APRIL – JUNE '94

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

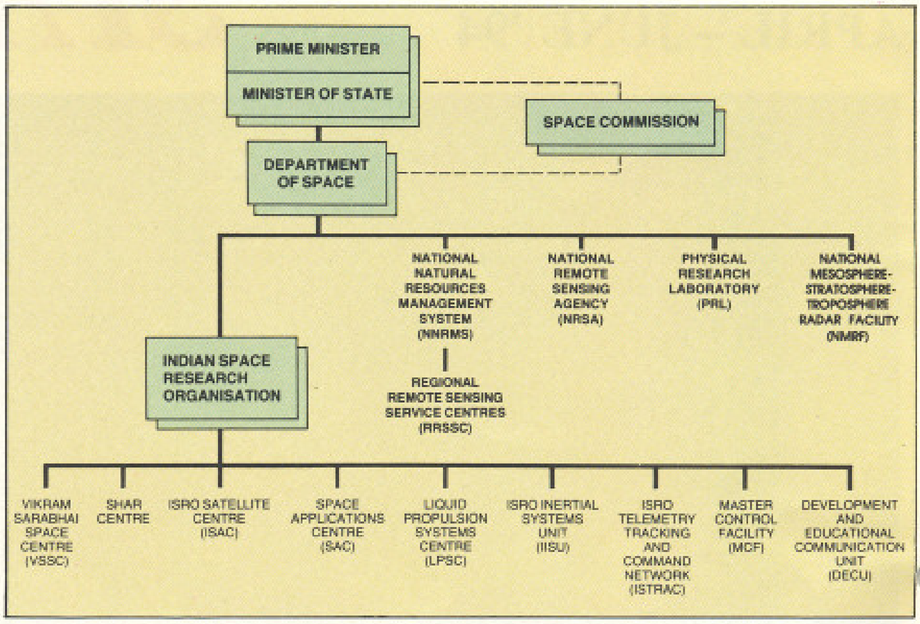
The Indian Space Programme

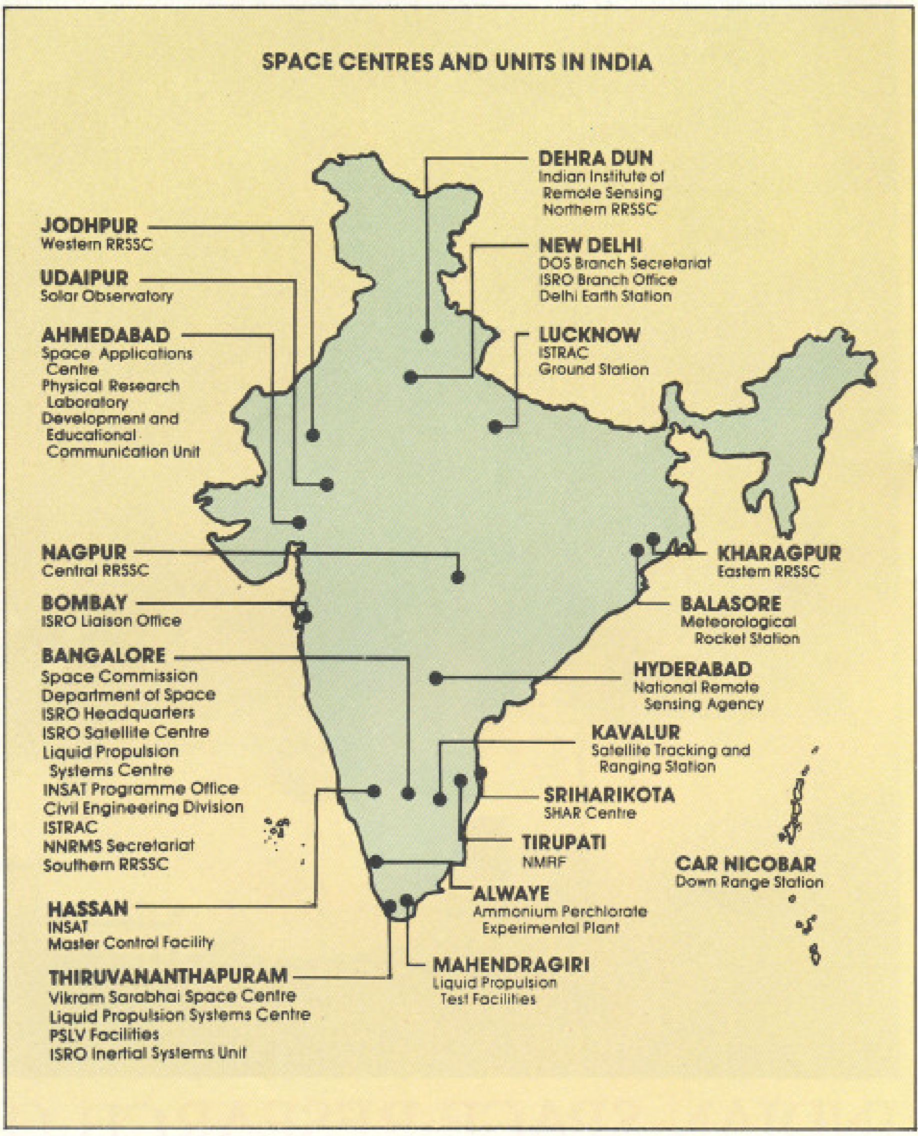
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science 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 satellite 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
ASLV-D4 lift-off

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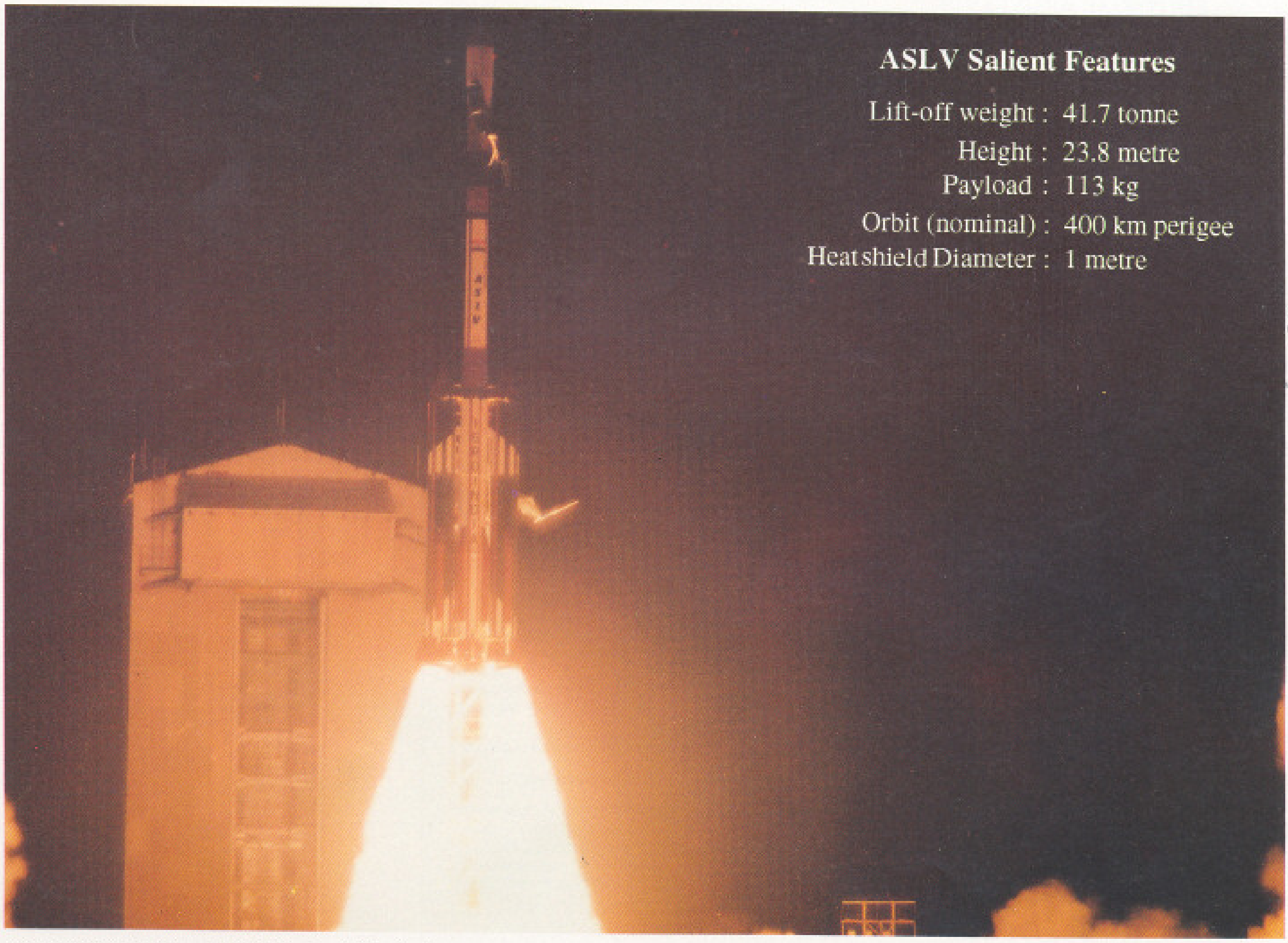
ASLV-D4 Launch Successful

The fourth developmental flight of the Augmented Satellite Launch Vehicle (ASLV-D4) was successfully conducted on May 4, 1994 from Sriharikota. ASLV-D4 injected the 113 kg SROSS-C2 satellite into a near-earth orbit of 437 km perigee and 938 km apogee at an inclination of 46 degree. The third developmental flight conducted earlier on May 20, 1992 was also successful (see Space India April-June 1992).

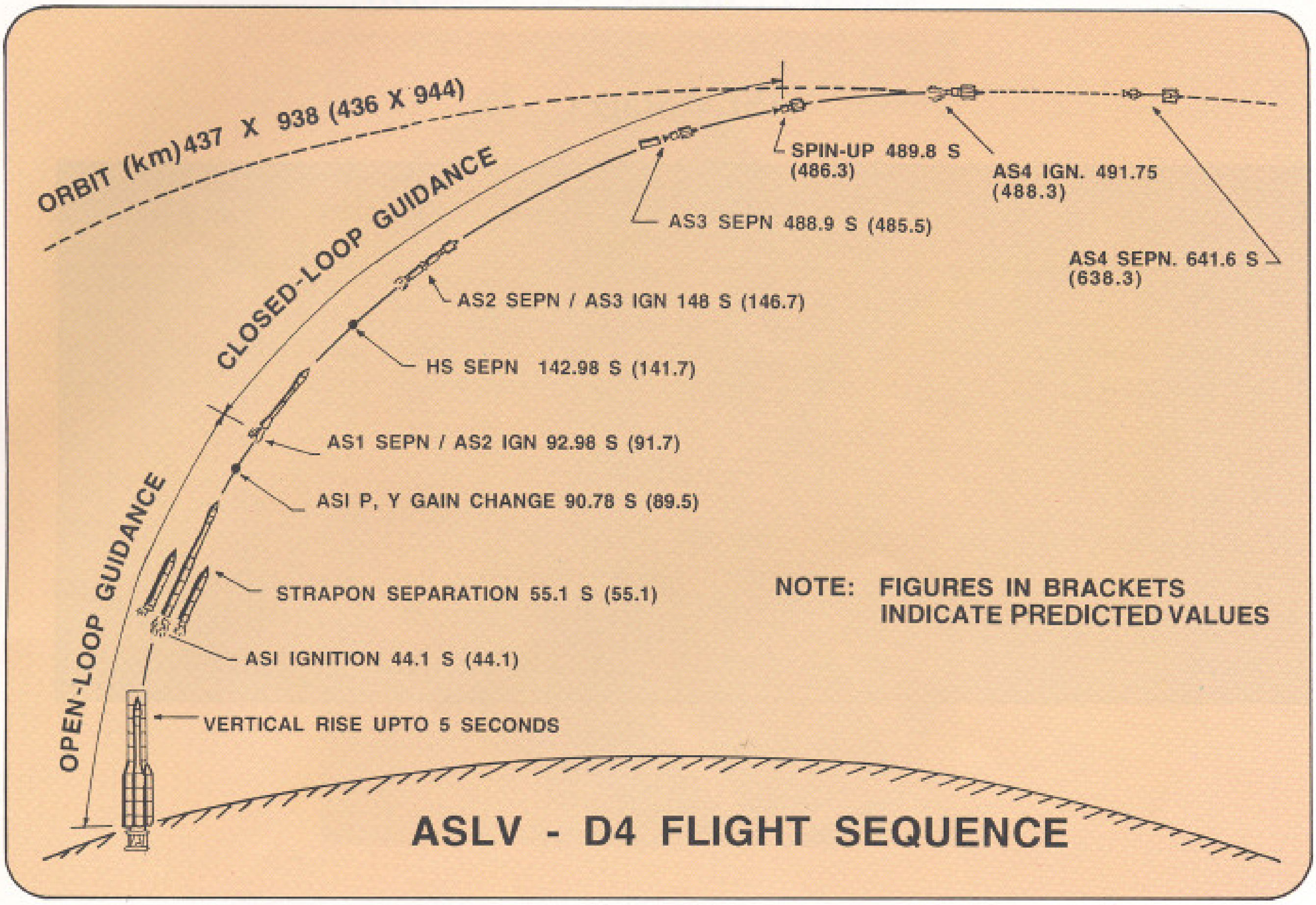
The primary objective of ASLV-D4 mission was to evaluate the performance of ASLV in placing the 113 kg SROSS-C2 satellite in an orbit with a minimum perigee of 400 km. SROSS-C2 carried two scientific experiments, namely, the Gamma Ray Burst detector and the Retarding Potential Analyser. The other objectives were to evaluate the performance of (i) closed-loop guidance system, (ii) the spin-up system of the fourth stage and (iii) validate orbit raising/circularisation using the propulsion system of on-board SROSS-C2.

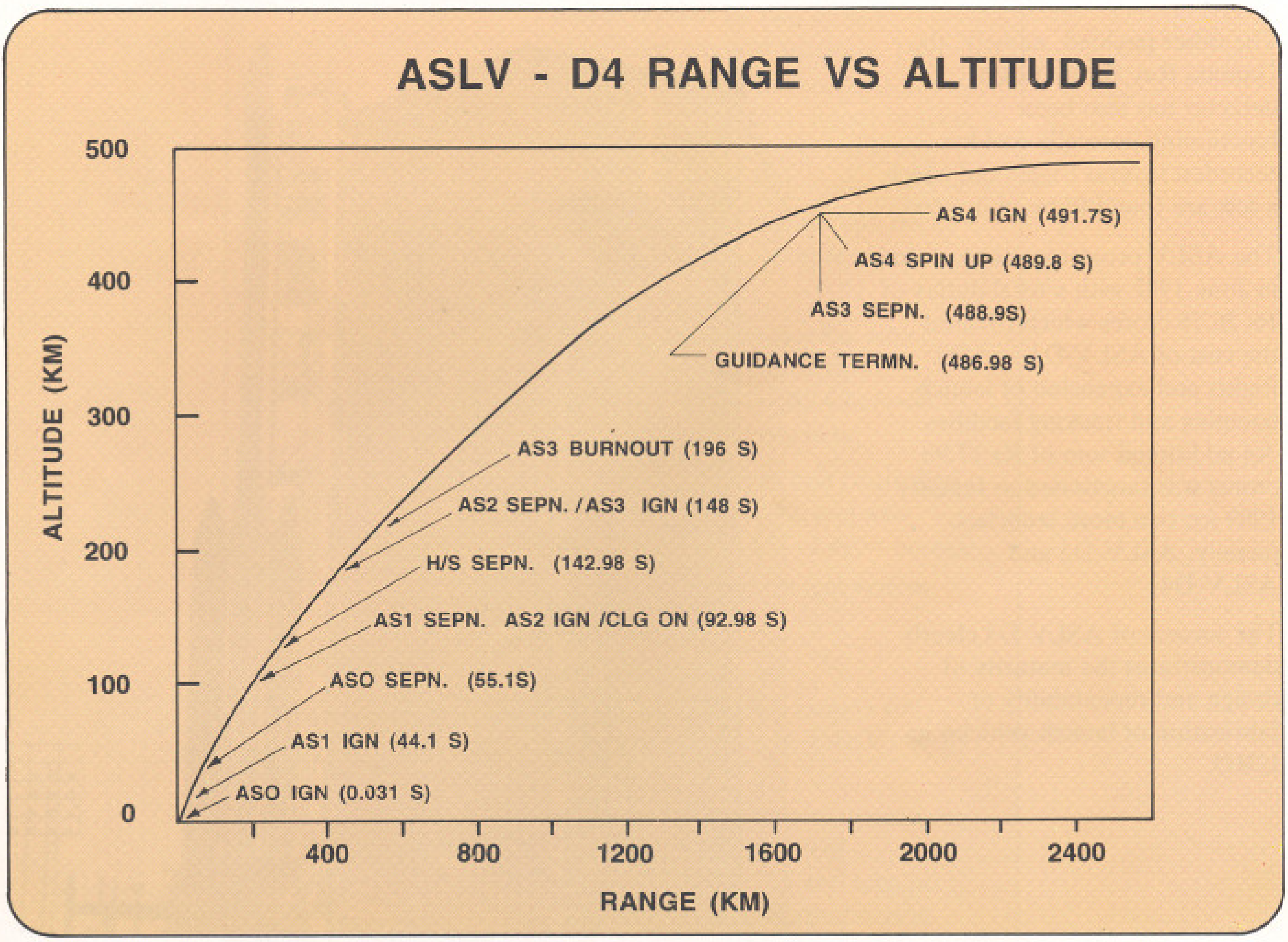
Gamma Ray Burst (GRB) payload on board SROSS-C2 was built by ISRO Satellite Centre, Bangalore, while the Retarding Potential Analyser (RPA) was built by National Physical Laboratory, New Delhi. The GRB experiment is intended to monitor the celestial Gamma Ray Bursts and their temporal variations in the energy range of 20keV-3meV. The data gathered by the RPA will be useful in studying the characteristics and energetics of the equatorial and low latitude ionosphere and thermosphere.

The Retarding Potential Analyser was switched "on" on May 9, 1994,thus enabling it to start collecting data on the thermal structure and electron densities of the ionosphere. The orientation of the satellite was manoeuvred so as to make its spin-axis perpendicular to the orbital plane. Next, its spin rate was brought down from 140 rpm (at the time of injection) to 5 rpm to enable the operation of the payload. With its high sensitivity for measuring the densities of hydrogen and helium ions the RPA payload provides a unique opportunity to study the upper ionospheric phenomena over the Indian subcontinent. The satellite will be manoeuvred during the first week of July 1994, using the on-board propulsion system to reduce the apogee altitude and continue the data collection.



ASLV-D4 lift-off from SHAR Centre, Sriharikota


ORBIT (km) 437 X 938 (436 X 944)
CLOSED-LOOP GUIDANCE
OPEN-LOOP GUIDANCE
SPIN-UP 489.8 S (486.3)
AS4 IGN. 491.75 (488.3)
AS3 SEPN 488.9 S (485.5)
AS4 SEPN. 641.6 S (638.3)
AS2 SEPN / AS3 IGN 148 S (146.7)
HS SEPN 142.98 S (141.7)
AS1 SEPN / AS2 IGN 92.98 S (91.7)
ASI P, Y GAIN CHANGE 90.78 S (89.5)
STRAPON SEPARATION 55.1 S (55.1)
NOTE: FIGURES IN BRACKETS INDICATE PREDICTED VALUES
ASI IGNITION 44.1 S (44.1)
VERTICAL RISE UPTO 5 SECONDS
ASLV - D4 FLIGHT SEQUENCE


ASLV - D4 RANGE VS ALTITUDE
ALTITUDE (KM)
500
400
300
200
100
0
AS4 IGN (491.7S)
AS4 SPIN UP (489.8 S)
AS3 SEPN. (488.9S)
GUIDANCE TERMN. (486.98 S)
AS3 BURNOUT (196 S)
AS2 SEPN. /AS3 IGN (148 S)
H/S SEPN. (142.98 S)
AS1 SEPN. AS2 IGN /CLG ON (92.98 S)
ASO SEPN. (55.1S)
AS1 IGN (44.1 S)
ASO IGN (0.031 S)
400
800
1200
1600
2000
2400
RANGE (KM)

ASLV Stages

	Stage-0 2 Strap-ons)	Stage-1	Stage-2	Stage-3	Stage-4
Length (m)	10.7	10.2	6.37	2.3	1.4
Diameter (mm)	1000	1000	800	800	650
Max. Thrust (kN)	645	662	269	89	32
Action Time (s)	47	48	39	47	33
Weight (kg)	11600(X2)	11800	4400	1750	510
Control System	SITVC & Bipropellant RCS	SITVC & mono prop. RCS	Bi-propellant RCS	Mono-propellant RCS	Spin stabilised
Propellant	HTPB	HTPB	HTPB	HEF-20	HEF-20

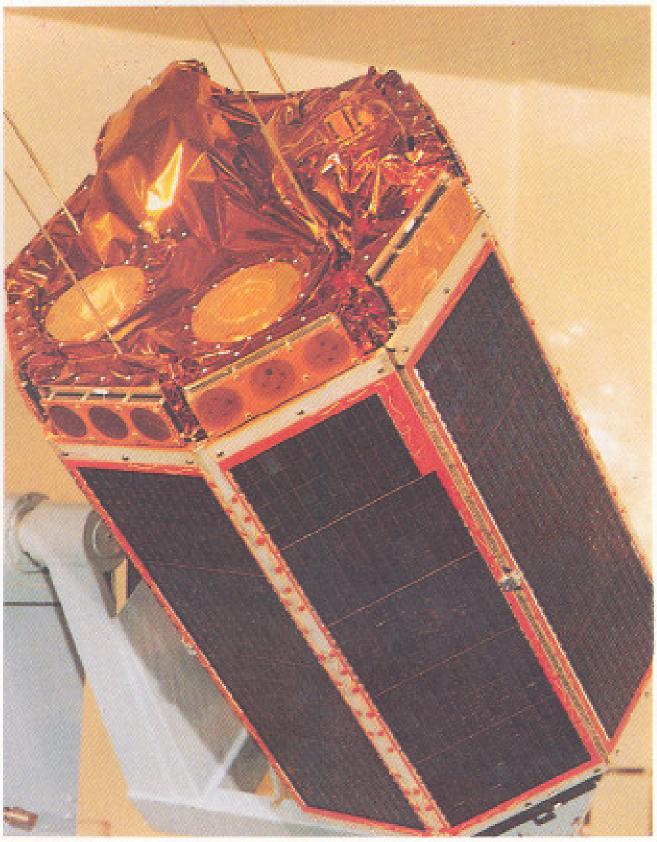
The other payload, namely, the Gamma Ray Burst (GRB) detector has also been functioning normally and has recorded several triggers of which a few are found to be of interest.

The ASLV project was approved in June 1982 with a total outlay of Rs 26.76 crores which covered the cost of ASLV-D1 and D2 flights and expansion of launch complex and tracking facilities. An additional sum of Rs 17.98 crores was sanctioned in January 1989 for two more launches, namely, ASLV-D3 and ASLV-D4.

The success of ASLV-D4 clearly demonstrates the maturity of design and repeatability of fabrication of launch vehicles in ISRO.

ASLV-D4 with MST in the background

SROSS-C2 – Salient Features



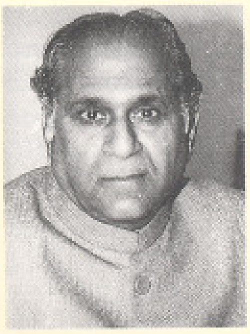
Structure	:	320 mm square frame with 865 mm height formed by two milled aluminium channel sections. Two horizontal platforms/brackets at 315 mm and 665 mm; upper bracket supporting the battery and lower bracket accommodating the RCS tank. Top and bottom honeycomb decks support the other subsystems and payloads.
Power System	:	Eight body-mounted solar panels with a total area of 2.1 sqm generating 40 to 50 W. Chemical battery of 12 AH capacity.
Control	:	Spin stabilised; spin rate controlled within 2 to 5 rpm and spin-axis maintained within 5° of orbit normal. Employs reaction control system with six thrusters.
Payloads		
Gamma Ray Burst	:	To monitor celestial gamma ray detector in 20 keV to 3 meV energy range.
Retarding Potential Analyser	:	To measure densities, temperatures and flux characteristics of ionospheric electrons and ions in thermal and suprathermal region.

Dr. K Kasturirangan, Chairman, ISRO, briefing the Prime Minister, Mr. P V Narasimha Rao,on ASLV-D4 mission.

President, Prime Minister and Minister of State Congratulate Scientists, Technicians

In a Press Communique, issued on May 4, 1994, from the President's Secretariat, Rastrapati Bhavan, New Delhi, the President of India, Dr Shanker Dayal Sharma, expressed satisfaction over the successful launch of the Augmented Satellite Launch Vehicle on 4th May, 1994. The launch marked an important step in India's quest for self-sufficiency in space technology. The President conveyed his congratulations to the Indian Space Research Organisation and all the scientists and technical personnel associated with the project.

Immediately after the launch of ASLV-D4, ISRO Chairman, Dr K Kasturirangan, informed the Prime Minister, Mr P V Narasimha Rao, of the success of the ASLV-D4 mission on Telephone and the Prime Minister conveyed his heartiest congratulations to each and every one of those involved in the Mission.



Mr Bhuvnesh Chaturvedi, Minister of State, Prime Minister's Office, in his letter addressed to Dr K Kasturirangan, Chairman, Space Commission, said, 'I Congratulate you and all your team members on the successful launch of the Augmented Satellite Launch Vehicle (ASLV-D4). The entire nation is proud of your achievement.'

Statement by the Prime Minister, Mr P V Narasimha Rao, in the Parliament on May 4, 1994 regarding Launch of Augmented Satellite Launch Vehicle – D4 (ASLV-D4)

I am pleased to inform the august House of the successful launch of ASLV this morning.

2. The Augmented Satellite Launch Vehicle was successfully launched today from Sriharikota. ASLV-D4 injected the 113 kg SROSS-C2 satellite into an orbit of about 437 kilometre perigee and 938 kilometre apogee at an inclination of 460° based on preliminary orbit determination. This is the second consecutive successful launch of ASLV. Preliminary analyses of the data from SROSS-C2, received at ISRO's Telemetry, Tracking and Command stations indicate normal performance of the satellite.

3. ASLV-D4 lifted off at 0530 hours with the ignition of the two strap-on boosters and 44.1 seconds later the first stage motor ignition was initiated by the on-board real-time decision system. The strap-on boosters separated at 55.1 seconds. The first stage separation and ignition of the second stage were commanded at 93 seconds from lift-off and the closed-loop guidance (CLG) scheme was initiated from then on. The heatshield was jettisoned after the vehicle had cleared the dense atmosphere at the predetermined altitude of 107 km, at 142.9 seconds as planned. The second stage separation and third stage ignition occurred at 148.1 seconds after lift-off. The burn out of the third stage occurred at 195.6 seconds which was followed by a long coasting phase and separation of the third stage at 488.9 seconds as planned. The fourth stage, along with the satellite, was spun up and the fourth stage ignited at 491.7 seconds. Separation of the SROSS-C2 satellite from the spent fourth stage took place about 641.6 seconds after lift-off.

4. All the events were monitored using the network of Telemetry and Tracking stations at SHAR, Bangalore, Thiruvananthapuram and Car Nicobar. Data received at Car Nicobar indicate that the separation of the SROSS-C2 satellite from the fourth stage was normal.

5. The success of the ASLV-D4 flight has demonstrated the repeatability of the vehicle subsystems and further helped in evaluating a number of technologies which are employed in ISRO's advanced launch vehicles, like PSLV and GSLV. They include the strap-on booster technology, closed-loop guidance system, real-time on-board decision system, etc., besides the telemetry tracking and command systems.

6. I am sure that the honourable members will join me in congratulating the Scientists, Engineers, Technicians and all others in the Department of Space who have made us proud by this significant achievement.

Indigenous Ni-Cd Batteries on SROSS-C2

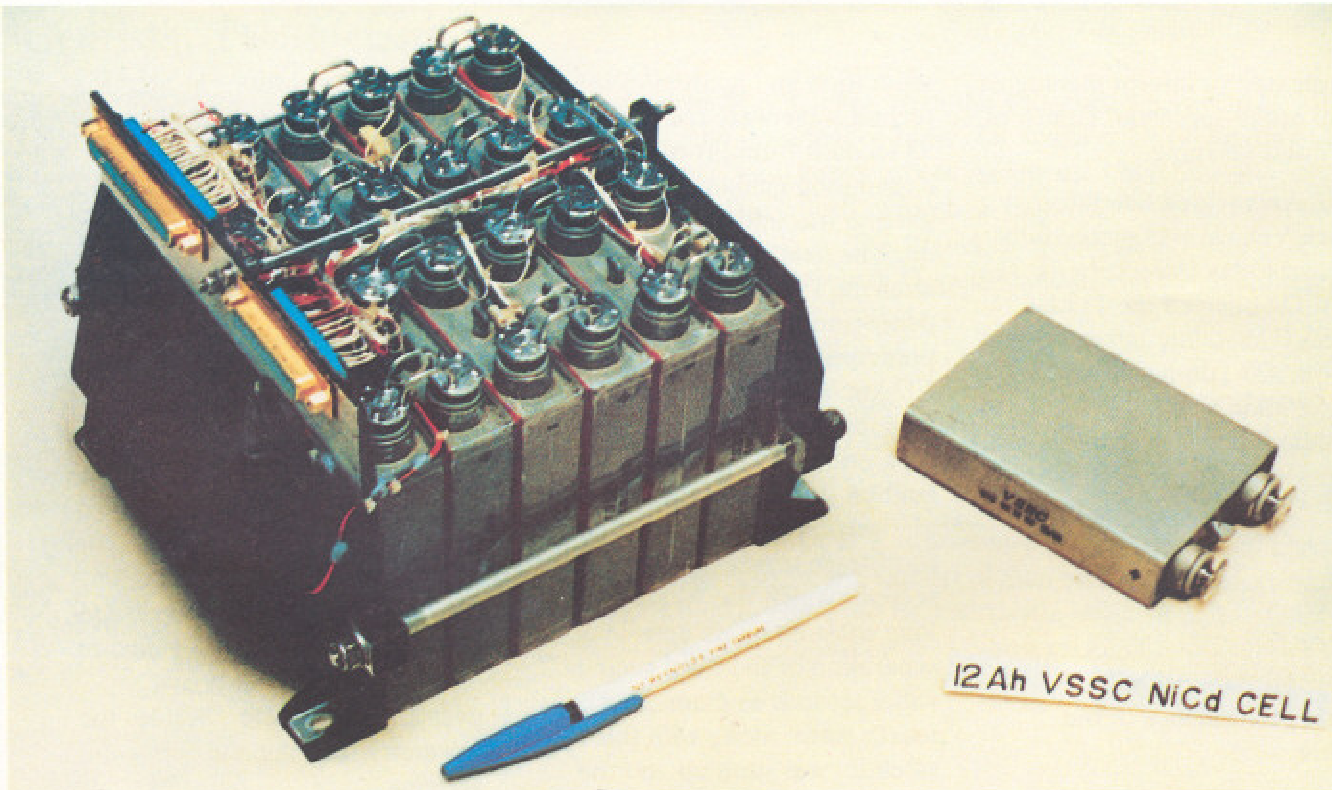
For the first time, the indigenously developed Nickel-Cadmium (Ni-Cd) batteries are powering an ISRO satellite, SROSS-C2, put into orbit by ASLV-D4. These Ni-Cd batteries were developed by the Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram.

The basic cell, which consists of nickel hydroxide (+ve) and cadmium hydroxide (−ve) electrodes immersed in the potassium hydroxide electrolyte, has a voltage of 1.2 V. The cells use sintered electrodes with the active materials (nickel and cadmium hydroxides) embedded in a highly porous nickel matrix called the plaque. The other important hardware parts of the cells are the stainless steel case that encloses the cell, the nylon separator between the electrodes and the ceramic-to-metal seal which insulates in terminals from the cell case.

The manufacturing process of the Ni-Cd cells consists of ten major steps: plaque processing, electrode processing, matching of electrodes, stacking, cell assembly, cell activation and precharge setting, stabilisation cycling, over charge testing, pinch-off and storage. Each of these steps is, of course, subjected to rigorous quality-protocol which ensures space-worthiness of the cells.

The 12-Ah cells developed by VSSC have successfully undergone all the electrical and environmental qualification tests at the ISRO Satellite Centre, Bangalore. One pack of these cells has successfully completed more than 18,000 charge-discharge cycles as part of life-cycle evaluation.

Thus the batteries currently on board the SROSS-C2 satellite consist of fully qualified space-quality cells.



The battery and a single cell

Specifications of 12 Ah Ni-Cd Cells for LEO Applications

1. Type: Sintered plaque hermetically sealed, prismatic cells
2. Name plate capacity: 12 Ah
3. Capacity and static impedance:
   0° C > 10.8 Ah < 23 milli ohms
   15° C > 13.2 Ah < 19 milli ohms
   25° C > 12.0 Ah < 17 milli ohms
   35° C > 9.6 Ah < 15 milli ohms
4. Working voltage : 1.2 Volts
5. He leak rate : 10-8 cc/sec
6. Electrolyte leak : No leak
7. Vibration level : 21 g (r.m.s.) Voltage transients <10 mV during vibration. (Cell to pass selected post-vibration electrical tests)
8. Cycle Life : 18,000 cycles at 20% DOD (Depth of Discharge) 15° C

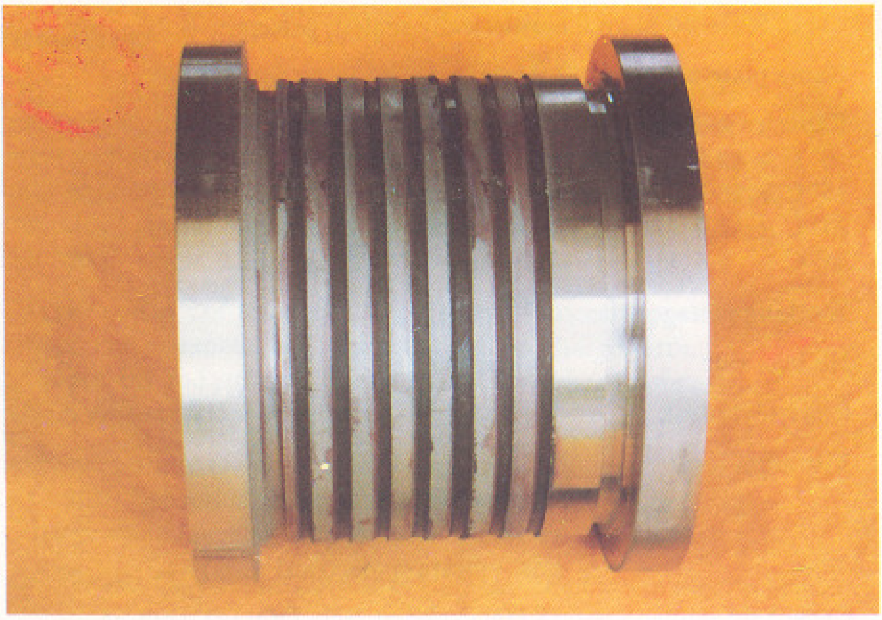
ASLV-D4/SROSS-C2 Participation

Pre launch phase	VSSC, LPSC, ISAC, NPL, ISTRAC and SHAR
Launch Phase	SHAR, ISTRAC, VSSC, LPSC, ISAC and External Tracking Support
Post Launch	ISAC, ISTRAC and NPL

More than 75 industries including, among others, Hindustan Aeronautics Limited, Larson & Toubro, Walchandnagar Industries Limited, ANUP, BEL, BDL, BHEL, MUKUND and NOCIL were actively involved in the mission. About 25 per cent of the work was carried out in the Indian industry.

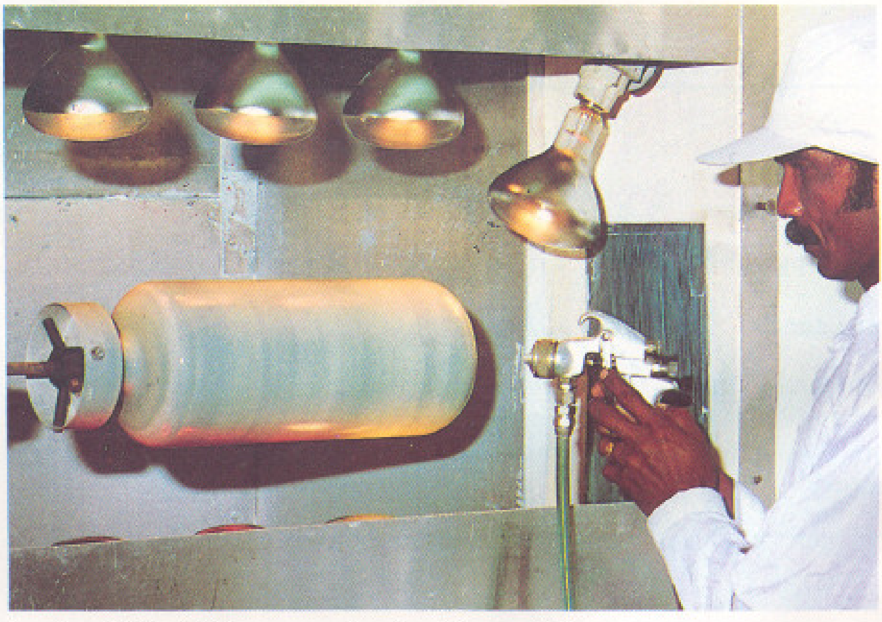
Rubber Products for Space

Rubbers are generally classified as natural and synthetic. Chemically, natural rubber is known as polyisoprene which is obtained from "Hevea Brasilienisis" more popularly known as the rubber tree. Synthetic rubbers are available in a large variety of forms the nomenclature of which depends on their chemical composition. Most of the synthetic rubbers are copolymers of different monomers and, depending on their chemical nature, their end use varies. For example, nitrile rubber is a copolymer of butadienes and acrylonitrile, and is well known for its oil resistance. By adjusting the type and quantity of monomers it is possible to tailor-make rubbers for a specified application. Other chemicals such as fillers, vulcanising agents, accelerators, activators and plasticisers are combined with rubber to obtain desired properties in the final products.



Sub-scale flex seal joint made by transfer moulding

Even in space technology, rubber products find a variety of applications which range from O rings weighing a few grams to case insulation of large solid rocket motors weighing a few tonnes. Depending on the type and geometry of the product, the manufacturing process varies: extrusion, compression moulding, calandering, transfer injection and so on.

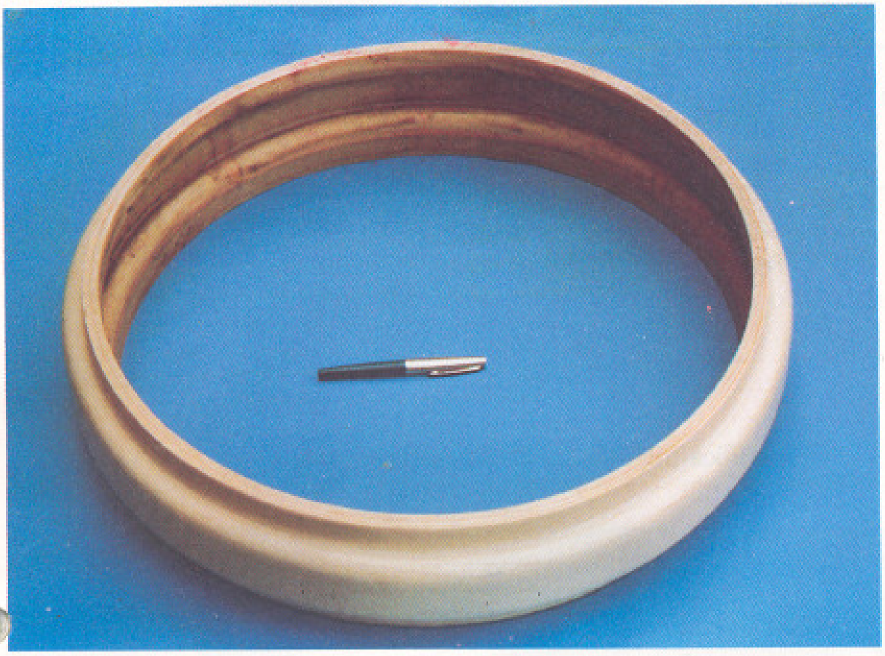


Spraying of teflon bladder compound on aluminium mandrel

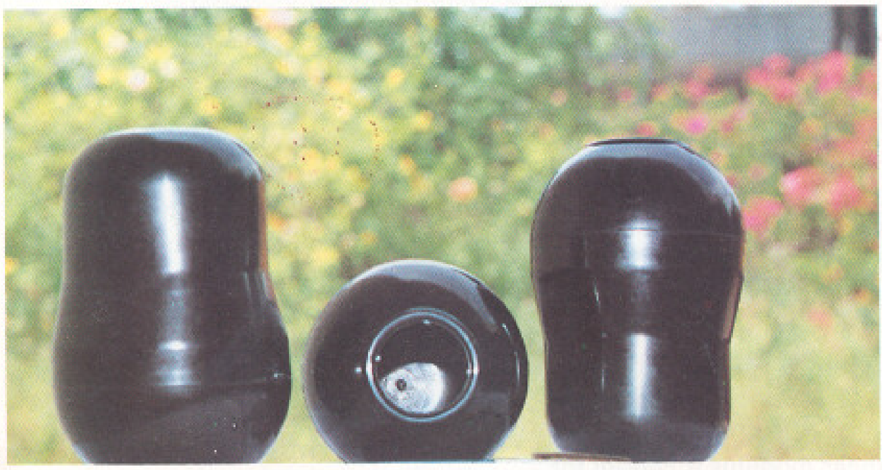
Rubbers for Launch Vehicle

Perhaps the most conspicuous use of rubber in rocketry is in the form of fuel-cum-binders in solid propellants. In high energy propellants, the fuel is a rubber of low molecular weight with functional groups on the ends which can be converted into solid form by cross linking agents. ISRO has, over the years, developed fuels like PBAN, CTPB and the HTPB, which is the workhorse propellant binder for the solid rocket motors.

Another important use of rubbers is in making solid rocket motor case insulation whose primary function is to prevent the motor case from attaining high temperatures during the burning



Thermal boot for PS-3 flex seal joint



Bladder for engine gimbal control system of PSLV

of the propellant. The most commonly used insulation material for this purpose is "Rocasin" (an ISRO acronym derived from Rocket Case Insulation) which is a silica filled nitrile rubber formulation. The insulation acts as an ablative when exposed to hot combustion gases, thus protecting the case from excessive heat which might otherwise imperil the very structural integrity of the case. This insulation also protects the case from possible particle impingement. The other types of rubber used as insulators are silicone, butyl rubber and EPDM (Ethylene Propylene Diene Monomer).

In solid rocket motors, the end surfaces of the propellant grain are necessarily inhibited to ensure strict control on burning area. For this purpose too rubbers are used. The inhibiting resin should (i) cure at room temperature, (ii) bond well with the propellant surface and (iii) prevent combustion of the end surfaces. For this purpose ISRO uses a polyurethane rubber formulation based on an asbestos-filled castor oil-disocynate system.

Teflon Bladders for ASLV-D4

In the wake of any major success, all the travails and agony of the past are forgotten. The same is true of the successful campaign of the ASLV-D4. There was a time, just months prior to the start of the ASLV-D4 campaign, when the teflon bladders needed to store and expel liquid propellants like the RFNA and hydrazine for the control systems suddenly became scarce. All the three vehicles preceding the ASLV-D4 had, of course, these teflon bladders, but then they were all imported. When it came to ASLV-D4, these bladders could not be imported due to embargoes on ISRO. Therefore, the Vikram Sarabhai Space Centre (VSSC), the lead centre for rocketry in ISRO, had no option but to produce these bladders in-house. And that's what VSSC did.

Starting from scratch, the entire job of establishing the needed facilities, producing the bladders, testing and qualification was done in five months flat. Major parts of the facility are: the spray booth, the sintering oven, the mandrel dissolving system and the inspection room. And all the operations, except mandrel dissolving, have to be carried out in clean environment. The starting material is a dispersion of teflon in water which is to be spray coated in thin layers, on to a seamless aluminium mandrel.

The critical thickness for each spray is of the order of 10 microns above which the film would crack during the next step of sintering. Thus, the cycle of spray coating and the sintering (at nearly 400)C) is repeated at least 30 to 40 times to build up the required thickness of about 300 microns. Finally, the bladder is subjected to qualification tests under a strict reliability and quality assurance protocol.

Details of these expulsion bladders used in the launch vehicles and satellites of ISRO are summarised below:

Satellite launch vehicle	Control System (and medium)	Type of rubber	Fabrication Technique
SROSS & IRS	AOCS (Hydrazine)	Silica-filled Peroxide cured EPDM	Compression moulding
ASLV	Roll Control (hydrazine)	–do–	–do–
	SITVC (Strontium perchlorate)	Silica-filled nitrile	Blowmoulding
PSLV	EGC (hydraulic oil	Carbon black filled nitrile	Compression moulding

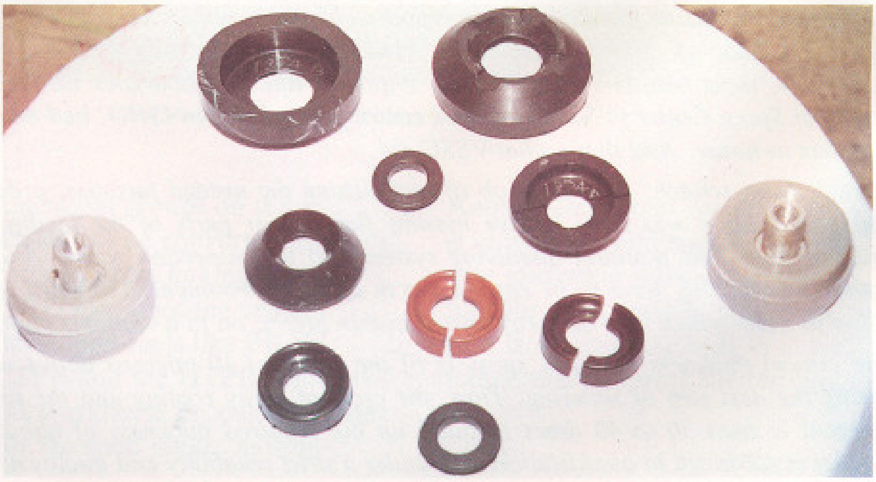
Rubbers for Expulsion Bladders and Diaphragms

Another area where rubbers are widely employed concerns bladders and diaphragms for storage and expulsion of liquid propellants used for controlling the attitude of rockets and satellites. Expulsion bladders are ideally suited for controlling the flow of liquid propellants even under the weightlessness conditions, for, they are simple, efficient and reliable. But different control systems in satellites and rockets use different types of liquid propellants like hydrazine, strontium perchlorate, red fuming nitric acid, nitrogen tetroxide and so on. This makes it impossible to evolve a single elastomeric formulation that can be used in all the control systems. Therefore, a variety of rubbers is used: EPDM for hydrazine and butyl, nitrile and natural rubbers for others. Irrespective of their formulation these elastomers should be flexible, impermeable, light, strong and compatible with the particular propellant stored inside.

Rubbers for Flex Seal

The third stage of the Polar Satellite Launch Vehicle (PSLV) is controlled in the pitch and yaw planes by a flex nozzle system. The flex seal in this system is made of a number of conical metallic shims arranged in a row, the gaps between which are filled with an elastomeric pad made of natural rubber filled with carbon black. To ensure flexibility to the joint, a formulation with a very low shear modulus is chosen for the rubber. The elastomeric pads are produced through the transfer moulding technique.

To protect the flex seal from the hot combustion gases during the motor operation, a thermal boot is provided. This should, of course, be flexible enough to allow complete vectoring of the seal and also be thick enough to act as a thermal barrier during the entire period of the thrusting phase of the motor. Though the insulating material rocasin, is found to be suitable for this purpose, the fabrication of the boot is rather complicated because of its shape: a ring shape with U-type cross-section. This could, however, be achieved by lining the sheet on a collapsible mandrel to the required shape and then autoclaving the same.

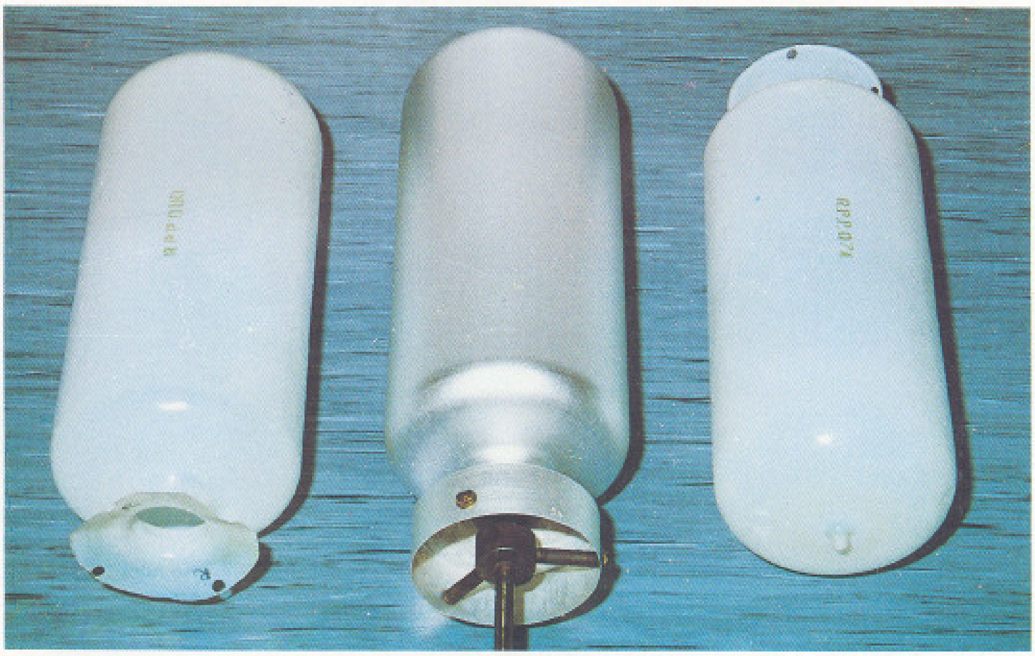


Rubber parts for vibration isolators

Foams, Bellows, O-rings and Others

In addition to the above, a large variety and numbers of speciality rubber products are routinely produced for the launch vehicles of ISRO. These include polyurethane foams used as thermal insulators, reinforced neoprene rubber (polychlorprene) bellows for the heatshield separation and jettisoning system, silicone based thermal protection paints, vibration isolators, bladders for pressure testing of composite cases and a large variety of O-rings.

Thus rubber, the innocuous sounding elastomer, plays a major role as a crucial raw material for the fabrication of many of the vital components of the launch vehicles and satellites of ISRO. □



Aluminium mandrel and extracted teflon bladders

EOSAT Co., US, Starts Receiving Indian Remote Sensing Satellite Data

Prof. U R Rao, Chairman, Antrix Corporation, addressing the gathering at the inaugural ceremony of IRS data reception facility

The Earth Observation Satellite Company's (EOSAT Co) ground station at Norman, Oklahoma in US, has become the first earth station outside India to receive data from the Indian Remote Sensing Satellite (IRS). The colourful inaugural ceremony of IRS-1B data reception held on June 21, 1994 was attended by Mr Siddartha Shankar Ray, Ambassador of India to the USA, Prof U R Rao, Chairman, Antrix Corporation and former Secretary to the Department of Space (DOS), and Mr Jack Mildren, Lieutenant Governor of Oklahoma besides representatives of DOS, EOSAT Co., and prominent citizens of Norman and students from University of Oklahoma.

During dedicatory remarks, Prof U R Rao dwelt on the thrust the Indian Space Programme gives to operationalising the space-based services for both communications and remote sensing; Prof Rao also reminisced about the beginning of satellite era in India with the launching of the first Indian satellite, "Aryabhata" in 1975.

Mr Jack Mildren termed this partnership as a great event for the people of Oklahoma who stand to benefit by it.

Ambassador Ray spoke about the long standing relationship between India and the United States and about India's commitment for harnessing high technology for peaceful applications.

The Prime Minister of India, Mr P V Narasimha Rao, in his message said, "The inauguration of the Indian Remote Sensing Satellite data reception facility at Norman, Oklahoma, is a testimony to the vast potential of cooperation that can be harnessed for the mutual benefit of our two countries."

Agricultural area in Oklahama State, USA, as seen by IRS-1B

Dr K Kasturirangan, Secretary, Department of Space and Chairman, ISRO, in his message expressed satisfaction noting that, within just about nine months of the signing of the agreement between the EOSAT Co., and Antrix Corporation, the Norman ground station in Oklahoma has started receiving and processing data from IRS-1B. He said that it is a clear indication of the zeal and enthusiasm between the personnel of both the Department of Space and EOSAT Co., to quickly implement the agreement.

Dr Kasturirangan said that with IRS-1C, which has greater capability than its predecessors, in the offing and with the acknowledged marketing expertise of the EOSAT Co., there should be greater demand for the IRS-generated data. He also wished a smooth and uninterrupted functioning of the Norman ground station in receiving and processing data from the present and the forthcoming Indian remote sensing satellites.

It may be recalled that the Department of Space (DOS), Government of India, and the EOSAT Co., signed an agreement on October 21, 1993 under which EOSAT Co., will receive and market the IRS satellite data on a global basis through its international network of more than 90 distributors (see Space India October 1993-March 1994). EOSAT Co., is the world's most important source for satellite imagery for commercial, research and academic applications. The company is the exclusive worldwide distributor of remote sensing data from the US Landsat series of satellites.

Within a few months of the signing of the agreement the augmentation of the Norman ground station was completed in April 1994; it was a joint effort by NRSA, Hyderabad, Space Applications Centre, Ahmedabad, ISRO Satellite Centre, Bangalore, and ISRO Telemetry, Tracking and Command Network (ISTRAC), Bangalore. The IRS data processing facility upgradation was completed by June 17, 1994. The Norman Station is now fully equipped to receive and process IRS data covered under the Norman stations footprint. A few more ground stations outside US are also planned to be augmented to receive IRS data.

IRS-1B, launched in August 1991, provides imagery from its cameras, Linear Imaging Self Scanners, LISS-1, with a resolution of 72.5 m and LISS-IIA and LISS-IIB both having a resolution of 36.25 m. LISS-1 provides a swath of 148 km, while the composite swath of LISS-IIA and LISS-IIB is 145 km. The cameras operate in four spectral bands in the range of 0.45 to 0.86 micrometres. The imagery is available with a repetitivity cycle of 22 days. EOSAT Co will also receive data from India's IRS-1C planned to be launched in 1995. IRS-1C will have an improved camera operating in three spectral bands in the visible and near-infrared regions with a ground resolution of about 20 m, and an additional camera in the middle infrared region with a ground resolution of 70 m. It will also have a camera in the panchromatic band with a resolution better than 10 m. Besides, a wide field sensor operating in visible and near-infrared region with a resolution of 188 m and swath of 774 km will be incorporated in the same satellite. Thus it is anticipated that there will be global demand for the IRS-1C data, once it becomes commercially available. □

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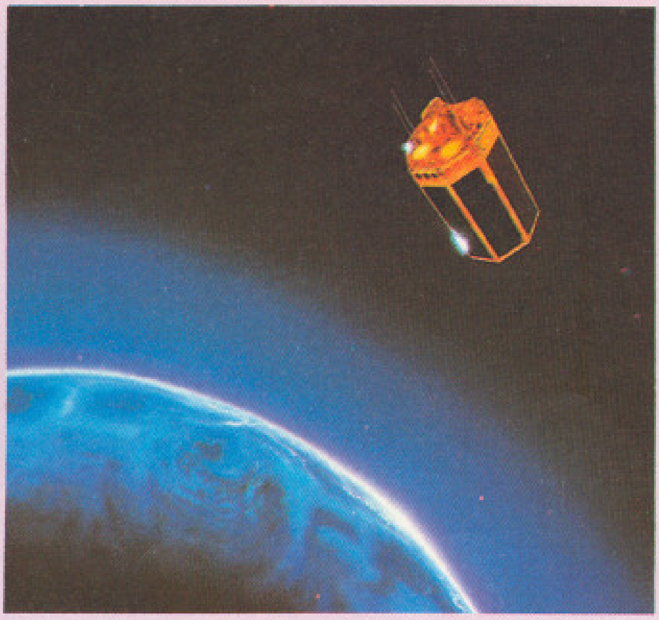


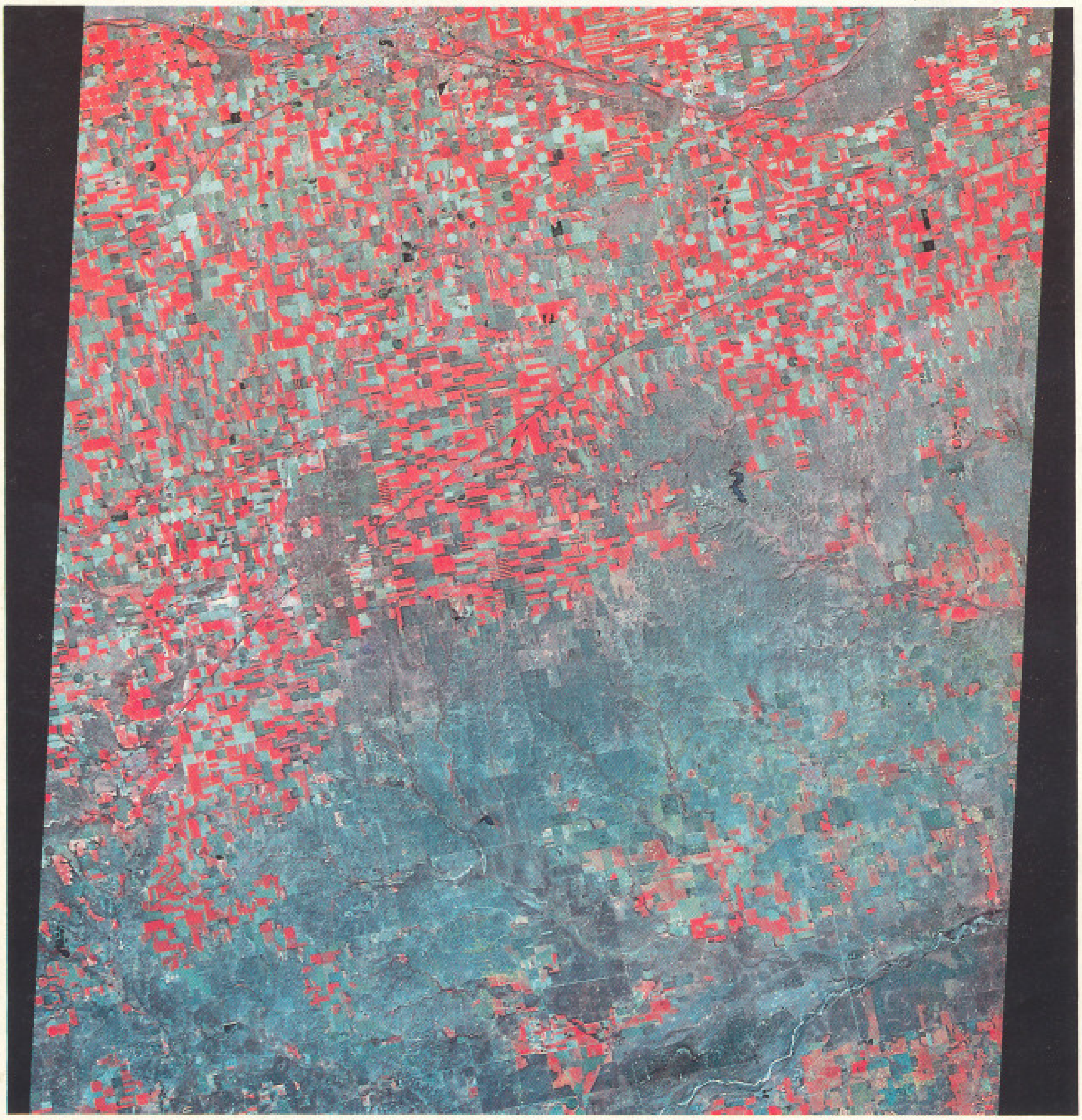
SROSS-C2 Satellite Orbit Manoeuvre Successfully Completed

The orbit of the SROSS-C2 satellite is successfully manoeuvred using the satellite propulsion system. The orbit manoeuvre operations commenced on July 1, 1994 and continued for a week. The satellite is now in the final intended orbit with a perigee of 429 km and an apogee of 628 km at an inclination of 46°. This orbit has been selected based on the mission requirements of the two experiments on board, namely, cosmic gamma ray burst experiment and the retarding potential analyser.

Before initiating the orbit manoeuvres, even in the initial orbit, scientific data was collected from both the payloads.

The GRB payload has been operated in different modes and 191 triggers have been recorded till June 30, 1994 at different threshold settings corresponding to increased radiation intensity levels. Of these, seven triggers are identified to be very interesting events and are being analysed further for their possible cosmic origin. Measurements of densities of hydrogen and helium ions have been made using the RPA which will help in understanding the upper ionospheric phenomena, particularly the effects of solar radiation heating and dynamics.

The satellite has still about 1.3 kg fuel left out of the 5 kg at the start of the mission. The remaining fuel will be used for the routine orientation control manoeuvres for the rest of its mission life. The satellite completed 1,000 orbits on July 11, 1994. All the systems on board SROSS-C2 are functioning normally.



Agricultural area (primarily wheat) in Kansas State, USA, as seen by IRS-1B