2,3&4/1989

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

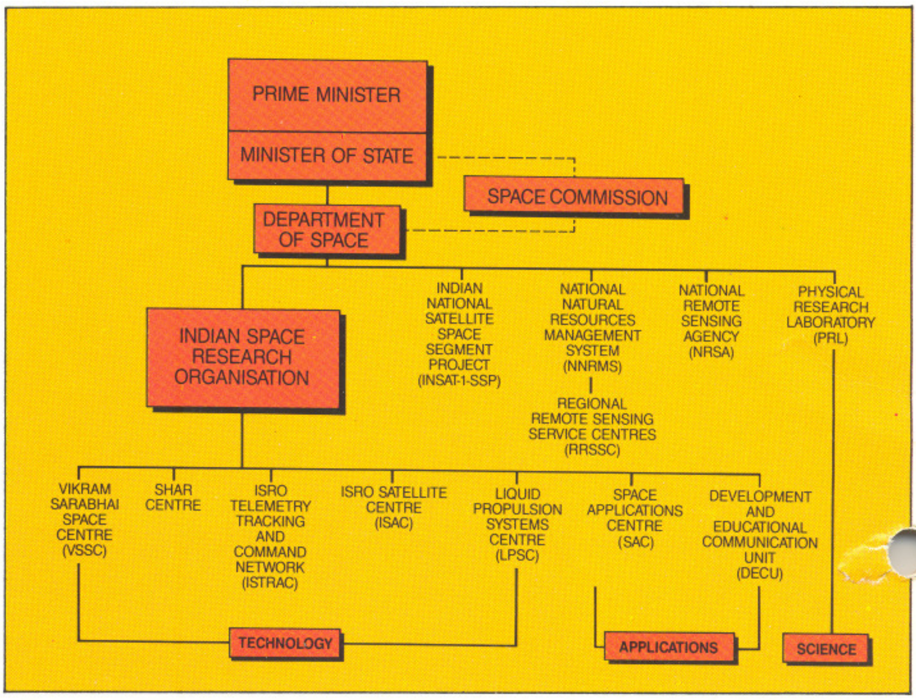
The Indian Space Programme

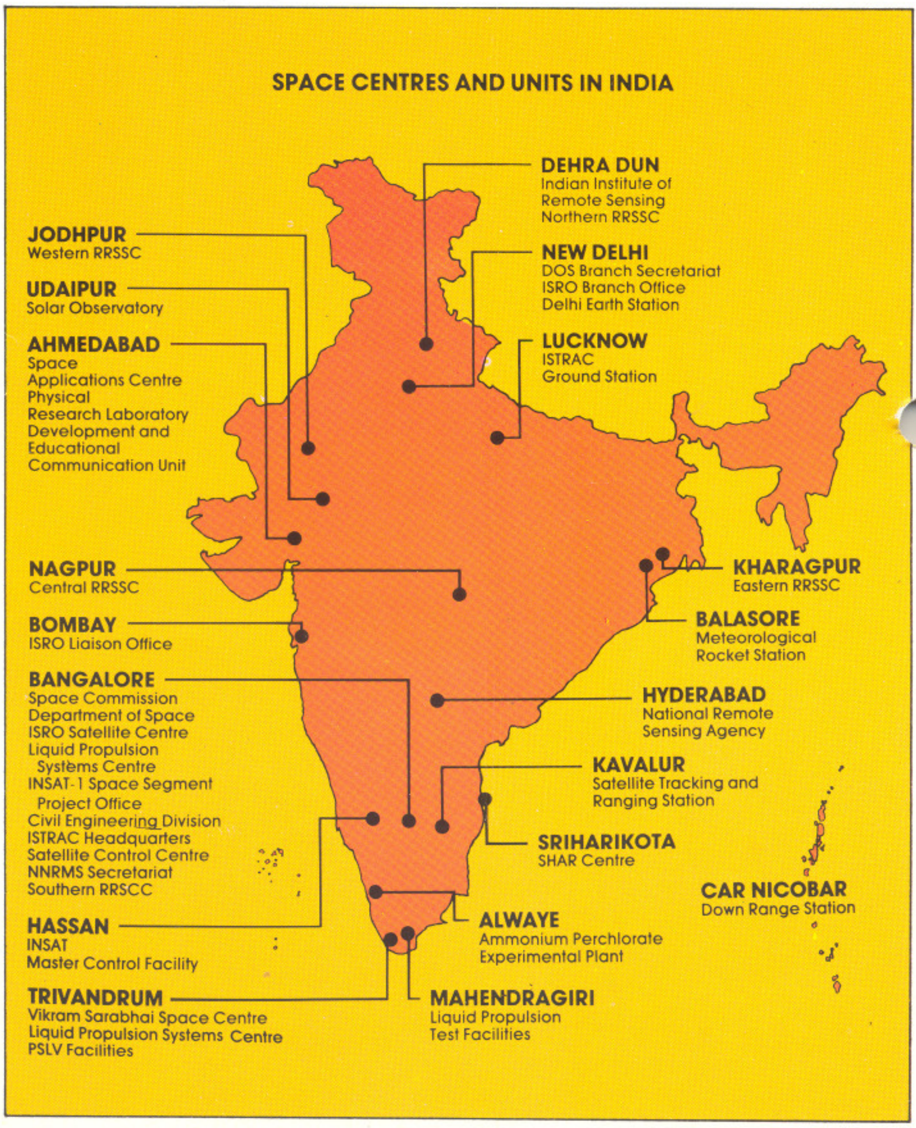
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science and technology for identified national objectives.

The Indian Space Programme is directed towards the goal of self-reliant use of Space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological services and (c) development and operationalisation of indigenous satellites and launch vehicles for providing these space services.

The Indian Space Research Organisation (ISRO) is the research and development wing of DOS and is responsible for the execution of the national Space programme. ISRO also provides support to universities and other academic institutions in the country for research and development projects relevant to the country's space programme.

Both the DOS and ISRO Headquarters are located at Bangalore. The development activities are carried out at the Centres and Units spread over the country. □





FRONT COVER

The five segment PSLV first stage solid booster motor.

EDITORS
S. Krishnamurthy
Manoranjan Rao

EDITORIAL ASSISTANCE
S. K. Dutta

PRODUCTION ASSISTANCE
B. Chandrasekhar

Contents

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PSLV First Stage Successfully Tested

The largest solid motor booster to be developed by ISRO till date has been successfully tested at Sriharikota Range (SHAR) on 21 October 1989. This is the first stage motor (PS-1) of the Polar Satellite Launch Vehicle (PSLV), which is designed for launching the Indian Remote Sensing Satellite of 1000 kg class.

This successful test marks an important milestone in the development of PSLV whose second (liquid), third (solid) and fourth (liquid) stage motors have already been successfully tested on ground. This test also marks an important step in the country's march towards self-reliance in design, development and production of large size solid propellant motors.

The development of PS-1 motor with a propellant loading of about 128 tonne represents culmination of ISRO's efforts in mastering a host of new technologies such as:

★ development and production of M-250 grade maraging steel in collaboration with MIDHANI,

★ fabrication of maraging steel motor cases (2.8 m dia) in collaboration with Indian industries,

★ development of high energy solid propellant based on HTPB (hydroxyl Terminated Poly Butadiene) resin and its subsequent productionisation with the help of Indian industry,

PS-1 Motor Static Test.

- ★ upgradation of ISRO's own plant in Alwaye, Kerala for production of the oxidizer, ammonium perchlorate,
- ★ upgradation of the Solid Propellant Rocket Booster Plant (SPROB) in SHAR,
- ★ development of igniters and pyrosystems,
- ★ commissioning of six-component test stand at the Static Test and Evaluation Complex (STEX) at SHAR,
- ★ design and development of Secondary Injection Thrust Vector Control (SITVC) system alongwith flight standard electronics,
- ★ design and development of high performance insulation systems and
- ★ design and development of nozzle liners using silicon and carbon phenolic composites

That the performance of PS-1 motor during the static test was close to prediction, was a shot-in-the-arm for the PSLV Project □

SYSTEM DETAILS

Motor configuration:

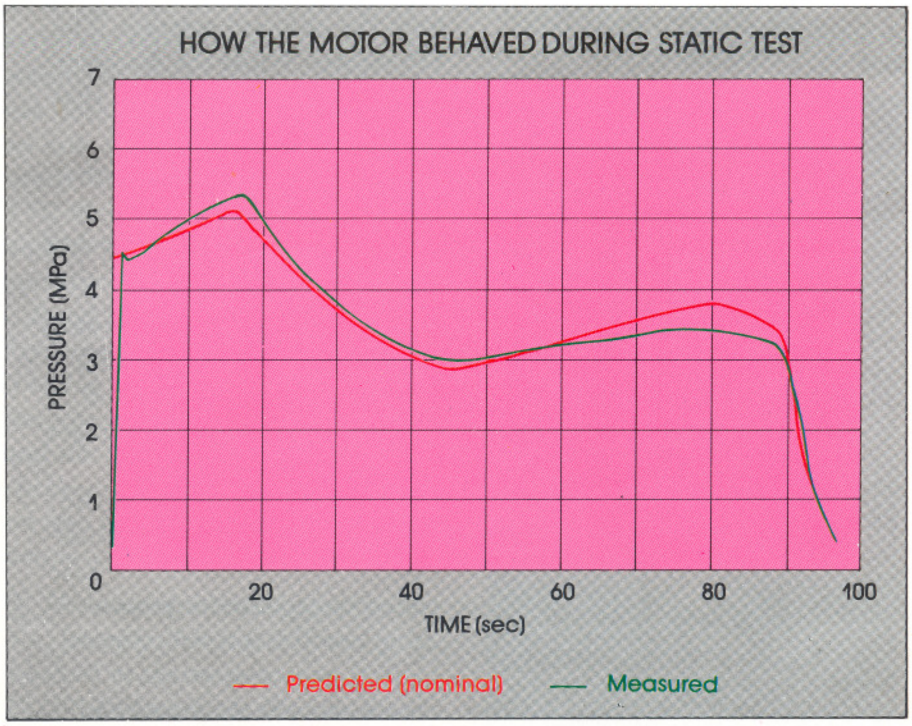
Outside diameter	–	2.8 m
Overall length	–	20.3 m
Motor case material		18% Ni M 250 grade maraging steel
Insulation	–	Rocasin
Propellant weight	–	128 t
Nozzle	–	Convergent divergent with 15CDV6 steel back up and silica/carbon phenolic composite liner.
Igniter	–	Pyrogen with remotely mounted safe arm system.

SITVC details:

Injectant	–	Strontium perchlorate
Actuator	–	Electro mechanical single pintle valve

Performance

Action time (sec)	: 93.4
Burn time (sec)	: 89.4
Maximum pressure (Mpa A)	: 5.33
Maximum sea level thrust (KN)	: 4622
Specific impulse S/L (N sec/kg)	: 2285
Total impulse S/L (KN sec)	: 294186



PSLV Progress

An Interview with Project Director.

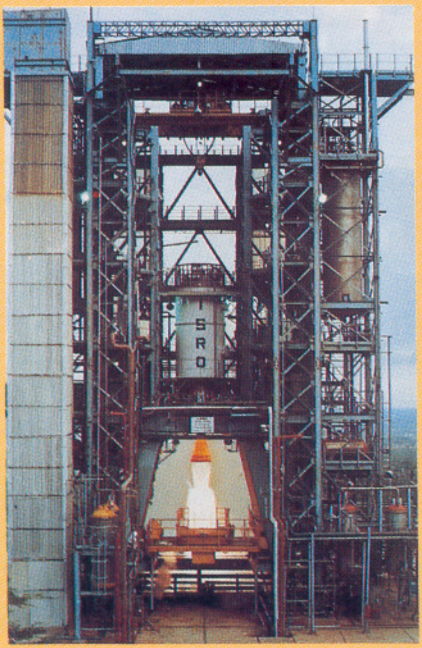
Following the successful testing of PSLV first stage motor, Shri. G. Madhavan Nair, Project Director, was interviewed by SPACE India, Excerpts:

G. Madhavan Nair

Q: *The Polar Satellite Launch Vehicle (PSLV) Project, over the years has made significant progress. Before we go into the details, could you tell us what is the basic mission of PSLV and what the configuration of the vehicle is?*

A: The Polar Satellite Launch Vehicle is designed to launch 1000 kg class of Indian Remote Sensing Satellite (IRS) for remote sensing applications into polar sun-synchronous orbit from SHAR, Sriharikota. The vehicle has a four stage configuration with the first stage using 128 tonne of Hydroxyl Terminated Poly Butadiene (HTPB) solid propellant in a maraging steel motor case, second stage with Viking liquid engine having 37.5 tonnes of Unsymmetrical Dimethyl Hydrazine (UDMH) and N_2O_4 propellant, third stage a Kevlar composite motor with 7 tonne of HTPB propellant and finally a liquid fourth stage using twin engine of 700 kg thrust, with two tonnes of N_2O_4 and Mono Methyl Hydrazine (MMH) propellant contained in titanium alloy tank. In addition, six strapon motors similar to the ones used in the Augmented Satellite Launch Vehicle (ASLV) will be employed to augment the lift-off thrust and to provide the required payload capability. Secondary injection thrust vector control system, engine gimbal system and flex nozzle control are employed for attitude control. Redundant inertial guidance system and Telemetry, Tracking and Command (TTC) systems overall length of the vehicle is 44 metres and lift-off weight is form the onboard avionics. The 275 tonnes. While the diameter of the core vehicle is 2.8 m that of the heatshield is 3.2 m.

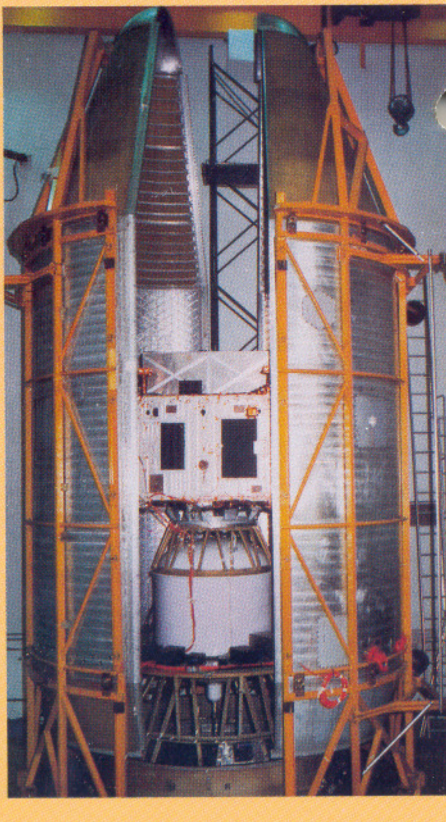
Second Stage (PS-2) battleship test.

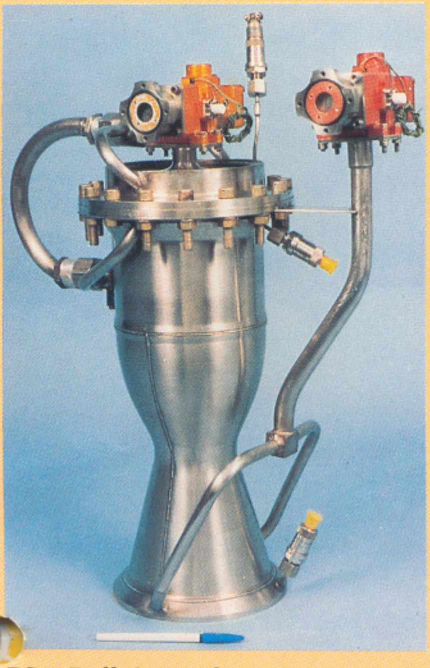


Q: *As far as basic technologies are concerned, what is new in PSLV compared to those we had used in SLV-3 and ASLV?*

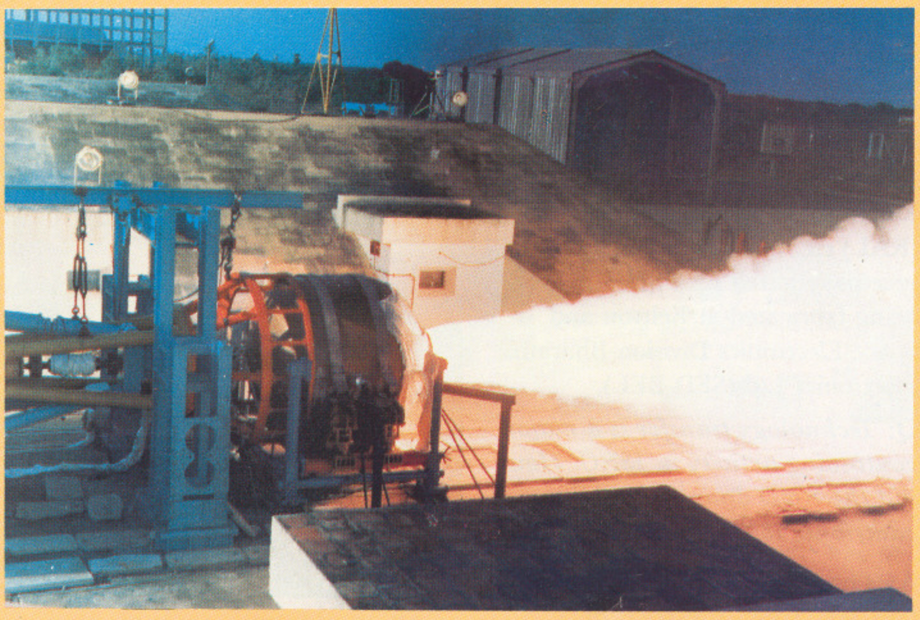
A: The main difference between PSLV and our earlier vehicles SLV-3 and ASLV is the use of alternate liquid and solid stages. Perhaps this is a unique configuration compared to the world class launchers of similar capability. In addition, we have closed loop guided injection using a self-contained onboard inertial guidance system to obtain an orbital tolerance of ± 15 km in altitude and ± 0.1 degree in inclination in the 904 km sun-synchronous orbit. Use of redundant inertial sensors and multiple onboard computers for implementing navigation, closed loop guidance and digital autopilot functions is a special feature. The solid propellant stages use the high energy propellant based on HTPB resin developed in Vikram Sarabhai Space Centre (VSSC) and productionised in industry. The stage system for the second stage is developed with the engine technology alone being acquired from SEP, France and the high performance liquid engine for

Heatshield in Acoustic Test Facility at NAL, Bangalore.





PS-1 Roll Control Engine.



Static Test of PS-3 motor.

the fourth stage is a major achievement of the Liquid Propulsion Systems Centre. The heatshield using isogrid structure and zip cord jettisoning system as well as engine gimbal and flex nozzle control systems are being used for the first time in ISRO.

Q: *Could you describe some of the major ground facilities for PSLV in SHAR Centre, Sriharikota? And their readiness?*

A: The major facilities at SHAR for the PSLV programme are the Solid Propellent Space Booster Plant (SPROB), Static Test and Evaluation Complex (STEX), ISRO Range Complex (IREX) and ISRO Telemetry, Tracking and Command network (ISTRAC). SPROB has been augmented to meet the requirements of large size propellant grain production. The total facility has been commissioned and the recent static test of the PS-1 booster is proof of the operational readiness of SPROB facilities for propellant casting and the related operations for large size solid boosters. After augmentation, STEX has taken up the pressure testing of the motor cases and the static test of the first and third stage motors. The six component test stand and the high altitude facility are the specific ones set up for the PSLV programme. The entire launch complex for the PSLV is being established by IREX the most important elements which are the Mobile Service Tower (MST), weighing nearly 3,000 tonne and the jet deflector and launch pedestal. These facilities are being commissioned along with those for liquid propellant stage servicing. The MST, including its hydraulic wheel bogie drive system developed indigenously, has been tested for its movement on rails for over a distance of nearly 200 metres. The ISTRAC TTC network at SHAR will support PSLV during the launch operations and two precision C-Band radars are being developed for the real time tracking and range safety purposes. The terminal buildings and the control centre for vehicle checkout and launch operations are also in the final stages of completion.

Q: *How many external agencies (i.e., outside ISRO/DOS) are involved in the realisation of PSLV? And what are the major sub-systems that are fabricated outside?*

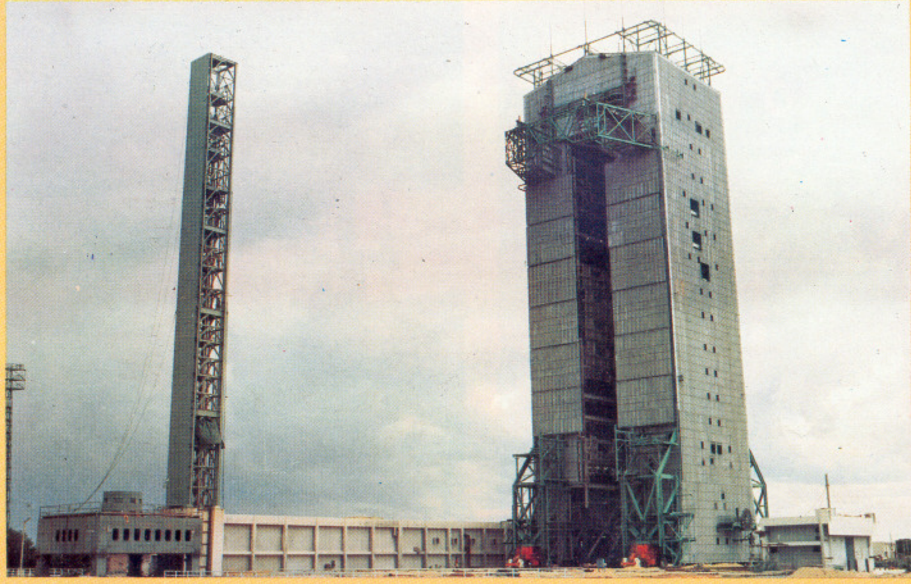
A: As part of the declared policy of the ISRO to contract out tasks to the maximum extent to the industries and institutions, PSLV Project has sub-contracted systems fabrication and testing to a number of external agencies in the country. Maraging steel sheets and forgings were supplied by M/s. Midhani. Most of the hardware for the programme is fabricated in major industries like M/s. Larsen & Toubro, Walchandnagar Industries, Godrej, etc. The light alloy structures which account for nearly 50% of the vehicle structural system is being realised through a dedicated facility set up jointly by ISRO and Hindustan Aeronautics Ltd. (HAL) at Bangalore. Though the propellant chemicals were developed in-house, they are being produced at industries like National Organic Chemical Industries Ltd. (NOCIL), Hindustan Organic Chemicals Ltd (HOC), Andhra Sugars, Wimco, etc. through the technology transfer process. In addition, fabrication of the components required for control systems, pyro elements, stage auxiliary systems are being sub-contracted to a large number of workshops having precision capabilities such as Auro Engineering, precision components, Kerala Automobiles Limited (KAL) etc. Some of the electronics systems required for PSLV are being fabricated at Keltron and Space Electronics Division-Bharath Electronics Ltd (SED-BEL).

Q: *Technology transfer is a major continuing activity in ISRO. How did the R&D done for PSLV contribute to this activity?*

A: The major technology transfers are in the areas of propellant chemicals. HTPB, Ammonium Perchlorate, UDMH, MMH and N_2O_4 are now under regular production in industries and are being used for various tests. Development and production of maraging steel in collaboration with Midhani and development of high precision radars in collaboration with BEL, are other examples.

Q: *We are aware that enormous efforts had gone into the analysis of the flight data of ASLV-D2. Do you think any of the findings of Failure Analysis Committee for ASLV-D2 has relevance to PSLV? If so what are they and how are they relevant?*

A: ASLV post flight analysis has given us added insight into PSLV vehicle design with respect to the mission sequence, aerodynamics, digital autopilot and the trajectory shaping required for achieving the desired load conditions, taking into account the wind profile. In addition we are now more confident of the strapon jettisoning system. Based on the ASLV experience, a review of the PSLV mission sequence has been carried out and it was noted that with the present design of the vehicle structure, there are constraints with respect to the angle of attack and the dynamic pressure conditions. In order to improve margins, after detailed analysis, a decision was made to modify the mission sequence by firing two strapons at lift-off instead of four as planned earlier. With this, the dynamic pressure will be brought down considerably leading to reduction in vehicle load and control force requirements. The estimates of aerodynamic forus have been revalidated by carrying out additional wind tunnel tests and inputs have been derived for the strapon jettisoning system design. The performance of onboard computer and digital autopilot in ASLV has also given valuable inputs to PSLV system design.



Mobile Service Tower, Umbilical Tower and Launch Pedestal at PSLV Complex, SHAR.

Q: *How do you describe the present status of the Project?*

A: The development of PSLV sub-systems has made significant progress and at present various qualification tests are in progress. The static test of the giant solid booster developed for the first stage was a total success. The second stage Viking engine has been tested for its sea level performance for a duration of more than 1,000 seconds and was also tested in the stage configuration in the battleship tests recently. These tests were conducted using the Liquid Propulsion Test Facilities set up at Mahendragiri by Liquid Propulsion Systems Centre (LPSC). The first test of the third stage motor has given satisfactory performance. Environmental qualification of the PS-3 Kevlar motor case is also successfully completed. After solving the development problems of the fourth stage engines, they were fully tested in battleship stage configuration along with control systems. The performance of the control systems for all the stages has been validated in various ground tests with the propulsion systems except for the third stage, which will also be tested shortly. The electronics sysems have been qualified and the development of the indigenous inertial navigation system is in progress. Development of onboard computers and associated software for navigation guidance and control are progressing well. After completion of the qualification tests, preparation of various flight hardware will commence shortly along with the integration activities for the sub-systems qualification and flight assemblies.

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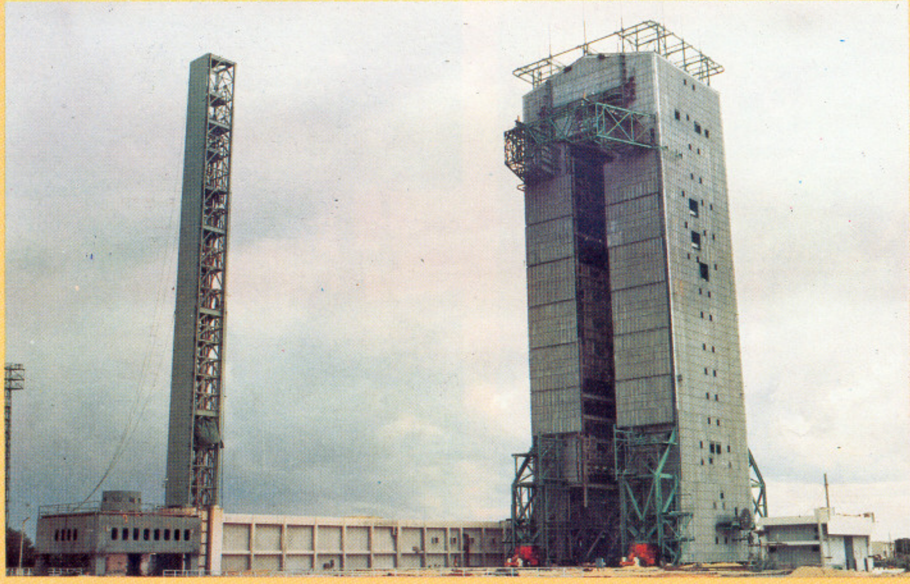

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Transportation of PS-1 Motor for Static Test.

Q: *What are the specific areas which are critical to the PSLV, that is, from the point-of-view of schedules?*

A: The progress in the propulsion, control systems and electronics is satisfactory. However, the developmental problems in the inertial navigation systems are yet to be solved. The precision sensors, namely, dry tuned gyros and servo accelerometers required for these systems are being developed fully indigenously. The precision required of these sensors is one order of magnitude better than that required for our earlier missions and their development poses considerable technology challenge. The teams are fully concentrating on the developmental tasks and qualifying them to PSLV specifications. Test results from initial lots are satisfactory but improvements are required. Further, recently we had some failure in the interstage structural members. This calls for some amount of re-design, fabrication and testing, which could cause schedule slippages. The failure analysis has been completed and the redesign of some of the structural members is in the final stages of completion. We hope to carry out these activities within a short period of time and the schedule impact on the overall programme will be kept to the barest minimum.

Q: *How do you describe the Management System adopted for PSLV? With your experience so far in the Project, do you suggest any changes in the system for adoption for future projects?*

A: The management system to be adopted for any project is determined by the project's requirement and the environment in the Centres. The organisational structure within the Centre and the availability of senior managers also influence the management set up. By and large, for R&D tasks in a multi-project environment, 'Matrix' type of management system is most suited. This ensures proper utilisation of expertise and facilities. The core project team should have the control of configuration, cost and schedule. Direct accountability of the concerned work centre executives to the core project is also to be ensured for speedy and successful implementation of the project. To a great extent, this type of philosophy is implemented in system projects, but the multiplicity of layers in decision making is to be avoided.

Q: *What is the likely date for the first launch of PSLV?*

A: The Project schedule is controlled by the successful completion of a large number of qualification tests and the realisation of the flight hardware, and carrying out of flight acceptance tests on them. The PSLV, as any other project, has worked out an optimistic schedule for completion of these tasks. Assuming that we do not get into any major problems in the remaining part of the qualification programme, the first launch of PSLV can take place by the beginning of 1991.

Q: *What are the specific technologies developed for PSLV which will directly feed into the design and fabrication of the proposed GSLV?*

A: The configuration studies of Geo-synchronous Satellite Launch Vehicle (GSLV) are in the final stages of completion. There is a mandate to use the PSLV systems to the maximum extent possible in GSLV. As I understand, the PSLV propulsion systems,i.e., the first and second stages can be used as they are. In addition, the strapon motors required for the first stage, either liquid or the solid version, can be derived from PSLV. However, the upper stages will use 'Cryogenic' systems for GSLV to achieve the higher payload capabilities. The TTC system can be used perhaps with some modifications in packaging to reduce the weight, and the closed loop inertial guidance system and autopilot can be adopted with software changes for the GSLV mission. There is also a plan to use the existing launch pad for GSLV launches □

INSAT-1D Launch postponed

ARABSAT to backup INSAT services

Mr. Abdel Kader Baire, Director General, ARABSAT (right) and Prof. U. R. Rao, Chairman, ISRO signing the lease agreement.

The launch of INSAT-1D, scheduled for June 1989, has been postponed. The satellite suffered damage while being mated with the Delta-4925 launch vehicle at Kennedy Space Centre, USA on June 20, 1989. After the incident, the satellite was transported to the test area, depressurised and defuelled. The damaged C-band reflector was also removed. Later the satellite was moved to the Ford Aerospace Corporation's facility at Palo Alto, USA where it is being repaired.

A detailed assessment of the damages and the schedule for repair and tests have since been made. INSAT-1D is now scheduled for launch by middle of 1990.

Meanwhile, arrangements are made to safeguard the continuity of services provided by INSAT. INSAT-1B was earlier expected to provide services till only October, 1989 but it has continued to be available and further extension of its life depends upon the fuel available onboard. INSAT-1C, which was operating with partial capacity due to a power bus anomaly, suffered loss of lock on November 22, 1989 and the spacecraft could not be put into safe mode. Keeping in view the impending end of life of INSAT-1B and the present status of INSAT-1D, the Department of Space has signed an agreement with ARABSAT Organisation on August 29, 1989 for lease of twelve C×C transponders for a period of two years from an in-orbit ARABSAT satellite.

The ARABSAT delegation led by its Director General, Mr. Abdel Kader Baire, and the Indian delegation led by Prof. U. R. Rao, Secretary, Department of Space, finalised the lease agreement in Bangalore. Arab Satellite Communications System (ARABSAT), established by the Arab States (Members of Arab League), operates a system of two satellites in orbit providing services to its member states.

ARABSAT-1B located at 26 deg. E longitude has since been tilted towards East so as to provide coverage over India. The lease has commenced from October 1, 1989. The coordination with ARABSAT Operations Centre in Riyadh, Saudi Arabia, is provided by INSAT Networks Operations Control Centre (NOCC) of Department of Telecommunications in Delhi □

SPACE & MAN'S FUTURE

— An exposition of the Indian Space Programme

School children entering through the "Space corridor."

An Exhibition "SPACE AND MAN'S FUTURE" at the Teen Murti House Grounds, New Delhi was organised by ISRO/ DOS as part of birth centenary celebration of Jawaharlal Nehru, the architect of modern India.

Inaugurated by the Prime Minister on November 14, 1989, this biggest and the most exhaustive exhibition ever organised by ISRO/DOS was open to the public till November 30, 1989.

Targetted towards school and college going students the exhibition had a number of live, interactive and working models besides a very large number of full scale and scaled down static models of space hardware. This exhibition was housed in ten specially designed, reusable domes whose geometry is as complicated as its name is difficult to pronounce: Rhombi icosi dodecahedron! The very shape of the domes is novel enough to arrest the attention of even a casual visitor.

The exhibition had a 3-fold objective:

★ To inform and educate students, specially children, on the relevance of the Indian Space Programme to the overall development of the country.

★ To expose the students to the various facets of space technology and space sciences.

★ To kindle interest in students to learn about the limitless potential of space.

The very inaugural piece was a big, (nearly 15′ high) impressive mosaic of India prepared using over 280 individual imageries taken by the Indian Remote Sensing Satellite, IRS-1A. In this cartographically accurate mosaic, one could discern the various physiographic features that characterise the contrasting climatic zones in the country such as the

★ Snow cover over the Himalaya

★ Thar desert in the western Rajasthan

★ High rainfall areas in the north-east

★ Aravalli, Vindhya and Satpura mountain ranges
★ Ganges delta, the western and eastern ghats and the ocean plateau
★ The islands of India, namely, Andaman, Nicobar, Lakshadweep, etc.

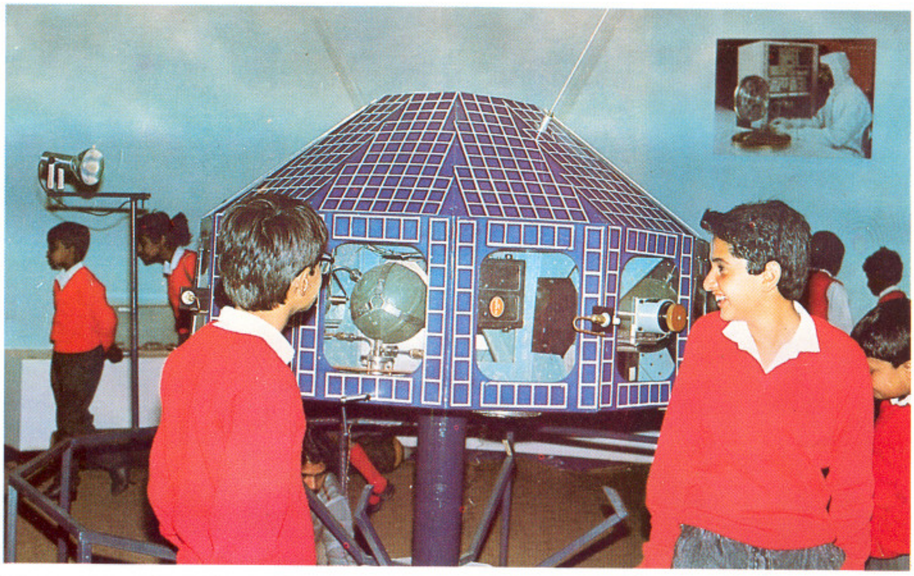
In the satellite communication field there were live demonstrations of Satellite-Based Rural Telegraphy, the PTI news services including facsimile transmission, the Emergency Communication Terminal, the direct reception system for TV and so on.

The remote sensing section had two demonstrations: the ISRO Vision and the Satellite Image Processing System. Besides, the section had on display large number of imageries showing various remote sensing application fields such as forestry, agriculture, water bodies and flood management.

In satellite technology, a working model which attracted large crowds was a demonstration that showed how the attitude of a satellite in orbit is controlled. This was a really sophisticated exhibit which made use of real space hardware like reaction wheels, gyros, titanium gas bottles for reaction control system, and the telemetry and telecommand systems. The 'satellite' was lifted on an air bearing and then commanded to change its attitude.

In a single dome was displayed the full complement of all the satellites (scaled down versions) so far developed by ISRO. A particularly impressive model was the 1/4 model of INSAT-II TS. To give the viewers an idea of the actual size of the spacecraft, the full size of the solar sail was displayed by the side of the model. Also demonstrated was the deployment system developed for the solar sail.

In rocketry too, there were many



Demonstration of satellite attitude control.

Explaining six component static test set up for PSLV first stage booster.

General view of Remote Sensing Pavilion.

Model Rocketry demonstration drew large crowds of children.

Children playing computer games.

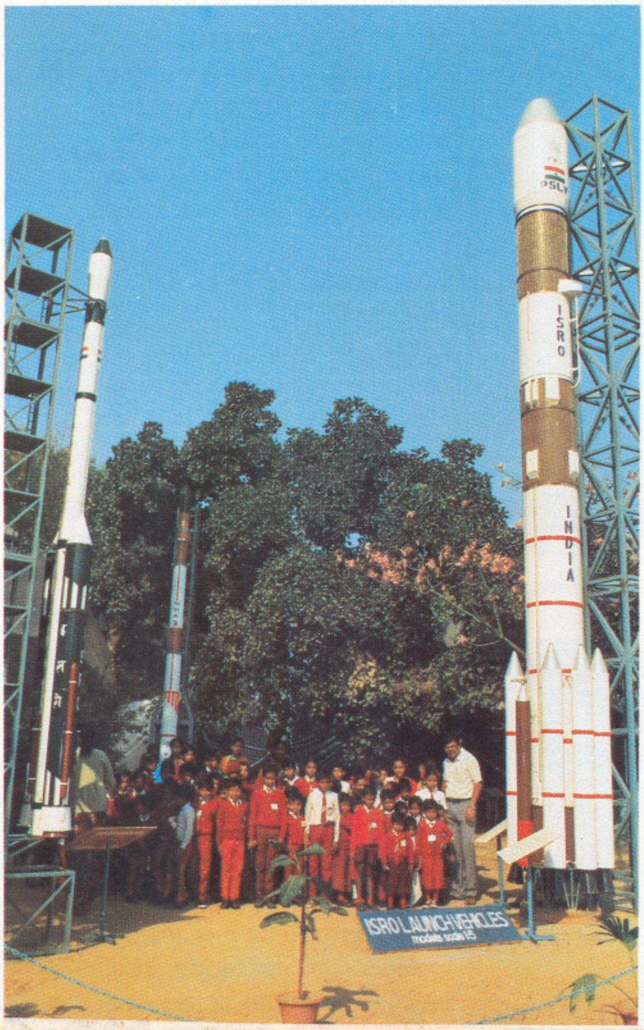
Working model of Mobile Service Structure for ASLV at SHAR.

working models of which the Mobile Service Tower used for ASLV in SHAR and the heat-shield separation (with fourth stage spinning) used in SLV-3 need special mention. Among other displays were: the Block House, the PCMC Radar, full complement RSR rockets (full size), 1:5 scale models of SLV-3, ASLV, PSLV and a range of components made of composite materials including the Kevlar motor case actually used in static testing of the third stage of the PSLV.

One of the domes was devoted exclusively to space sciences in which a live demonstration of sun-spots arranged by the Udaipur Solar Observatory drew large crowds. Besides, 'Anuradha' the cosmic ray experiment flown on Space Shuttle and a working model of the Ooty Radio Telescope were also on display. In addition, one could learn about the birth and death of stars, the ozone depletion, the powerful nature of tropical cyclones, and the future satellite-based experiments planned for the next decade.

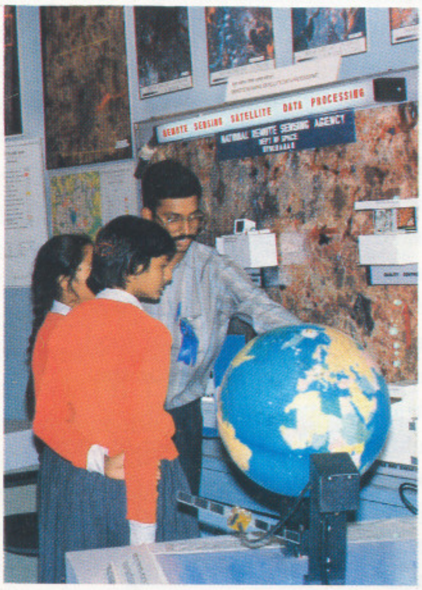
Similarly, the exhibits related to manned flights were arranged in a separate dome. The Institute of Aerospace Medicine, Bangalore (formerly known as the Institute of Aviation Medicine) put up a cute and interesting show that explained the various facets of training pilots and cosmonauts. One could also see the actual space suits worn by Rakesh Sharma and Ravish Malhotra. The display which attracted children's attention most was that put up by the Defence Food Research Laboratory, Mysore. They displayed a variety of food items specially prepared for the astronauts and cosmonauts. Children could get samples of these foods prepared to strict internationally recognised specifications.

There were many interesting displays specially designed for children: The Gimbal Mounted



Scaled down models of launch vehicles of ISRO

Full scale models of ISRO's sounding rockets, also seen at left corner is the Kevlar motor case for PS-3



Students watching IRS going round the globe

Simulation of firing of second stage liquid engine for PSLV.

Pavilion of Manned Space Flight: Displays put up by Institute of Aerospace Medicine, Bangalore and Defence Food Research Laboratory, Mysore. Space suits worn by Rakesh Sharma and Ravish Malhotra are seen in the centre. (Courtesy, Nehru Planetarium, New Delhi)

Children collecting Space food samples.

Live demonstration of satellite TV and Telecommunication.

Gimbal Mounted Tumbling Device.

Students entering the first "Rhombi icosi dodecahedron" dome

Panoramic view of the exhibition domes.

Tumbling Device on which hundreds of children had a "free ride", the gyro toys, rocket assembly kits, "planetary" weighing machine and so on. A special attraction was the bank of Personal Computers on which children could play games including self-evaluating space quiz. There were prizes for those who scored high marks in the quiz. The volunteers had a tough time controlling hordes of children who refused to move out of the tumbling device or refused to vacate the "Computer enclosures" even after several rounds of playing!

Next to children's item, the exhibit which drew large crowd was the 'working' model of the Principal Test Stand at Mahendragiri (1:10 scale) in which the firing of the second stage liquid engine of PSLV was simulated. The simulation had to be repeated a large number of times on demand from children.

As an adjunct to the main exhibtion, agencies like National Council for Eductional Research and Training, the National Book Trust and others put up stalls where books for children were sold at concessional rates.

For hundreds of people who had worked for the exhibition, it was a very trying but highly satisfying experience.

The institutions which contributed significantly to the success of the venture by ISRO and DOS are: Defence Food Research Laboratory, Mysore, the Institute for Aerospace Medicine, Bangalore, Vikram A. Sarabhai Community Science Centre, Ahmedabad, Udaipur Solar Observatory, Udaipur, Tata Institute of Fundamental Research, Bombay, the Phsycial Research Laboratory, Ahmedabad, The National Physical Laboratory, New Delhi, the Radio Astronomy Centre, Ooty, Indian Institute of Astrophysics, Bangalore, Midhani, Hyderabad, The Press Trust of India, New Delhi, India Meteorological Department, New Delhi and the Nehru Planetarium, New Delhi □

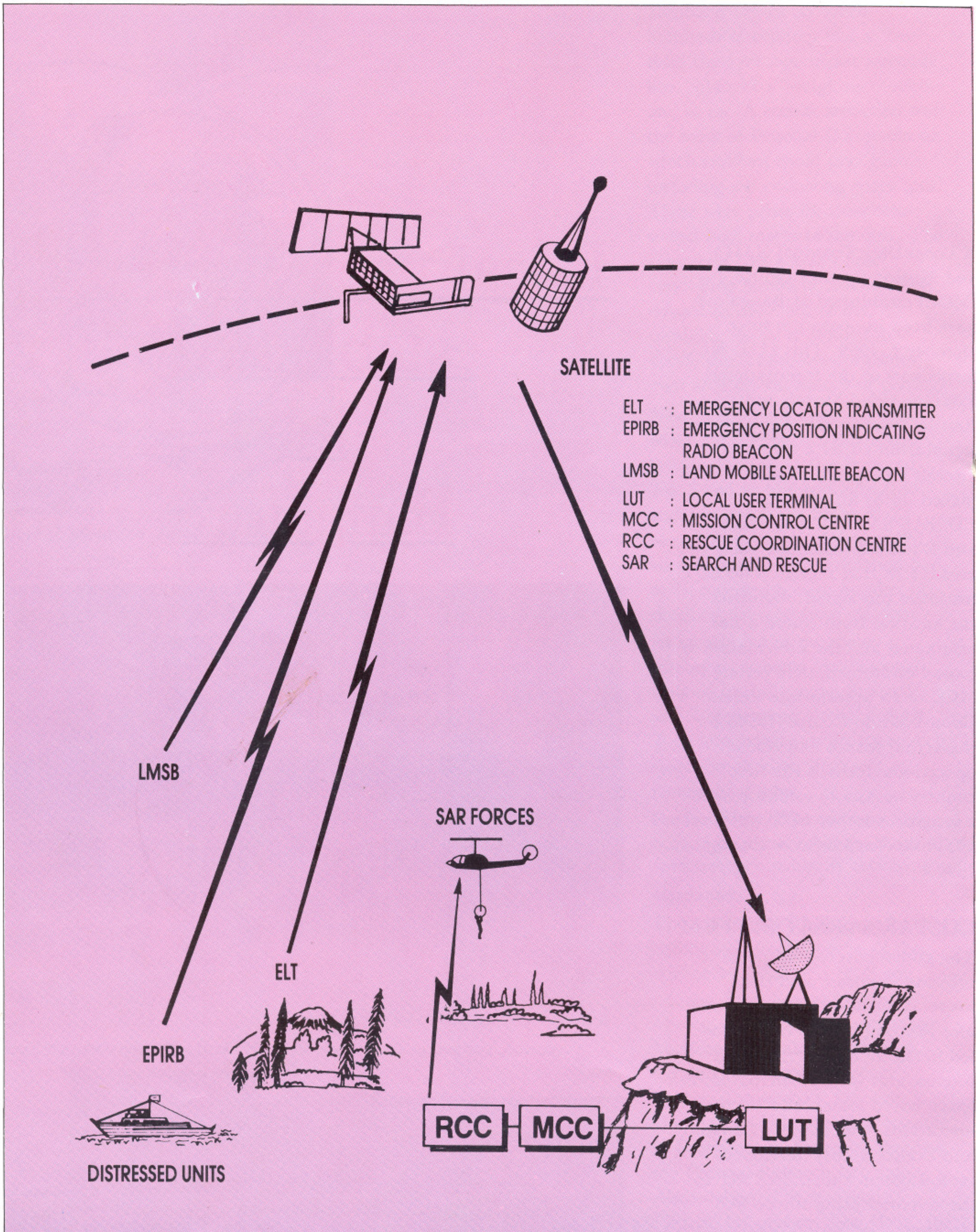
Local user Terminal established in Bangalore

A Local User Terminal (LUT) and Mission Control Centre (MCC) established at Bangalore, have been in operation since October 1, 1989. This LUT/MCC forms part of the International Satellite-Aided Search and Rescue Programme. Any distress signal from either a ship or an aircraft emergency beacon is picked up by an orbiting COSPAS/SARSAT spacecraft, and is relayed instantaneously to an LUT in that region. The LUT processes this signal, identifies the location from where it has originated and the information is passed on immediately through MCC to an appropriate Rescue Co-ordination Centre (RCC) for the actual search and rescue operations. India is the first country in Asia to establish such a system. Another LUT will be established at Lucknow during 1990.

COSPAS/SARSAT SYSTEM

The global coverage of polar orbiting satellites, and the universal need to improve Search and Rescue (SAR) services, have led to the active international interest and wide participation in space-based search and rescue operations. The U.S.A., Canada and France jointly developed such a system called SARSAT in the seventies using the NOAA satellites. The Soviets also developed a similar system known as COSPAS. One of the characteristics of a satellite in a low, polar orbit is that it will "see" the entire globe once every twelve hours. The contact time

Local User Terminal and Mission Control Centre at Bangalore



Concept of the COSPAS-SARSAT System

with any one area is, however, relatively short, but the waiting time between the activation of a distress transmitter and its detection by an overflying satellite is significantly reduced by having more than one satellite available in the orbit. With four satellites in orbit, the mean waiting time is approximately one hour. (It has been possible to provide required number of satellites, through the cooperation between COSPAS and SARSAT organisations.) The joint COSPAS/SARSAT Programme was formalised in November 1979. Inter-operability among the two systems has also been established, allowing all participating nations to use both systems to detect and locate emergencies.

HOW IT WORKS

There are three types of uplink units, known as airborne Emergency Locator Terminals (ELTs), maritime Emergency Position Indicator Radio Beacons (EPIRBs) and Personal Locator Beacons (PLBs). These units transmit signals that are detected by COSPAS-SARSAT polar orbiting satellites and are relayed to a ground receiving station termed as Local User Terminal (LUT), which processes the signals to determine the beacon location. Alerts are then relayed, together with the location data, via a Mission Control Centre (MCC), either to another MCC or to an appropriate Search & Rescue Point of Contact (SPOC) to initiate search and rescue operations.

The location of beacons is determined by Doppler principle using the relative motion between the satellite and the beacon. The carrier frequency transmitted by the beacon is reasonably stable during the short period when the beacon is within a satellite's visibility. The frequencies used are 121.5 MHz (and 243 MHz) international distress frequency and the 406.0/406.1 MHz band. The 406 MHz units are more sophisticated than the 121.5 MHz beacons because of the inclusion of identification codes in the message. The complexity in this is still kept to a minimum by the retention of Doppler location concept. The use of low altitude near polar orbiting satellite has the advantages of (i) low uplink power requirement, (ii) a pronounced Doppler shift, (iii) shorter intervals between successive passes and (iv) global coverage.

Of the nominal four satellites system configuration, two each are provided by COSPAS and SARSAT Organisations. The SARSAT satellites carry, in addition to the 121.5 MHz and 406 MHz receive equipment, the 243 MHz receivers on-board, while the COSPAS spacecraft carry only the 121.5 MHz and 406 MHz receivers.

The COSPAS-SARSAT system provides two coverage modes for the detection and location of beacons, the real-time mode and the global coverage mode. Both the 121.5 MHz and 406 MHz systems operate in the real-time mode, while the 406 MHz system operates in the global coverage mode also. A repeater on-board the spacecraft relays the 121.5 MHz (and 243 MHz in the case of SARSAT) signals directly to the ground. If an LUT is in view of the spacecraft, the signal can be received and processed at the LUT. In the case of 406 MHz beacon signals received by the satellite, the Doppler shift is measured on-board and the beacon digital data recovered from the beacon signal. This information is then time-tagged, formatted as digital data, and transferred to the repeater downlink for real-time trasmission to any LUT in view. The data is also simultaneously stored on the spacecraft for later transmission. This stored data is continuously dumped for reception by other LUTs, thereby making it possible for all LUTs to locate each 406 MHz beacon.

LOCAL USER TERMINAL (LUT)/MISSION CONTROL CENTRE (MCC)

LUT is the ground station that receives the distress signals relayed by any of the orbiting SARSAT-COSPAS satellites.

The Mission Control Centre (MCC) collects, stores and sorts the data from LUTs and other MCCs, and provides data exchange within the COSPAS-SARSAT system and to Search and Rescue networks.

INDIA'S PARTICIPATION

Recognising the potential of satellite based search and rescue system, an Inter Agency Steering Committee (IASC) consisting of representatives of Coast Guard, Directorate General of Shipping, Civil Aviation, all the three Defence Services, Department of Telecommunication and Department of Electronics was set up in April 1986 with the Department of Space as the nodal agency. The IASC decided that India should join the COSPAS-SARSAT system by establishing an appropriate ground system in India. The location of LUT to receive the signals from the COSPAS-SARSAT satellites depends on the coverage necessary for the various users. After detailed studies, it was decided to set up two LUTs in the country, one at Bangalore and the other at Lucknow. The Indian Mission Control Centre, which is responsible for coordination with the Rescue

Coordination Centres, and other international MCCs, is co-located with the Bangalore LUT. To effect economy it was decided to locate LUT's at the existing ISTRAC Stations at Bangalore and Lucknow.

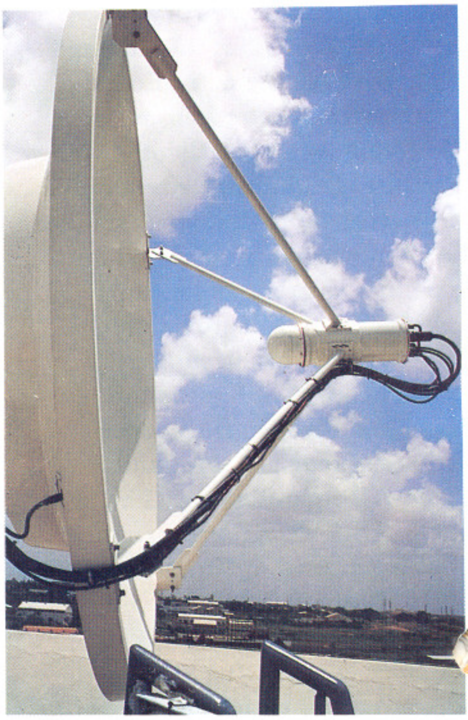
The Indian MCC is connected with the Rescue Coordination Centres (RCC) of the National Airports Authority of India through public telex network. Any distress alert received from the areas covered by these RCCs is automatically transmitted to the respective RCC by the MCC. These RCCs coordinate the search and rescue operations with the appropriate agencies — Coast Guard/Navy/Air Force, etc.

In the case of 406 MHz beacons, the global mode of the COSPAS-SARSAT system could provide alert service for distress occuring anywhere in the world. But the majority of the beacons presently carried by aircraft and ships are in the 121.5/243 MHz frequency, for which a real-time LUT coverage becomes essential.

The Indian LUT at Bangalore provides the only coverage for the Indian Ocean region. Hence, COSPAS-SARSAT Organisation has requested the Indian MCC to serve the adjacent countries as well. Thus, the Indian MCC will provide alert service to the following countries to begin with:

*Bangladesh *Indonesia
*Kenya *Malaysia *Maldives
*Singapore *Somalia *Sri Lanka
*Tanzania *Thailand

India is also incorporating a Search & Rescue Payload in the second generation INSAT spacecraft, the first of which (INSAT-II TS) is scheduled for launch in 1991. This would be a major contribution by India to the space-segment of the international Satellite-Aided Search & Rescue Programme. Efforts for indigenous development of the new version of emergency beacons (operating in the 406 MHz band) are also in advanced stage in ISRO as well as in the industry □



2.4 m Local User Terminal Antenna.

Signal Processor at Local User Terminal

Successors to IRS-1A

With the successful launch of IRS-1A on March 17, 1988 and its operationalisation, an indigenous operational space based remote sensing system has been established to support the National Natural Resources Management System (NNRMS). IRS-1A is functioning satisfactorily and has completed more than a year and half of successful operation, covering the country every 22 days once. The spacecraft weighing about 975 kg. carries two types of cameras, Linear Imaging Self Scanning sensors, LISS-I and LISS-II, with spatial resolutions of 73 metres and 36.5 metres respectively for imaging over the Indian subcontinent with a swath width of about 140 km .

To provide remote sensing data to the user community on a continued and assured basis, action for the launch of the follow-on satellite IRS-1B has already been initiated. IRS-1B systems are identical to those of IRS-1A.The experience of on-orbit and ground operations of IRS-1A has, however, been suitably reflected in realising the final configuration of IRS-1B. The hardware fabrication and integration of various subsystems of IRS-1B are in progress. Launch of IRS-1B is scheduled in the first half of 1991.

Work on IRS-1E spacecraft to be flown on the first developmental flight of PSLV is in progress. IRS-1E will carry a LISS-I camera with a spatial resolution of 73 metres and operating in four visible/near IR bands. IRS-1E may also carry a West German payload, Monocular Electro-Optical Stereo Scanner (MEOSS) which will operate in pushbroom mode and will have three CCD arrays mounted in such a way as to provide oblique viewing of 23° in both forward and backward directions, besides the nadir viewing.

To ensure continued and enhanced support to the Indian remote sensing user community, launches of second generation remote-sensing satellites IRS-1C and 1D are also planned for 1993-94 and 1995-96. IRS-1C/1D will have improved spatial resolutions of around 10 meters and 20 metres, besides an additional spectral band in the shortwave infra-red, stereo viewing and on board video data recording capabilities □

Mr. I. N. Goroshkov (third from right) and Shri N. Pant, Director, ISAC are signing the agreement for launch of IRS-1B in the presence of Prof. U. R. Rao, Chairman, ISRO.

Focus on Development and Educational Communication Unit

While the main emphasis of the Indian Space Programme is on communications and remote sensing applications, a significant effort is made to directly deal with the development and educational communication needs of the society. This is the responsibility of the Development and Educational Communication Unit (DECU) of the Indian Space Research Organisation.

The DECU, started in 1983 at Ahmedabad, is a logical outcome of the "Software" activities in system planning, TV programme production and social research initiated under the Satellite Instructional Television Experiment (SITE). The major tasks of DECU include: a) Kheda Communication Project: (b) Training of TV programme production personnel, especially for Doordarshan; (c) Social research, especially related to communication; (d) Policy and techno-economic studies related to applications of space technology; and (e) Consultancy in the area of communication planning, studio design, etc.

The programme production facilities in DECU include two TV studios, outdoor recording, editing (low and high band U-matic) and post-production facilities, simple video animation and sub-titling equipment.

KHEDA COMMUNICATIONS PROJECT

The Kheda Communications Project (KCP) is an exercise in developing approaches to local programming. It has not only provided grass-roots involvement for ISRO, but has also established the critical role that local TV can play in the development process. This activity is carried out under a Memorandum of Understanding between the Ministry of Information & Broadcasting and the Department of Space, and is jointly funded. Programmes on agriculture, animal husbandry, health, nutrition, family planning and socio-economic issues, as well as specifically for women and children are regularly produced. These are transmitted for one hour on all week days by the Pij transmitter in the Kheda district (Gujarat). Community TV sets installed in the villages provide access to these programmes to all. School-education programmes have also been produced by KCP.

Communication research plays a vital role in making the Kheda system responsive. The "team-mode" of production, and an approach that emphasises participation and involvement of the audience has made KCP unique. International recognition of these efforts in the use of local TV for development has come through the award of the IPDC-

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Villagers watching a Community TV.

Video shooting in progress.

People participating in a video programme.

UNESCO Prize for Rural Communication in 1985.

While DECU has been deeply involved, through KCP, in local TV, it has also undertaken productions of interest to a wider audience. Some of these programmes have been telecast over the national network. DECU has also produced social-marketing "spots" about the minimum age of marriage and other aspects related to women's health. A major effort on health communication aimed at 10 to 14 year olds has also been undertaken. In addition, DECU is involved in producing programmes for some of the National Missions and other areas of importance, like adult education, drinking water, wastelands, consumer education, environment/ecology, etc.

DECU is also involved in the conception, planning and implementation of the "Countrywide Classroom" — the UGC-sponsored programmes for the undergraduate level. Apart from helping UGC to plan the programme and the selection of equipment configuration for studios to be set up at various Universities, DECU has worked closely with Gujarat University in the selection of equipment for their studio and its installation.

DECU has provided studio planning consultancy/advice to various other institutions like the Indira Gandhi National Open University, State Institutes of Educational Technology, Nehru Centre, and the National Institute of Design.

TRAINING

DECU is probably the only place in the country where training in programme production is given in an 'operational' environment — i.e., in a setting where productions are undertaken for

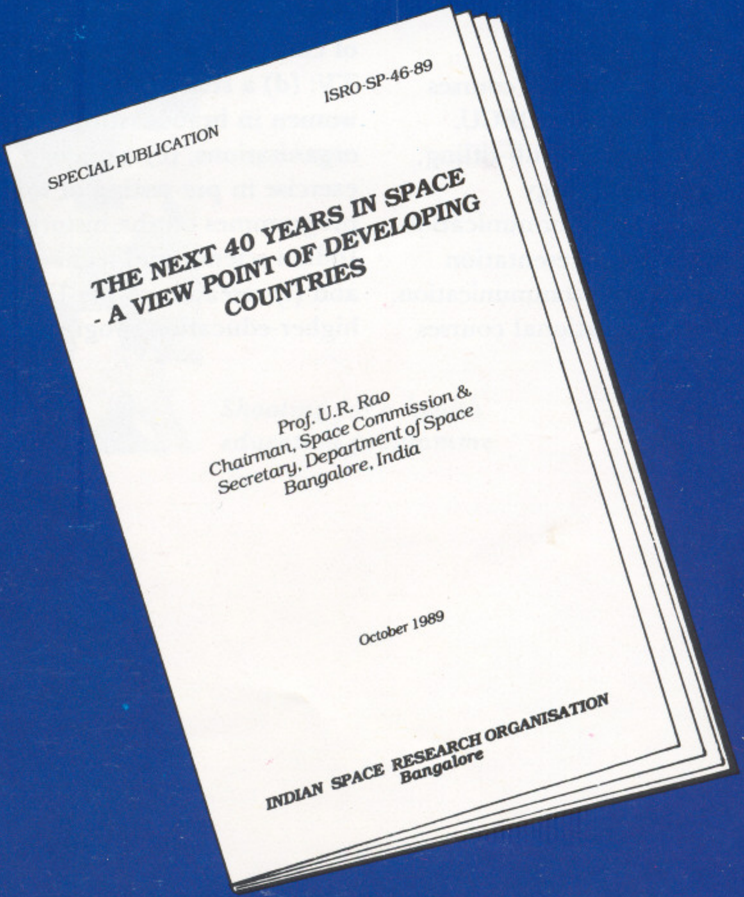
From India to Spain

TORREMOLINOS
MALAGA-SPAIN
October 7-13
1 9 8 9

The 40th Congress of the International Astronautical Federation (IAF) held at Malaga — Teremolinos, Spain from 7 through 13, October 1989 had the theme: "The Next Forty Years in Space".

Prof. U. R. Rao, Chairman, ISRO and Vice-President of the IAF was an invited speaker at the Theme Session. In his lecture titled **"The Next forty years in Space— A view point of Developing Countries".** Prof. Rao said that global survivability depends on the well-being of the developing countries which, in turn, can be ensured only through fullest exploitation of Space. He also argued that only "environmentally friendly" technological solutions to development problems could ensure habitability and cleanliness of this planet and that such technologies should be made freely available to the developing countries.

The theme for the Special Current Event Session in the 40th Congress was **"Space and Flood Management"**; experts from Latin America, Africa and India gave lectures on the subject with special emphasis on the use of remote sensing data. It was Prof. U. R. Rao who, as the Chairman of the IAF Committee for Liaison with International Organisations and Developing Nations (CLIODON), introduced this practice of Special Current Events Sessions for the benefit of developing nations. At the 40th Congress, he further suggested that to ensure wider participation by developing nations in these sessions, the U.N. should conduct one of their regular workshops in the country where the IAF Congress is held. This suggestion was widely welcomed and it was agreed that it could be implemented in the very next Congress to be held in Dresden, GDR for which the theme for Current Event Session has been chosen as **"Space and Forest Management".** Prof. Rao also suggested that low cost Search and Rescue Systems, Emergency Communication Terminals and other aids could be freely distributed to disaster-prone developing countries. It is heartening to learn that INMARSAT has agreed to pursue this suggestion further.


SPECIAL PUBLICATION

ISRO-SP-46-89

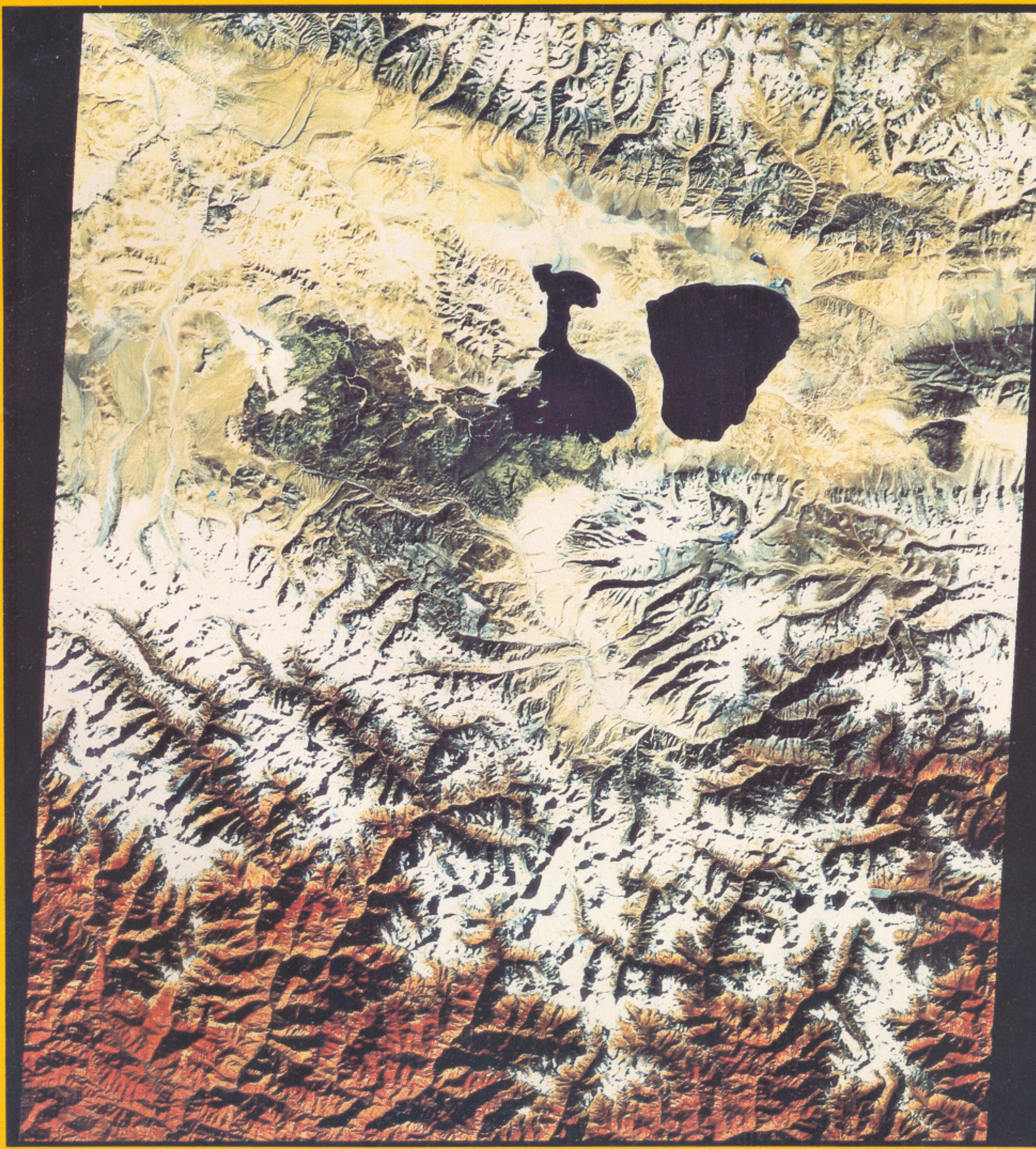
THE NEXT 40 YEARS IN SPACE - A VIEW POINT OF DEVELOPING COUNTRIES

Prof. U.R. Rao
Chairman, Space Commission &
Secretary, Department of Space
Bangalore, India

October 1989

INDIAN SPACE RESEARCH ORGANISATION
Bangalore

Copies of this Special Publication are available from Publications and Public Relations Unit, ISRO Headquarters, Antariksh Bhavan, New BEL Road, Bangalore-560 054, India, on request.



Himalaya as seen by IRS-1A.

A view of "Space and Man's Future" Exhibition at New Delhi with Teen Murti House in background.