlemen,

Achieving self-reliance in space research and in the application of space technology for national development is the driving force of India's space programme. The Vikram Sarabhai Space Centre and Liquid Propulsion Systems Centre at Thiruvananthapuram, ISRO Satellite Centre at Bangalore and Space Applications Centre at Ahmedabad strive continuously to achieve this goal. They are all justly recognized internationally as centres of excellence.

An ambitious plan is in hand for this Centre to meet the challenges of the future. A world-class propellant plant will be set up to meet the demands of the next generation launch vehicle, GSLV-Mk III. A number of other facilities to test and integrate a new generation of satellites are also on the anvil.

Ladies and Gentlemen,

As our space programme moves into higher gear, ISRO will increasingly be called on to meet our growing requirement for access to space for purely civilian purposes. Main key areas of our national effort are dependent on the optimum use of our space assets. Therefore your efforts should be geared to achieve low-cost access to space through innovative space transportation systems. At the same time, while providing these services, you must not compromise in the quest for excellence. We look to you to keep abreast of the latest technologies and to continue to maintain your leadership in this field. I am sure that you will take India to the forefront in the global space arena.

As we reap the benefits of space technology and pledge to strive for higher goals, it is fitting that we pay tribute to the leaders who showed the way.

Let us remember:

- *Prof Satish Dhawan whose spirit is ever present on this island to inspire you and*
- *The vision of Dr Vikram Sarabhai, the founding father of our space programme is also a source of great inspiration and strength.*

We should also remember the other titans of our space programme, including President Kalam, Prof U R Rao, and many others. Guided by these towering figures, ISRO's committed efforts have taken India to the horizon and beyond in space technology, and its diverse applications.

Ladies and Gentlemen,

In conclusion, I am particularly pleased that today the Astronautical Society of India is honouring some of our high achievers in the fields of space technology and science. I congratulate Dr K Kasturirangan, who led ISRO with great distinction, on being conferred the Aryabhata Award. This is a very well-deserved recognition of a lifetime of achievement. I also extend my warmest congratulations to the young scientists who are receiving awards today. You are part of a most distinguished community – one that is based on a commitment to excellence and motivated by the spirit of intellectual adventure. May you continue to venture far in spirit and in your attainments.

My sincere thanks and best wishes are with all of you, members of the ISRO family. May your path be blessed.

Prime Minister Presents Astronautical Society of India Awards

The Prime Minister, Dr Manmohan Singh, during his visit to SDSC SHAR to unveil the bust of Prof Satish Dhawan, also presented the annual awards of the Astronautical Society of India. Dr K Kasturirangan, Member of Parliament (Rajya Sabha) and Director, National Institute of Advanced Studies, Bangalore and former Chairman of ISRO received the coveted 2003 Aryabhata Award for his outstanding life-time contribution to the promotion of astronautics in India.

ASI awards in Rocket and Related Technologies were given to Mr R N Bhattacherjee, Director, TMS, Defence Research and Development Laboratory, Hyderabad and Mr M K G Nair, Deputy Director, Liquid Propulsion Systems Centre, Valiamala, Thiruvananthapuram. The ASI award for Spacecraft & Related Technologies was given to Mr N K Malik, Deputy Director (Control and Mission), ISRO Satellite Centre, Bangalore while Prof Shyam Lal, Chairman, Space and Atmospheric Sciences Division, Physical Research Laboratory, Ahmedabad received the award for Space Science and Applications. Mr K Thyagarajan, Programme Director, Small Satellite Systems, ISRO Satellite Centre, Bangalore and Mr R K Rajangam, Project Director, INSAT-4B, ISRO Satellite Centre, Bangalore received the awards for Space Systems Management.

The Prime Minister also presented the Space Gold Medals to Mrs Annie Nelson, Engr 'SG', ISAC, Bangalore, Mr Khamitkar Sachin Pundlik, Tradesman 'D', SDSC SHAR, Sriharikota, Mr H N Madhusudana, Engineer-SG, ISRO HQ, Bangalore, Mr L M Gangrade, Engr 'G', ISAC, Bangalore, Mr M Enamuthu, Engr 'H', VSSC, Thiruvananthapuram, Mrs E Sujatha, Engr 'SG', VSSC, Thiruvananthapuram, Mr Tomy Abraham, Sr Technician 'C', SAC, Ahmedabad, Mr M B Mahajan, Engr 'SE', SAC, Ahmedabad, Mr V Kumbakarnan, Engr 'SF', SDSC SHAR, Sriharikota and Dr V Narayanan, Engr 'SF', LPSC, Thiruvananthapuram.

The Astronautical Society of India (ASI) fosters the development of astronautics in the country through dissemination of technical and other information related to astronautics by conducting technical meetings, bringing out technical publications and organising exhibitions. The society is also playing an active role to promote the interests of other developing countries in astronautics through the International Astronautical Federation, Paris, of which the ASI is a voting member.

Prime Minister presenting the award to Dr K Kasturirangan (right), Member of Parliament (Rajya sabha) and Director, National Institute of Advanced Studies, Bangalore

ISRO-Amrita Village Resource Centre Inaugurated

The President of India, Dr APJ Abdul Kalam inaugurated the Village Resource Centre (VRC) network set up by ISRO in partnership with Amrita Vishwa Vidyapeedham in Tamil Nadu and Kerala on July 6, 2005 from Ettimadai, Coimbatore.

Nine VRCs have been set up in this network and are connected with Amrita Vishwa Vidyapeedham, Ettimadai, Coimbatore and Amrita Institute of Medical Sciences (AIMS), Kochi. The nine centres are (i) Amritapuri, Kollam (ii) Puthiyakavu, Karunagappally, Kollam (iii) Azheekkal, Karunagappally, Kollam (iv) Parippally, Kollam (v) Mananthavady, Wayanad (vi) Kalpetta, Wayanad (vii) Ettimadai, Coimbatore (viii) Nagapattinam, Tamil Nadu and (ix) Arcot, Chennai. In this endeavour, corporate houses like Intel, HP, Cisco, Microsoft, Cognizant Technologies, Oracle and Dhanalakshmi Bank have also joined hands with Amrita Vishwa Vidyapeedham. These VRCs are located at Tsunami relief camps, schools and orphanages.

In order to disseminate the services emanating from the space systems as well as other Information Technology (IT) tools directly to the rural communities, ISRO has initiated a programme to set up VRCs in partnership with concerned state and central government agencies as well as NGOs. VRCs aim to promote a single window delivery of need-based information services in the areas of education, health, nutrition, weather, environment, agriculture and alternative livlihoods to the rural population.

His Excellency Dr A P J Abdul Kalam, President of India, addressing the audience during the inauguration

Silver Jubilee of SLV-3 Launch Celebrated

The successful launch of India's first Satellite Launch Vehicle (SLV-3) on July 18, 1980, was a historic landmark for the Indian space programme. The maiden national launch vehicle effort, SLV-3, gave ISRO a remarkable insight into the conceptualisation, design, development and management of a technically complex multi-disciplinary project as the young team was experimenting with and learning the nuances of launch vehicle technology. SLV-3 weighed just about 17 tonne at lift off and was able to launch only about 40 kg spacecraft into Low Earth Orbit compared to the present GSLV which has a lift-off weight of 414 tonne and capability to place about 5 tonne satellite into low earth orbit. Yet SLV-3 laid the very foundation for the future generation heavy lift vehicles enabling the country to aspire for the moon today.

It was indeed fitting and nostalgic that Dr A P J Abdul Kalam, the President of India, who was the Project Director of SLV-3, participated in the Silver Jubilee Celebrations on July 23, 2005, to reminisce the SLV-3 and to look to the future of space transportation through a Symposium on Launch Vehicle Development at Vikram Sarabhai Space Centre, Thiruvananthapuram, the lead Centre of ISRO for launch vehicle technology, along with Astronautical Society of India.

From right–Mr. G Madhavan Nair, Chairman, ISRO, His Excellency Dr. A P J Abdul Kalam, President of India, Mr. Oommen Chandy, Chief Minister, Kerala and Dr. B N Suresh, Director, VSSC

To mark the Silver Jubilee of SLV-3, Space India reproduces below an article on SLV-3 authored by S/Shri A P J Abdul Kalam, E Janardhana and D Narayana Moorthi, which had been published immediately following the successful launch of SLV-3 in "the university herald" the quarterly publication of the University of Kerala (July 1980).

The Indian Satellite Launch Vehicle – SLV-3

A P J ABDUL KALAM, E JANARDHANA & D NARAYANAMOORTHI

1. Introduction

Dr Vikram Sarabhai pioneered the space efforts in India at the picturesque little Thumba near Trivandrum in 1963 with a small team of engineers and scientists. This enthusiastic group who laid firmly the strong foundation of this advanced technology in the country, firmly believed that Space Science and Technology would, in due course, immensely assist a developing nation like India in the field of mass education, communication, meteorology, remote sensing and thereby uplift the standard of our life. This line of thinking has been the main thrust of all the major space programmes in India.

2. Sounding Rockets

It was tense drama, anxiety and excitement when the first sounding rocket was shot up from Indian soil in 1963. Just four years there after announcement could be made of the launching of our own maiden sounding rocket-75 mm dia with 10 kg propellant. With this modest beginning, we have today a series of sounding rockets ranging in diameter from 75 mm to 560 mm, catering to maximum payload weights of 100 kg and altitudes varying from 15 to 350 km.

3. Satellite Launch Vehicle

Next logical corollary to Sounding rockets, was the development of a satellite launch vehicle. Realisation of the launch vehicle is a sophisticated technology by itself and the related infrastructure was required to be built in the areas of propellant, propulsion, avionics, materials, motor testing, vehicle assembly, vehicle checkout and ground telemetry/tracking. ISRO establishments in the country (fig.1) were geared to these mammoth efforts through time bound projects. Vikram Sarabhai Space Centre (VSSC) is responsible for launch vehicle design, development and management. Sriharikota is a launch base. It also houses propellant production and rocket motor test facilities, ISRO Satellite Centre (ISAC) specialises in building spacecrafts. Space Application Centre (SAC), Ahmedabad, has the primary task of applying the space technology for the socio-economic benefit of the nation.

The launching of 35 kg Rohini Satellite by SLV-3 on 18th July'80 is a major "Leap into Space". In the process India became the sixth nation to have indigenous launch capability. The other countries who have achieved this feat are, USSR, USA, France, China and Japan. Rohini Satellite is the 3rd Indian Satellite in orbit. The earlier ones, Aryabhatta and Bhaskara were launched from USSR.

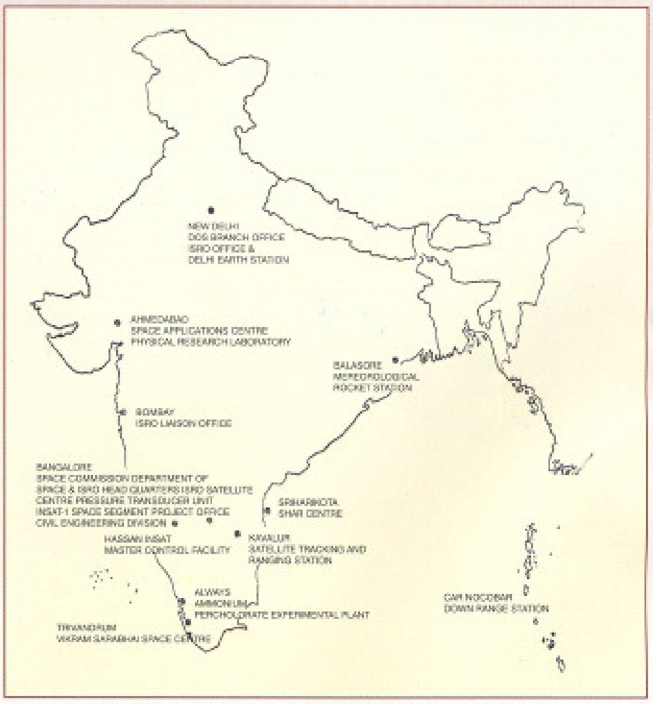


Fig 1. Establishments of the Department of Space

4. Vehicle Description

SLV-3 is a four stage solid propulsive vehicle designed and developed by VSSC. It has taken approximately seven years to realise the vehicle from start. This vehicle with a lift off weight of 17 tonnes and total length of 22 meters can impart the required velocity of 28000 km/hr to 35 kg satellite to inject the same into a low earth elliptical orbit. SLV-3 consists of forty four major functional subsystems which are indicated in the exploded view (fig. 2). The flight sequence of the launch vehicle from lift off till orbital injection of satellite is given in fig. 3.

The main constituents of the vehicle are:

- Vehicle propulsive system
- Rocket systems
- Guidance and control system
- Vehicle electronics.

4.1 Vehicle Propulsive System

This forms the main 'muscle' for achieving the required altitude and velocity for orbital injection. The four stages are solid propellant type. The first stage is of 1000 mm diameter and carries 8.6 tonnes of PBAN (Polybutadine Acrylo Nitrate) propellant developed indigenously. The motor case fabricated from 15 CDV6 steel sheets and forgings is in three longitudinal segments. Propellant is cast separately in each segment and then joined together. The segmented motor technology has been specifically developed for the first stage motor. This motor develops an average thrust of 46 tonnes and burns for 50 seconds. with a specific impulse value of 254 seconds (vacuum). The second stage motor is of 800 mm diameter and carries 3 tonnes of PBAN propellant in a single monolithic grain. This motor is also made of 15 CDV6 steel sheets and forgings. The motor has an average thrust of 20 tonnes and burns for 44 seconds and gives a specific impulse of 268 seconds (vacuum). The third and fourth stage motors use fibre reinforced plastic motor cases and high energy propellant (HEF 20) developed inhouse. Third stage with a diameter of 800 mm houses one tonne of propellant and gives an average thrust of 6.3 tonnes. Fourth stage has a diameter of 650 mm, carries 262 kg propellant and provides a thrust of 2.4 tonnes. The specific impulse of fourth stage is 284 seconds (vacuum). Numbers of tests have been

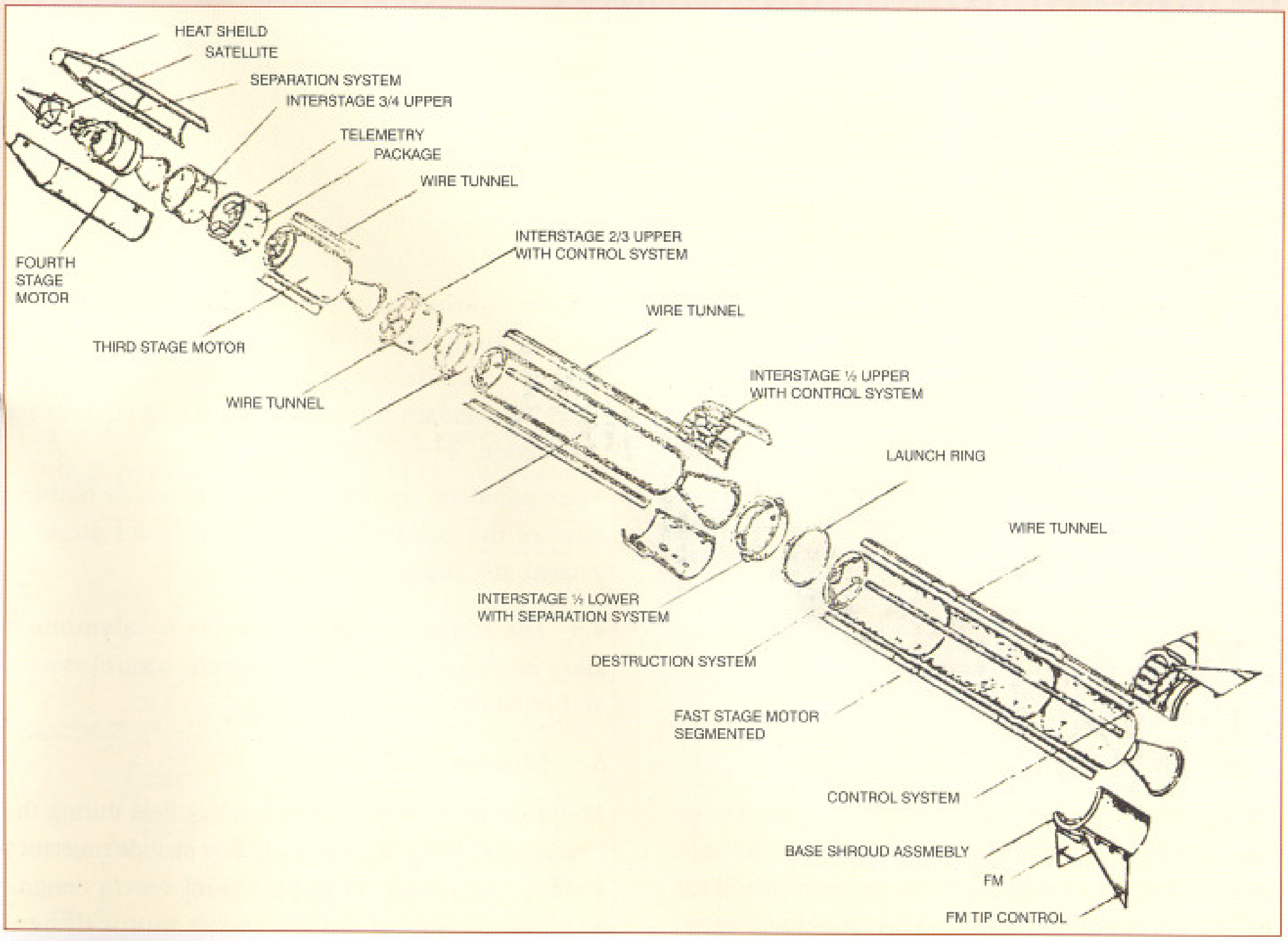


Fig 2. Exploded view of SLV-3

carried out both in scaled down size and in full scale to confirm the reliability of performance of individual stage motors.

4.2 Rocket Systems

Rocket systems comprise stage separation systems, destruct system and heat-shield.

The separation between the stages is carried out by initiating "Flexible Linear Shaped Charge" (FLSC) system located between the stages for the first two stages. Ball type separation system is employed for third and fourth stages. Fibreglass honeycomb heatshield is provided around satellite and fourth stage to protect them from aerodynamic heating during atmospheric flight region. After the vehicle crosses the dense atmosphere, the heat-shield is separated from the vehicle at an altitude of about 85 km. Also FLSC type destruct systems are housed in first three stages to destruct the vehicle based on ground command in the event of vehicle deviating from specified flight path.

4.3 Guidance and Control System

Guidance and control system of the vehicle is responsible for three axis stabilisation and for steering the vehicle along the preset trajectory profile. The system mainly does three functions.

- Sense the inertial attitude of the vehicle.
- Generate suitable control function to actuate the control power plants.
- Generate appropriate control forces to stabilise and steer the vehicle.

4.3.1 Guidance System

Four gimbal stabilised inertial platform is used to sense the vehicle attitude. Autopilot compares attitudes with command angles as given by pitch programme stored in vehicle attitude programmer and with launch references for yaw and roll axes. The error signals thus generated are mixed with vehicle body rates measured by rate gyro package to generate command signals for control systems.

4.3.2 Control Systems

For the first stage, Secondary Injectant Thrust Vector Control system (SITVC) in proportional mode has been employed (using strontium perchlorate as injectant) for the first 17 seconds of flight, for pitch and yaw control. For roll control throughout and pitch and yaw control beyond 17 seconds electrohydraulically operated aerodynamic control surfaces (fin tip control) are used. For the second stage, bipropellant on-off reaction control power plant (using RFNA and hydrazine) is used for pitch, yaw and roll control, both in power and coast phase. The third stage has monopropellant on-off reaction control system (using hydrazine and indigenously developed catalyst), to generate control forces required during third stage flight regime. The fourth stage is spin stabilised.

SITVC control system has been evaluated in the static test of first stage motor. Second and third stage control systems have undergone a number of system level ground tests. In addition to computer simulation, the total guidance and control chain has also been tested in the hardware in the loop simulation checks.

4.4 Vehicle Electronics

The telemetry, telecommand, tracking and sequencing system constitute the vehicle electronics systems.

During flight the health and performance of vehicle systems are monitored by telemetry system. This employs two schemes – one FM/FM and the other PCM/FM – accommodating about 400 vehicle parameters like motor pressures, temperature, guidance commands, attitude errors.

Onboard tracking subsystem includes C-band transponder and tone range receiver.

Vehicle sequencer generates actuation commands for stage ignition, separation and control system gain change. Redundant telecommand receivers are provided onboard to execute ground commands for destruction, if required.

The equipment bay – the brain of the vehicle housing most of the guidance and electronic subsystems is located just above third stage.

4.5 The stages are interconnected by aluminium alloy interstage housing instruments, control system and separation system.

5. Mission Software

Major strides have been made in this field during the course of SLV-3 development. They include trajectory studies, heat transfer analysis, control system design/ analysis, structural design, rocket motor design, separation disturbance studies error analysis, digital/

hybrid/hardware in loop simulation, checkout software, range safety studies, orbit studies, visibility calculation, post flight software and several others.

6. Support from Industries and Academic Institutions

Apart from various units, a number of institutions and industries have participated in SLV-3 programme. Institutions like ADE, DLRL, GTRE, IITs, IISc, NAL have contributed towards hybrid simulation studies, antenna testing, heatshield evaluation tests, heat transfer studies and wind tunnel testing. Major industries like WIL, Poona, L & T, Bombay, HAL (Kanpur, Bangalore, Nasik, Lucknow and Koraput), R & C, Bombay; BHPV, Vizag; HSL; Rourkela; RFC, Hyderabad; Anup, Ahmedabad and HMT, Kalamassery have played major roles in fabrication of components like motor cases, interstages, launcher, etc. A number of small scale industries, specifically in and around Trivandrum have remarkable contributions towards SLV-3 programme.

7. Rohini Satellite (RS-1)

SLV-3 flight on July 18, 1980 carried an experimental satellite (RS-1) instrumented to monitor the performance of the fourth stage motor and satellite in orbit. It carried with it, magnetic aspect sensor, velocity encoder, pulse code modulation, telemetry and solar panels including indigenously developed solar cells.

8. Integration and Checkout

8.1 At Thumba

The integration of nearly one lakh individual parts of the vehicle into components, subsystems,

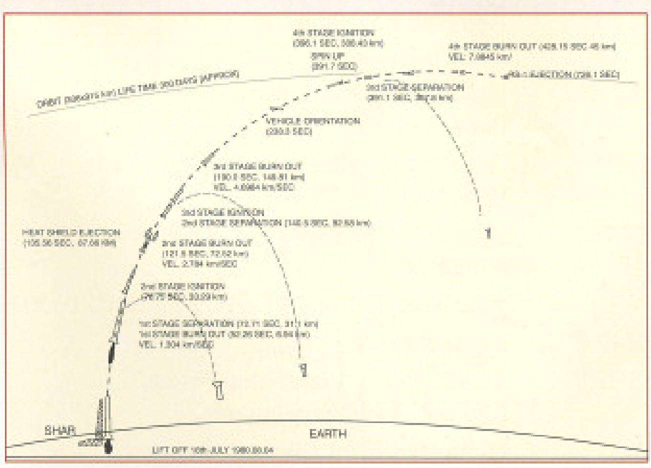


Fig 3. SLV-3-E-02 Trajectory

subassemblies, stages and vehicle is an arduous task, spanning over more than a year. The four rocket motors are processed at VSSC/SHAR. The other eight interstage subassemblies housing control systems, equipment bay, separation system, electronic monitoring/interface circuits are integrated and checked out at Vehicle Integration Laboratory/ Electronic Checkout Laboratory, VSSC, before being transported to SHAR. The checkout process, conceived in four phases, is carried out for components, individual subassemblies, electrically interfaced stages and fully integrated vehicle.

The computerised checkout system for the above is also developed at VSSC. This has been built around two small computers and individual test sets for powering various onboard subsystems, checkout, simulation of signals and monitoring.

Satellite, which is built at ISAC, Bangalore, is brought to Trivandrum, checked for its electrical/mechanical compatibility with vehicle, dynamically balanced and then taken to SHAR.

8.2 Launch Campaign at SHAR

The various subassemblies and rocket motors are brought to SLV-3 Complex which consists of a Vehicle Integration Building, Block House, Launcher and other facilities such as pneumatic sources. During this period, commonly known as launch campaign, the vehicle is built up in stages, with a concurrently running checkout from Block House. Block House is nearly midway between vehicle integration building and launcher and connected with them through 1000 lines of checkout cable. After integration and checkout of the vehicle at integration building, it moves to launch pad. The final count down of the vehicle, in conjunction with ground stations spans over more than 23 hrs, preceded by a rehearsal. The last 11 minutes of operations are entirely taken over by checkout computer at Block House. Nearly 600 parameters are checked during this phase and the computer clamps down a hold if the monitored parameters do not fall within set limits.

9. SLV-3 mission

For a successful completion of SLV-3 launch, a close coordination among elements of the mission viz., vehicle, satellite, ground stations, tracking networks and mission software, is essential. The ground stations at SHAR include telemetry receiving station, telecommand transmitter, tone range interferometer system, radars (medium and long range - a total of three numbers), real time system employing IRIS 55 computers, closed circuit TV network and photography. The mission control during the final phase is done from control centre where real time information on vehicle performance is displayed. Range safety decision, if needed, is also taken from control centre. The ground stations have been checked out as integrated system during sounding rocket flights and special aircraft sorties. They are also used in vehicle check out during launch campaign.

The tracking network includes the telemetry tone range interferometer stations at SHAR, telemetry tone range, S-band tracking systems at Car Nicobar and Telemetry receiving stations at Trivandrum and Ahmedabad.

10. Project Management

In addition to the technology development, production, integration and launching of SLV, the programme has been a landmark for developing a planning and management methodology itself. SLV-3 is a unique combination of multi-disciplines functional areas such as aerodynamics, structure, propulsion, control system, guidance, electronics, materials, quality assurance and each area has a gamut of functions varying from design, development, facility establishment, production and operation. Added to this are the critical – time bound nature of the programme, stringent resources, conflicting decision situations. A management methodology enveloping all these constraints had to be evolved, the highlights of which have been:

- a matrix type of management structure
- a thorough design review methodology
- configuration and weight control
- a closed loop failure safe mechanism involving on-line quality control, waiver boards, tests and evaluation, quality assurance teams
- Flight, mission readiness review
- Periodical review meetings
- PERT scheduling
- Budget control.

11. Future Goals

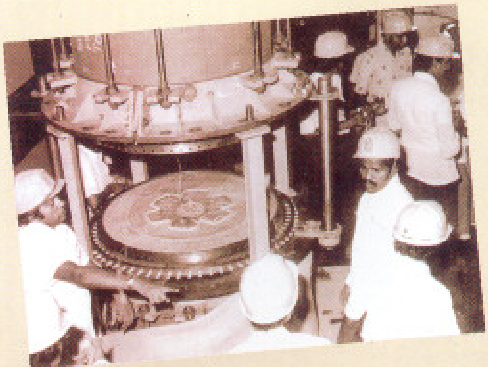
The successful performance of SLV-3 giving the required velocity for the orbital injection of Rohini Satellite, is the forerunner of the 'India's major space programme' ahead. Heavier application satellites in low-earth orbits as well as in geosynchronous orbit are to be launched to derive the full benefit of the technology to our nation. The "Satellite Instructional Television Experiment (SITE)" programmes carried out by ISRO during 1976-77, using an American ATS-6 (Application Technology Satellite) for a period of one year is good demonstration as to how the space technology can improve the life style of people in remote areas by way of education, and by flow of information regarding agriculture, hygiene and health problems, and also how the national integration process can be accelerated. In addition, launching of remote sensing satellites would help faster survey of our national agriculture, mineral and forest resources. Weather forecasting is a boon to the agriculturist. The technology infrastructure and management methodology developed within the country, in the process of making SLV-3 is very valuable to proceed confidently to build larger launch vehicles of the future to put application satellites of larger size, both in low earth orbit and in synchronous orbits. Ten years profile projected for ISRO, Department of Space, for the development of larger launch vehicles and satellites is on the anvil and expected to be carried out by improving and adding on the base created by SLV-3. India is poised for having a launch vehicle capability of putting 600 kg class spacecraft in 1000 km sun-synchronous orbit.

"Well, it is time for starting countdown to go upward from the Sixth Nation Classification."

Note:

ADE	- Aeronautical Development Establishment, Bangalore
DLRL	- Defence Electronic Research Laboratory, Bangalore
GTRE	- Gas Turbine Research Establishment, Bangalore
NAL	- National Aeronautical Laboratory, Bangalore
WIL	- Walchand Nagar Industries Limited, Poona
R & C	- Richardson & Cruddas, Bombay
BHPV	- Bharat Heavy Plates and Vessels Limited, Vishakapatanam
HSL	- Hindustan Steel Limited, Roorkela
RFC	- Republic Forge Company, Hyderabad

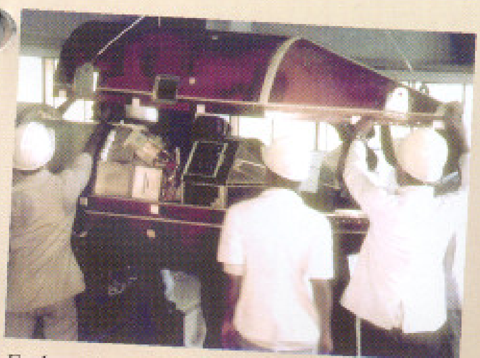
SLV 3: Nostalgia!



Assembling skillfully...

Crafting carefully...

Explaining a technical point...



Enshrouding the Rohini satellite...

Maiden journey

Expectant crowd at Sriharikota...

Pat from the press

Towering Personality: The bust of Prof Satish Dhawan at Satish Dhawan Space Centre SHAR, Sriharikota