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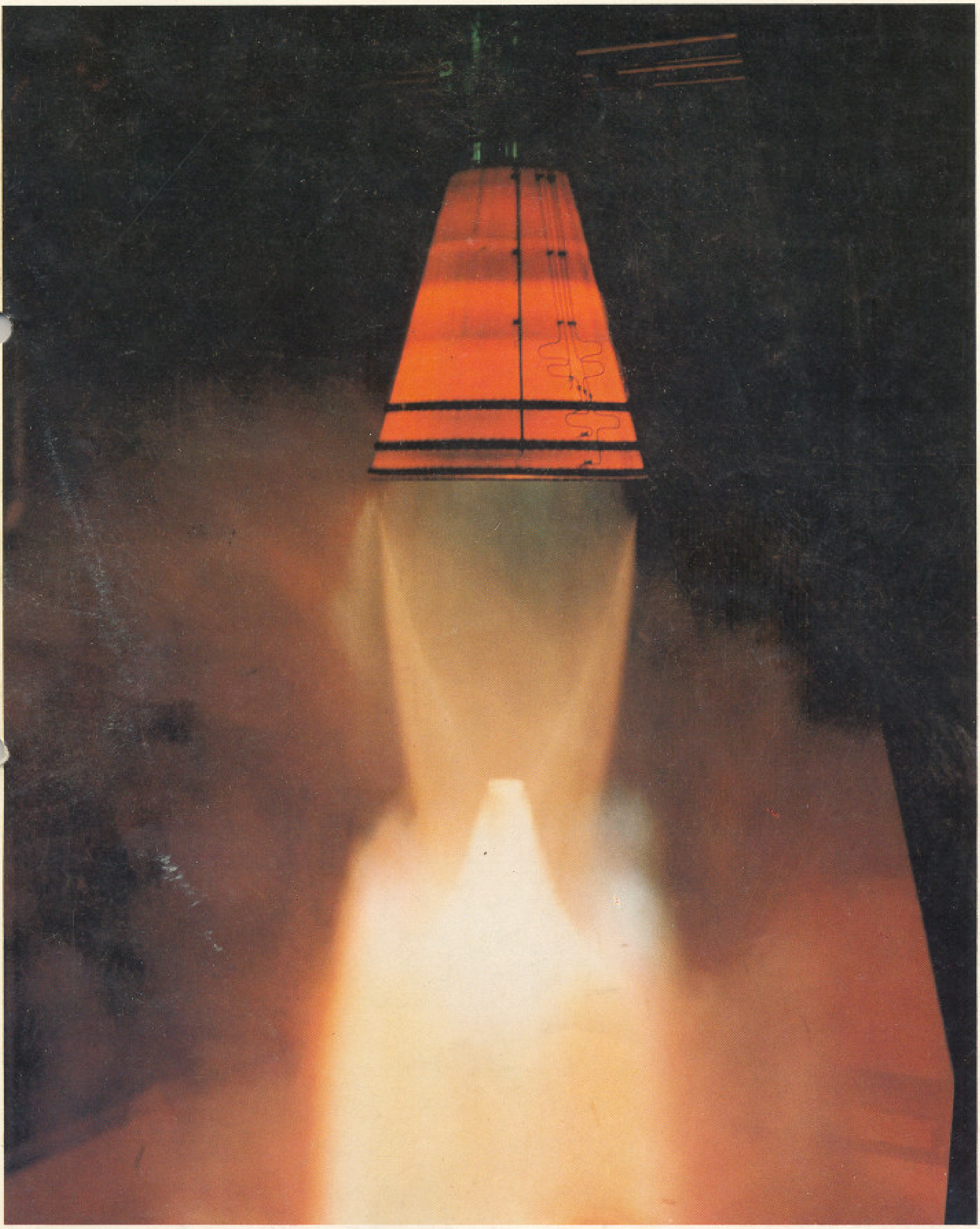
SPACE india



INDIAN SPACE RESEARCH ORGANISATION

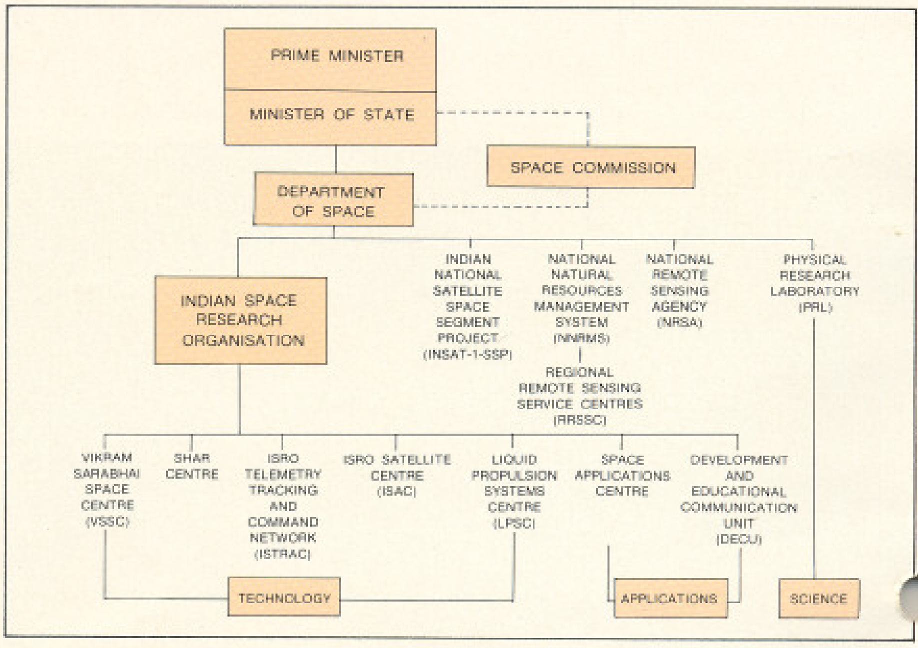
The Indian Space Programme

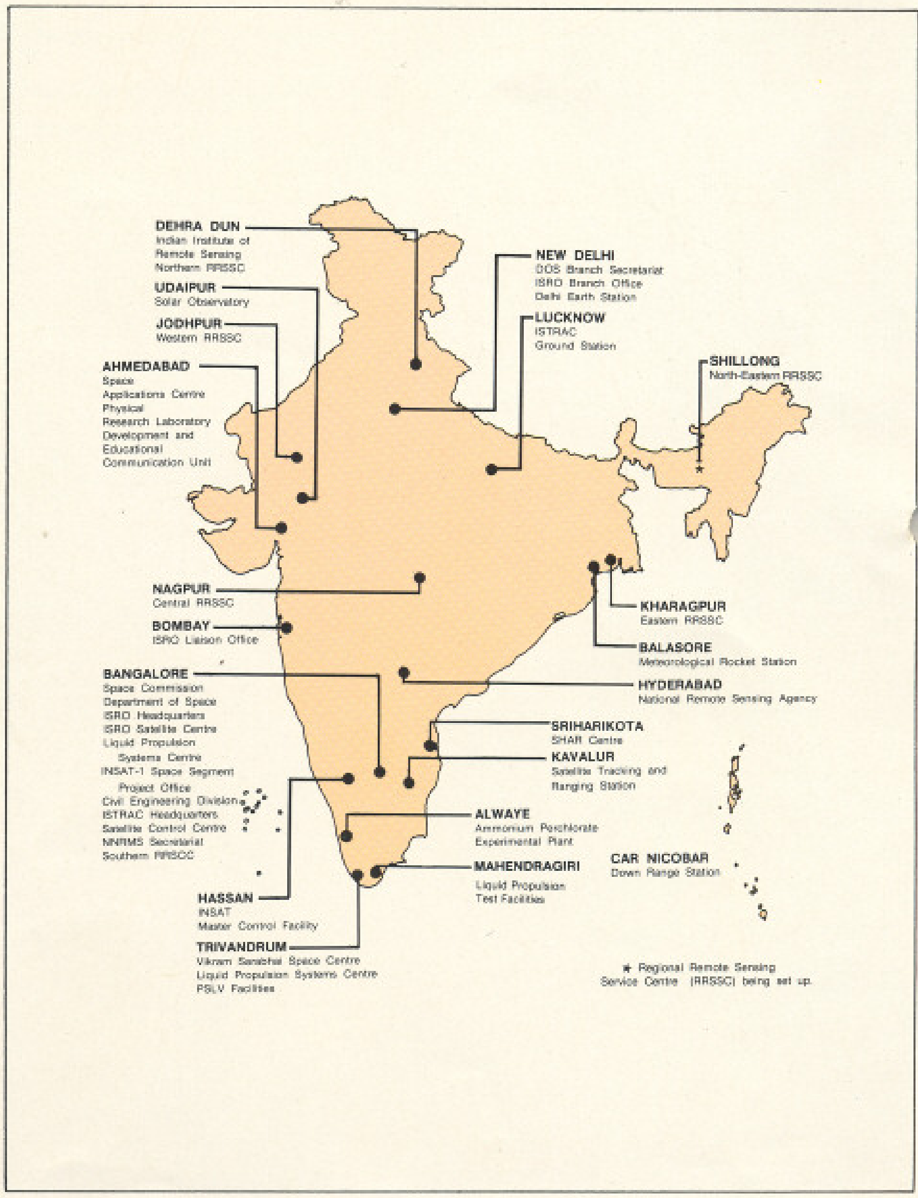
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963, marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science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

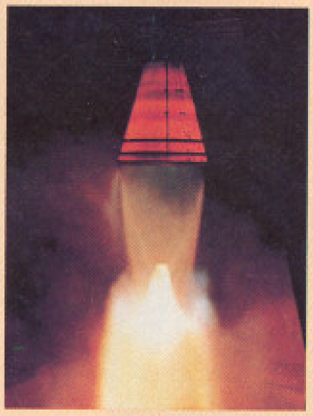
The Indian Space Programme is directed towards the goal of self-reliant use of Space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological 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 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
Vikas Engine Test at Principal Test Stand of LPSC, Mahendragiri.

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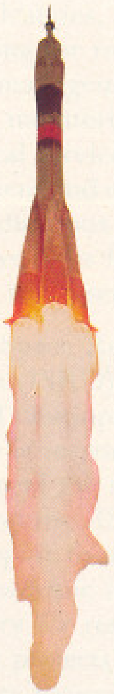
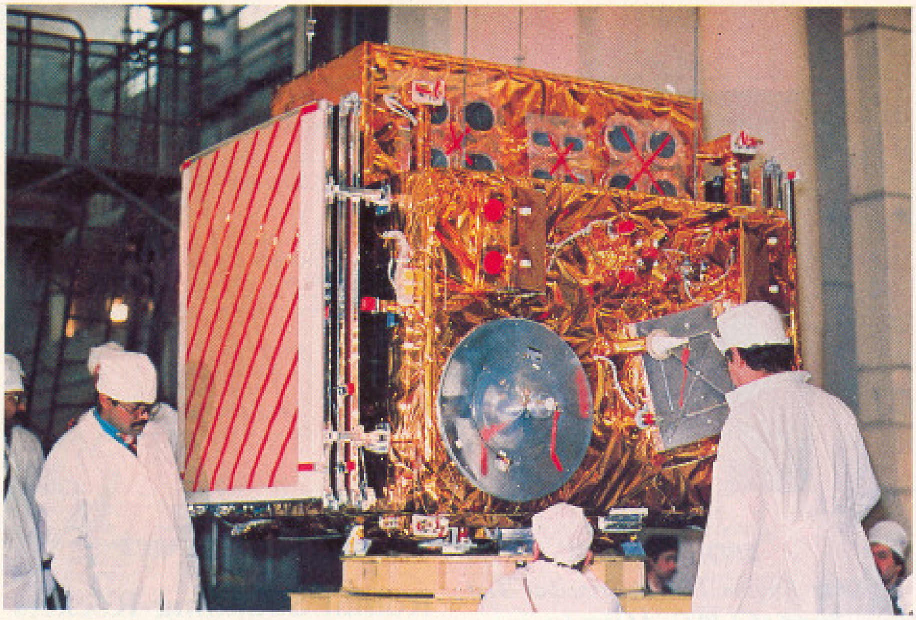
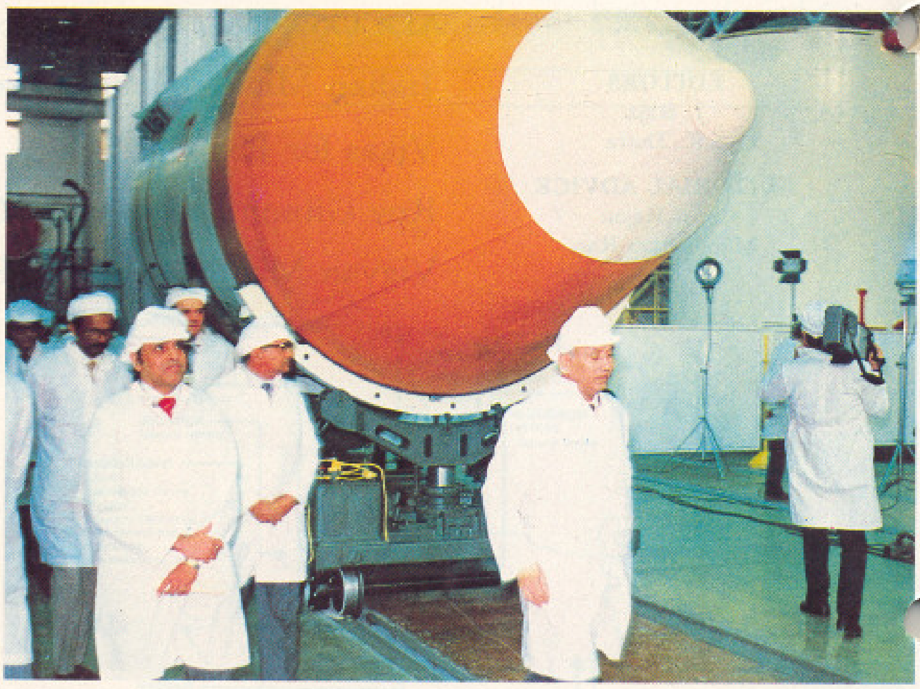
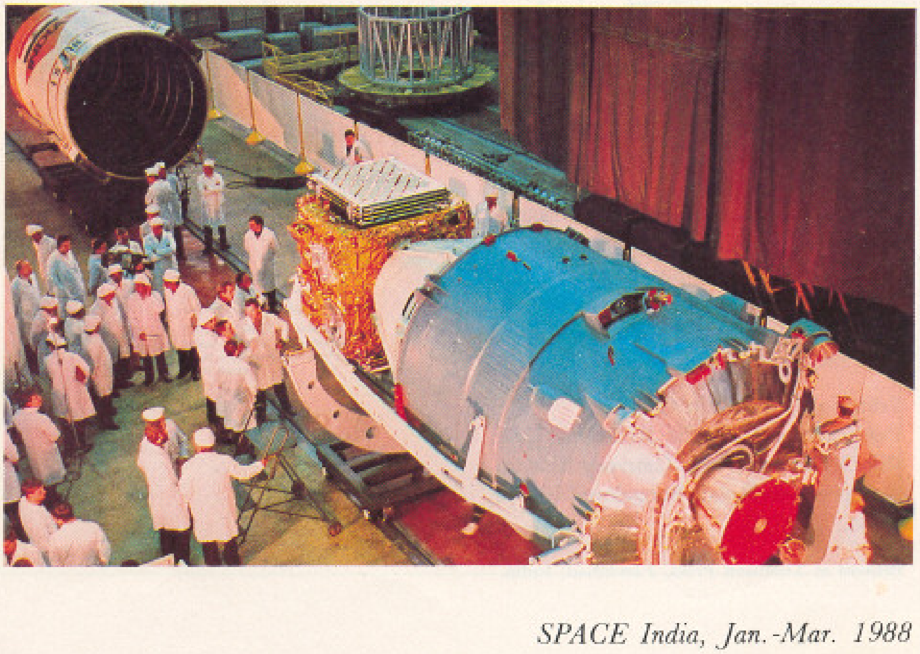
The Indian Imager









IRS-1A undergoing final checks at the launch base (top).
Prof. U.R. Rao, Chairman, ISRO (extreme right) accompanied by (left to right) Dr. George Joseph, Associate Project Director, IRS Dr. K. Kasturirangan, Project Director, IRS and Col. N. Pant, Director, ISAC on an inspection tour of launch base operations (middle). The Spacecraft mated with the upper stage of the VOSTOK launcher (bottom).

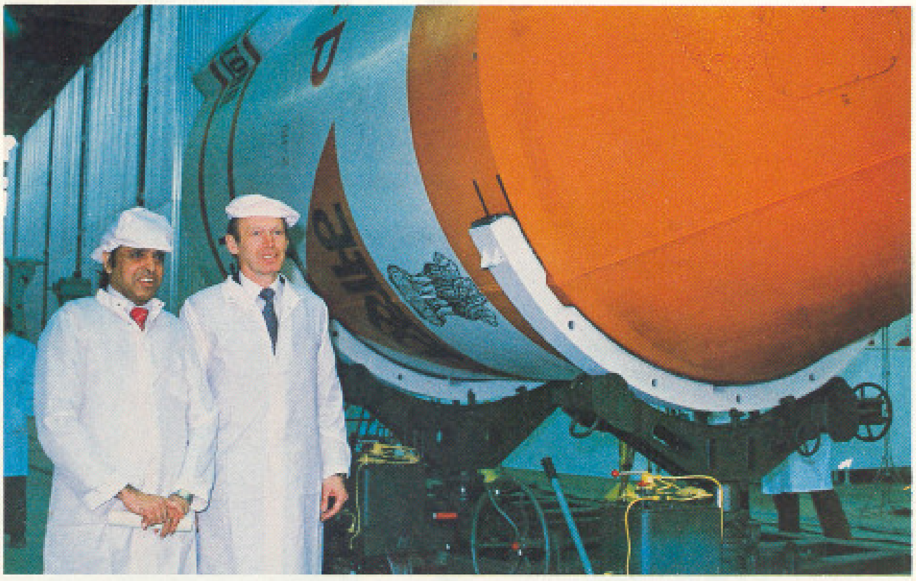
At 12 hrs. 13 min. 30 sec., Indian Standard Time, on March 17, 1988 a Soviet VOSTOK launcher lifted off from the Baikonur Cosmodrome in the midst of a snow storm and sub-zero temperature.

Among the select spectators of the launch were a team of Indian scientists; for, the precious payload carried by the Soviet rocket was ISRO's first operational remote sensing satellite IRS-1A.

Within twelve minutes after launch one could hear a chorus of hand-clapping and could experience a general atmosphere of jubilation at the Spacecraft Control Centre, Bangalore. The IRS-1A had separated from the VOSTOK about 900 km above the earth and the solar panels had instantly deployed, assuring adequate power from the Sun for operating all the systems thereafter.

It was a momentous occasion for ISRO and the country in general. In less than twenty four hours after launch, the

The VOSTOK with IRS-1A on-board ready for lift off.

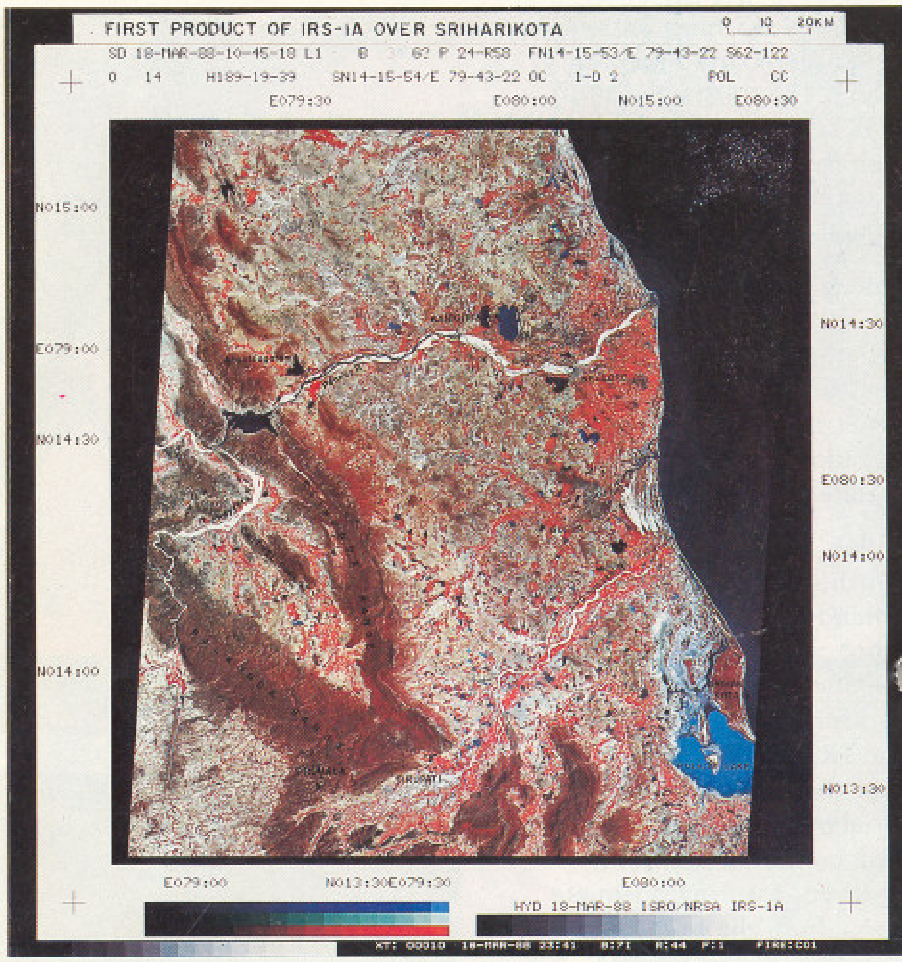


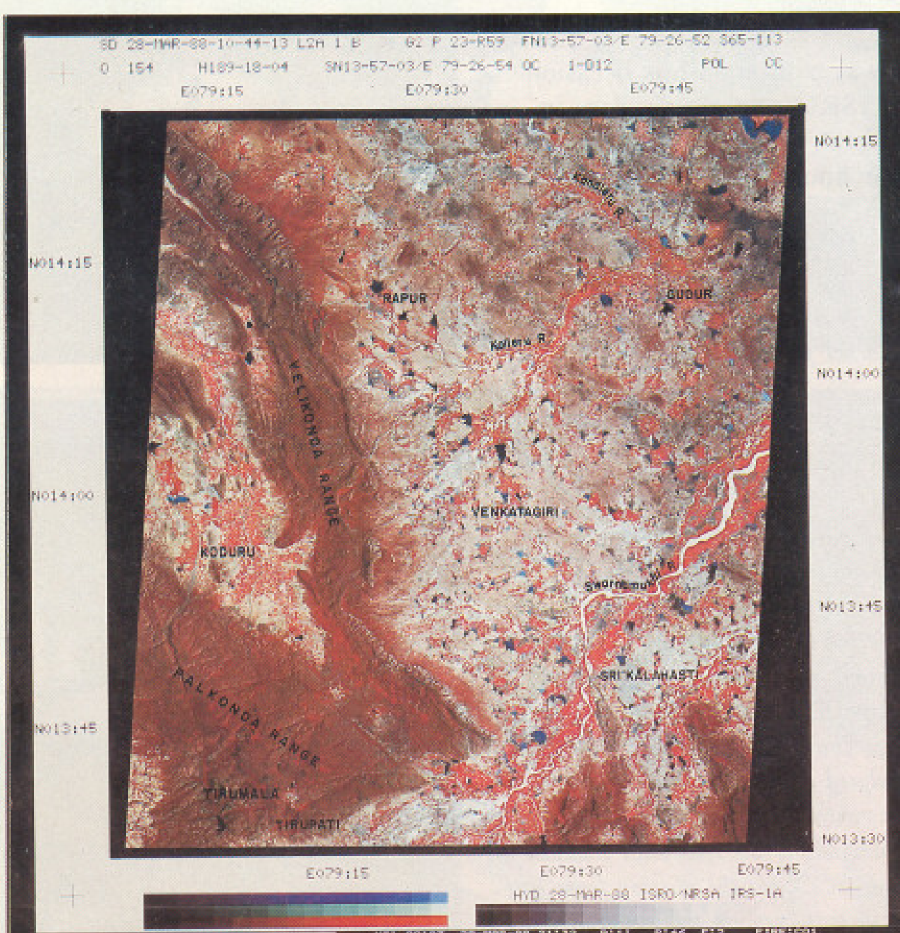
Dr. K. Kasturirangan and Dr. I.V. Goreshkov, Project Director of the Soviet side (right) by the side of the launcher pay-load shroud.

The Spacecraft Control Centre (SCC) at Bangalore is the nerve centre of IRS-1A mission operations. Tracking data from the network of ISTRAC stations and from the foreign ground stations, whose services are hired for the initial phases of the mission, are analysed at SCC for maintaining proper control of the spacecraft. All commands to the spacecraft emanate from SCC and the mission team keeps a constant vigil on the health of the spacecraft.

...as good as the best in the world

— Prof. U.R. Rao





The very first data products over Andhra Pradesh obtained from LISS-I (top) and LISS-II cameras. The data was received at the Shadnagar earth station and the processing was done at the NRSA facility at Hyderabad.

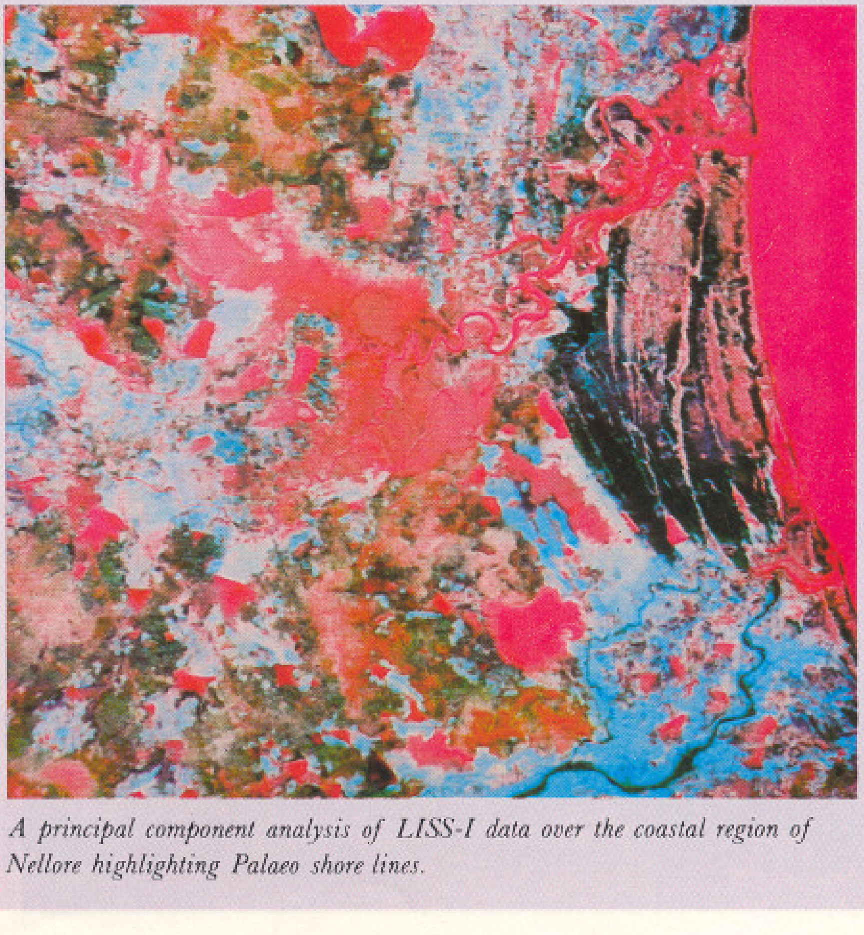
first set of cameras termed LISS-I were operated to image a strip of the country from Allahabad to Sriharikota along the eastern coast of India. The data products obtained after processing of the signals at the National Remote Sensing Agency (NRSA) were of excellent quality, heralding a new era of Indian remote sensing efforts.

Events followed in quick succession leading to successful testing of all the three sets of cameras on-board. A series of orbit trimming operations enabling repetitive coverage of the whole country in 22 days and a further set of on-board check-out operations will render the spacecraft operational in about a month's time.□

IRS-1A data reception terminal at the Shadnagar station of NRSA.

Data Analysis Begins

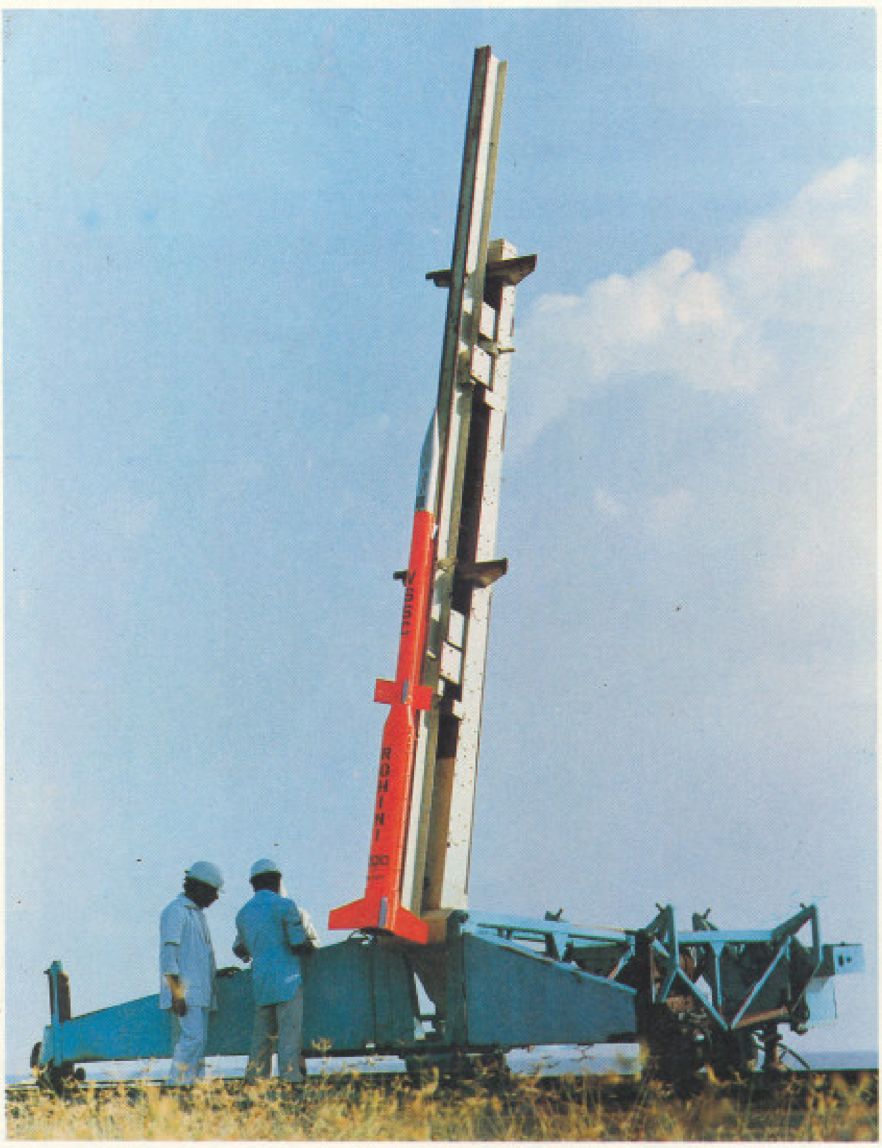
The analysis of a large volume of data obtained from IRS-1A will be handled by a chain of Regional Remote Sensing Service Centres (RRSSC) and a host of Associate Centres (see Space India No. 4/87) besides various user agencies in the country. The Service Centres at Bangalore, Dehra Dun, Jodhpur and Nagpur are already operational and so is the Associate Centre at Anna University, Madras. Training programmes on various aspects of digital image analysis have been conducted. With a view to standardise application packages for operational use, an Application Validation Programme has been initiated. Shown alongside is one of the first IRS-1A imageries digitally analysed at RRSSC, Bangalore.



A principal component analysis of LISS-I data over the coastal region of Nellore highlighting Palaeo shore lines.

Rohini Sounding Rockets

RH-200 Rocket getting ready for launch.



The Indian Space Programme took off in November 1963 when the two stage Nike-Apache sounding rocket was launched from Thumba, an inoccuous fishing village near Trivandrum, in Kerala. In less than five years, the Thumba Equatorial Rocket Launching Station (TERLS) had become a symbol of international collaboration when in February 1968, it was dedicated to the United Nations.

During the formative years of the Indian Space Research Organisation (ISRO), a decision was made to design, develop and produce sounding rockets. indigenously. Thus, over the years, ISRO has developed a family of sounding rockets with the generic name of Rohini Sounding Rockets (RSR). These range from the tiny RH-75 with its lift-off weight of few tens of kg to the two-stage RH-560 with a lift of weight of 1350 kg (In these designations RH stands for Rohini and the number indicates the diameter of the booster in mm).

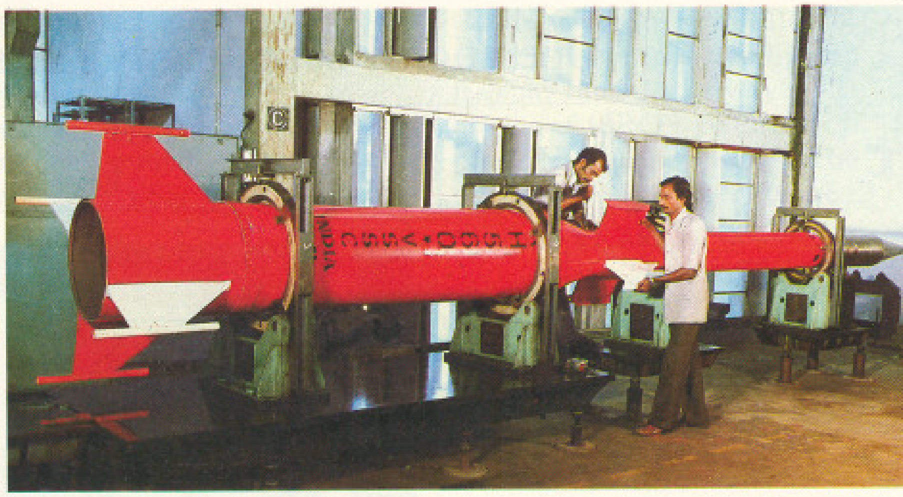
Having developed and tested a large number of designs, ISRO has zeroed-in on three of them to be produced on an operational basis. These are: RH-200, RH-300 and the RH-560.

Suitable for meteorological and upper atmospheric studies, RH-200 is a two-stage rocket that can lift a nominal payload of over 10 kg to an altitude of about 80 km. On the other hand, RH-300 is a single stage version ideally suited for investigating the middle-atmosphere; it lifts a payload of 50 kg to over 100 km. The biggest of threesome, RH-560, is also a two-stage rocket that is capable of carrying a 100 kg payload to 350 km; it is thus a very convenient vehicle for conducting ionospheric experiments.

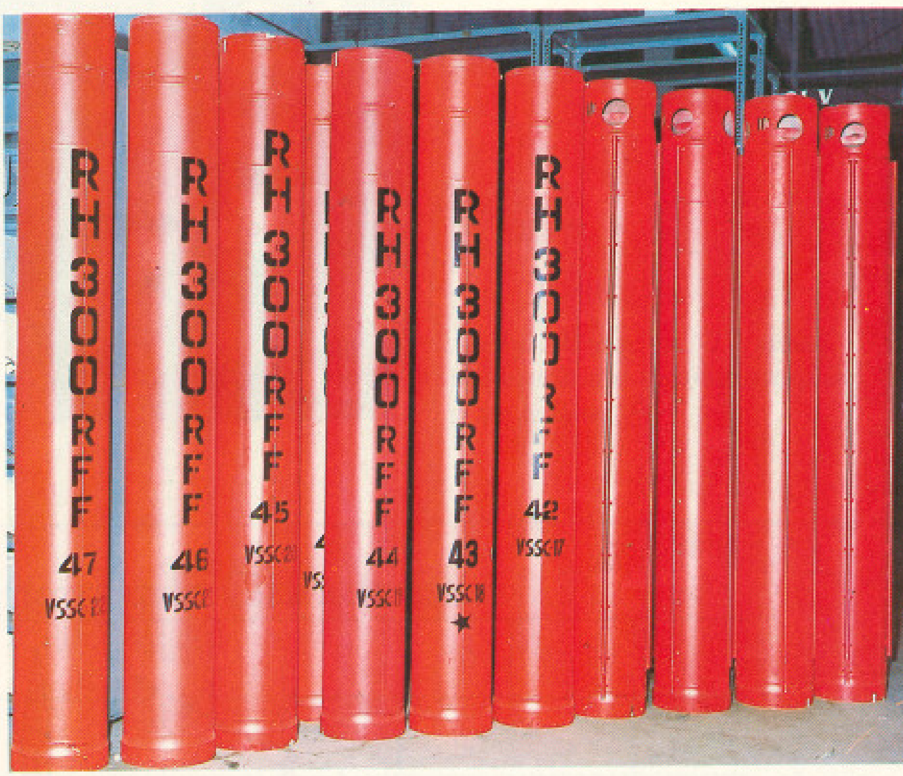
The development of the Rohini Sounding Rockets is the responsibility of the Vikram Sarabhai Space Centre (VSSC), Trivandrum, which is the premier R&D Centre for rocketry in ISRO. The high performance solid propellants, like those based on polyurethane, required for these rockets are developed in VSSC. The strategic chemicals required for the rockets are manufactured at the Centre's Propellant Fuel Complex (PFC) and the propellants are produced at the in-house Rocket Propellant Plant (RPP) of VSSC. Nearly 20 private and public sector industries participate in the fabrication of these rockets. More than half of these industries are located within the state of Kerala and the rest are spread all over the country.

VSSC has adequate expertise in integration of scientific and technological payloads, telemetry and telecommand systems, and tracking aids such as transponders and tone range receivers. An important offshoot of this programme is the development of onboard rocket mechanisms such of those used for ejecting or opening of payload fairings at specified altitudes, deployment of long booms with experimental probes and others.

The Rohini rockets are launched from all the three ISRO ranges, viz. the Thumba Equatorial Rocket Launching Station (TERLS), the Sriharikota Launch Complex at the Sriharikota Island in Andhra Pradesh and the Balasore Rocket Range in Orissa. Apart from the scientists of ISRO, a number of other Indian and international



Final assembly of the RH-560 in progress.

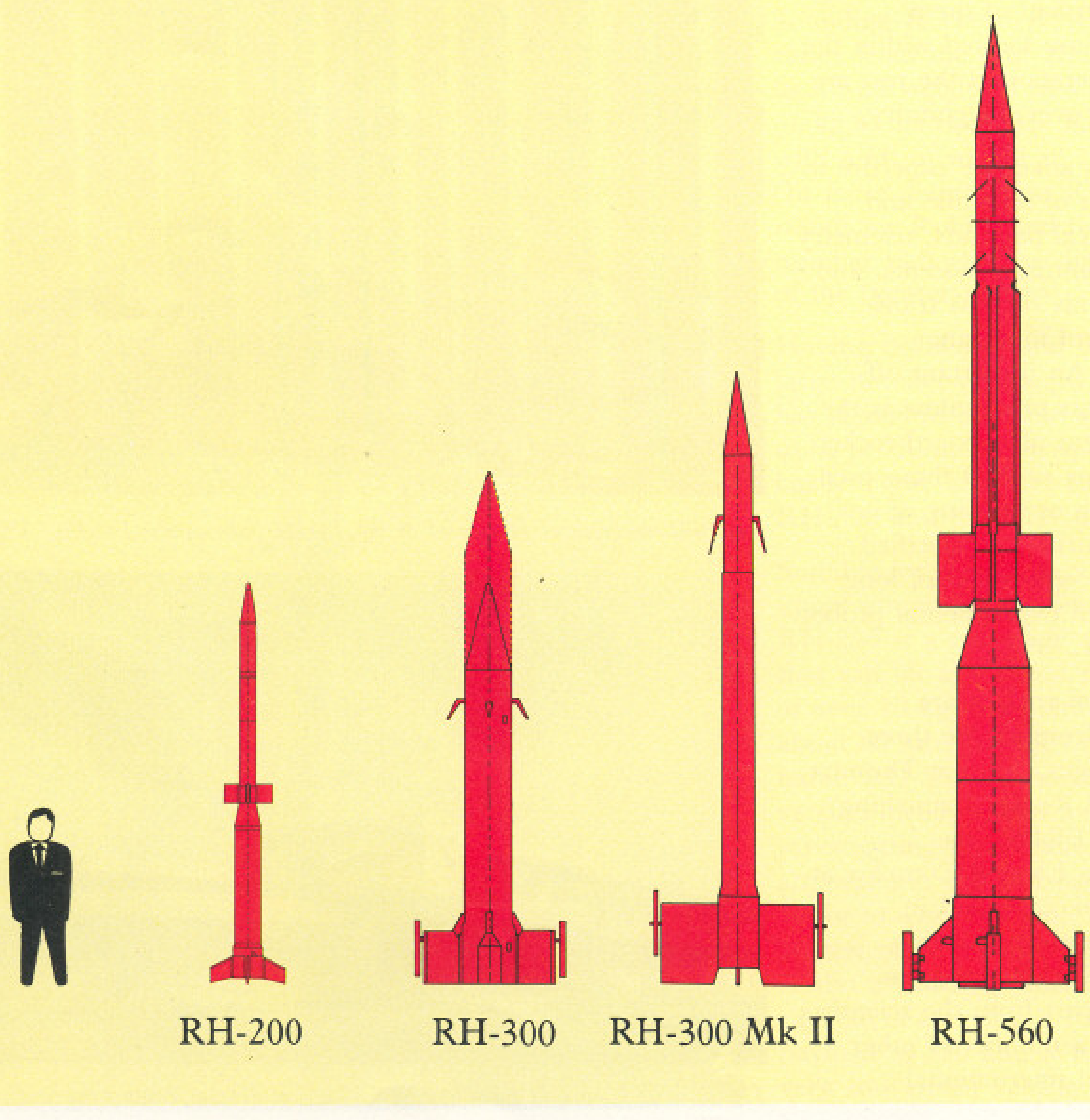


RH-300 motor cases fabricated at the Rocket Fabrication Facility, VSSC.

The Control Centre at the Thumba Equatorial Rocket Launching Station (TERLS)

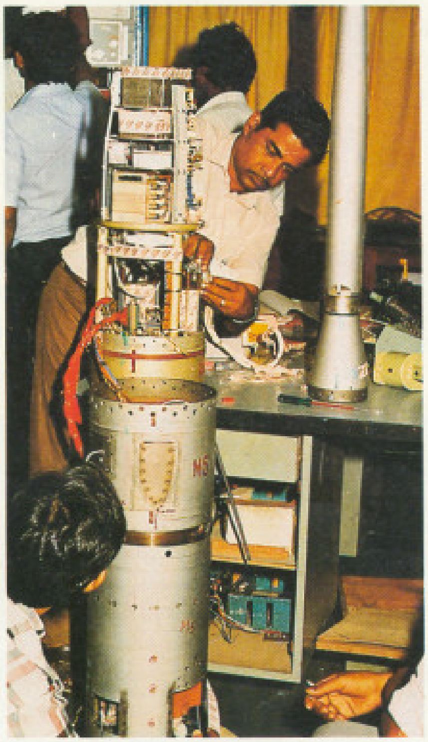
Operational Sounding Rockets of ISRO

Features	Type of Rocket		
	RH-200	RH-300	RH-560
No. of Stages	2	1	2
Length, m	3.6	4.4	7.7
Weight at lift off, kg	108	370	1350
Payload wt., kg	10	50	100
Altitude, km	80	140	350
Field of Application	Meteorology	Middle Atmosphere	Ionosphere

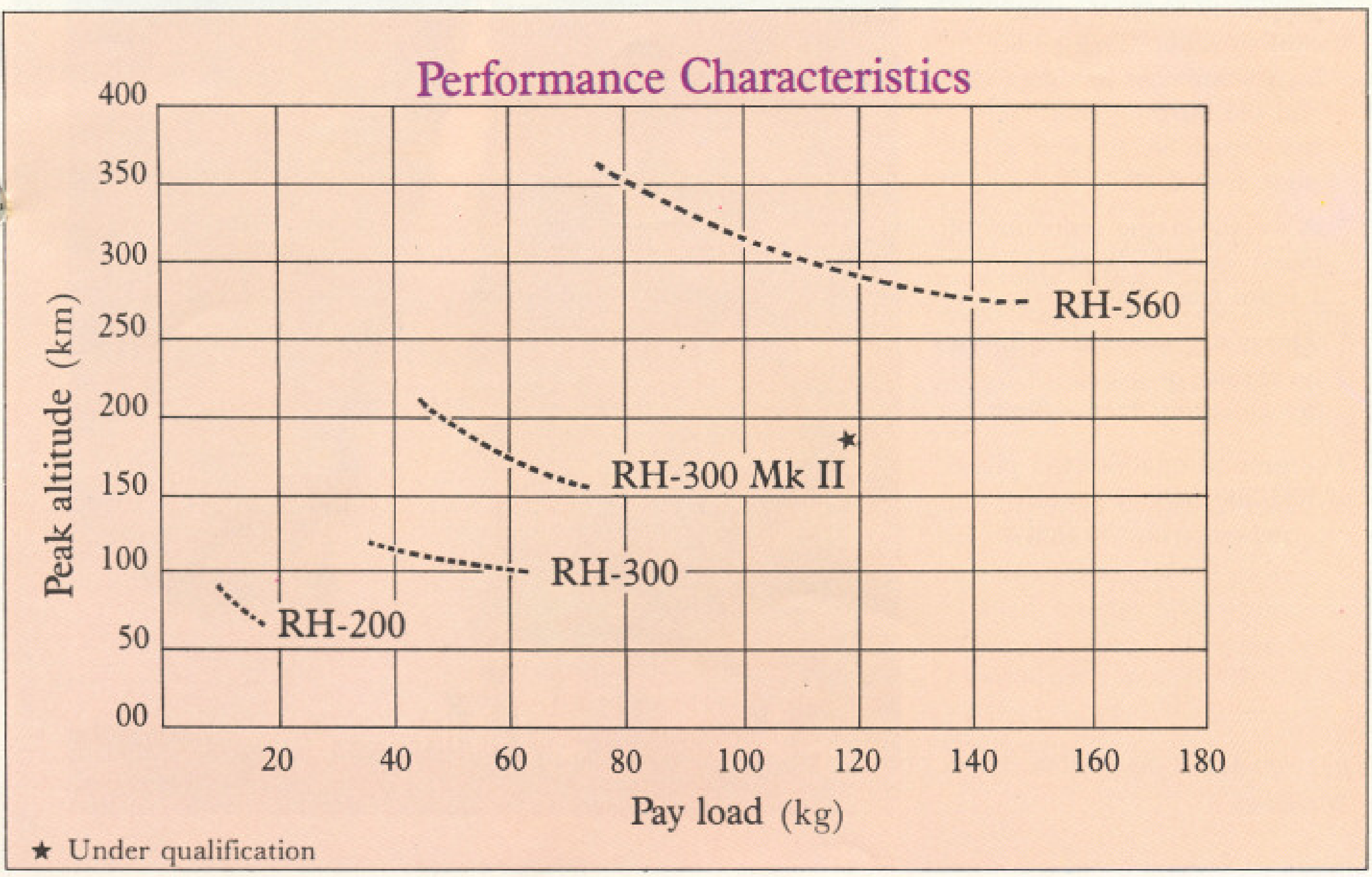


experimenters use the Rohini rockets. The range of scientific experiments conducted with these rockets includes the study of neutral and ionised parts of the upper atmosphere, the equatorial electrojet, X-ray astronomy and various meteorological studies. Occasionally, they are used for flight-testing certain subsystems developed for the launch vehicles of ISRO.

In the overall context of ISRO's progress over the years, the RSR programme has played a key role. Firstly, it provided the wherewithal for the scientists, both from India and outside, for conducting a variety of experiments in the fields of meteorology, aeronomy, X-ray astronomy, middle-atmospheric physics and so on. Secondly, by bringing together specialists in different disciplines like aeronautics, propellant chemistry, avionics, mechanical engineering, reliability engineering, etc., it created a nucleus around which the edifice of VSSC as the lead-Centre for rocketry in ISRO could be built in a step by step fashion. Indeed, the very origins of ISRO's culture of projectising its activities can be traced to the RSR programme. □



Final checking of the NPL optical Ozonesonde after electrical integration of the payloads.



RH-300 Mk II
A New Addition to the RSR Family

Many scientific investigations of the upper atmosphere, specially in the lower ionosphere regions, require a payload of about 50 to 70 kg to be carried to about 150 to 200 km altitudes. Since the RH-300 rockets fall short of this capability marginally, a new addition to the RSR family was required. Vikram Sarabhai Space Centre (VSSC), whose responsibility it is to design and develop rockets, readily found an answer in RH-300 Mk II.

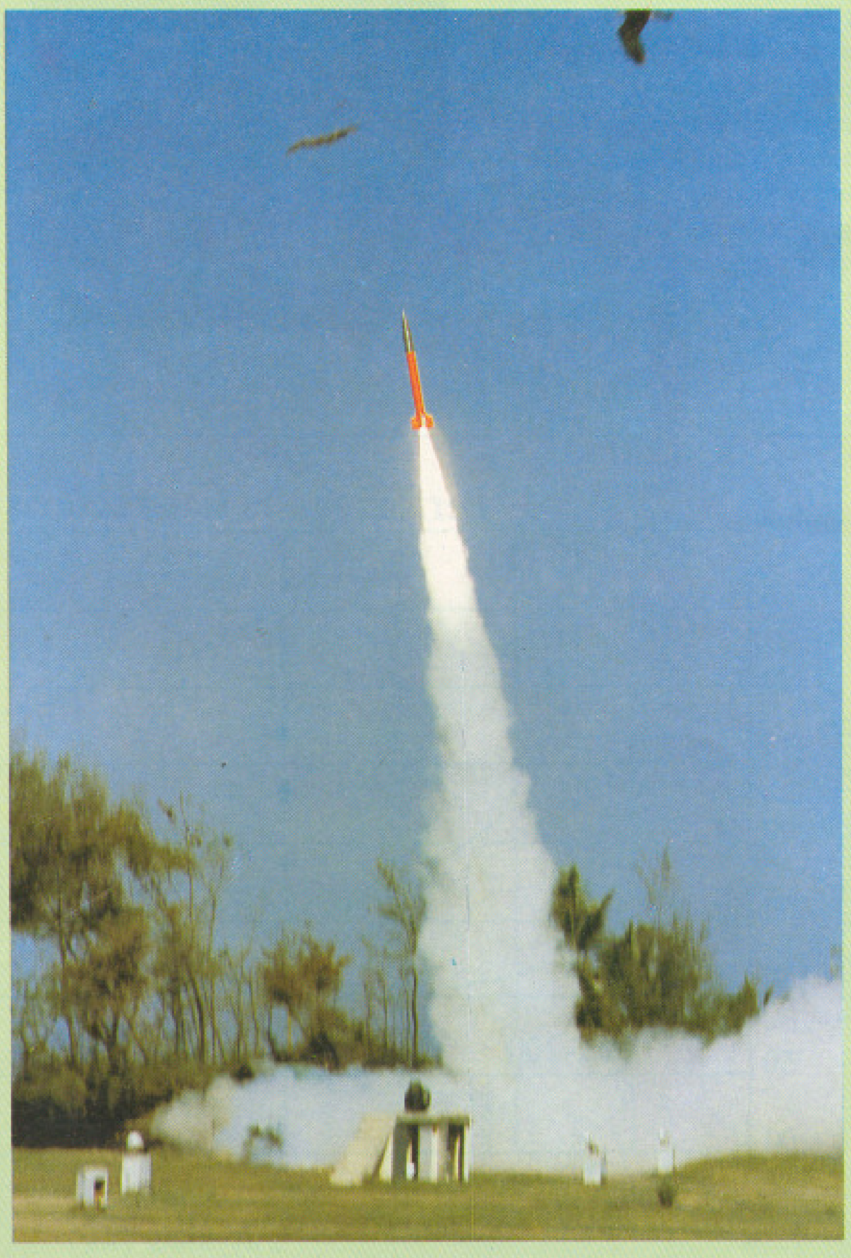
Some of the major modifications thus introduced into the design of RH-300 for this purpose are:

* Increase of motor length from 2.2m to 3.4m
* Increase of propellant weight from 240 kg to 340 kg
* Use of case bonded IPP-40 propellant in dual grain configuration. This allows high volumetric loading (93%) and the burning characteristics resemble those of a two stage system
* A weight-saving reduction of motor case thickness to 1.6mm from 2.0mm
* Thermal protection of fin and fin-shroud to avoid deformations during flight.

The ground qualification phase of RH-300 MK II motors commenced with the first successful static test in 1985 and concluded with the final test in 1987.

The RH-300 MK II rocket has been successfully flight tested twice. The first launch, which took place on June 8, 1987, was made at an elevation of 77 deg. and carried a payload of 58 kg to an altitude of over 135 km. Launched at an elevation of 78.5 the second flight on Sept. 30, 1987 lifted a payload of 56 kg to an altitude of 158 km.

The qualification phase of the RH-300 MK II will be completed with one more successful flight □



RH-300 Mk-II flight test at Sriharikota.

ADCOS

To Foster Space Science

Space Science is undoubtedly an exciting frontier research area. In order to promote contemporary scientific interest and provide collaborative research opportunities an Advisory Committee for Space Sciences (ADCOS) was set up by ISRO in 1980. Coordinating research programmes among scientists in the Universities and other advanced research institutions is the prime task of ADCOS. Integral to this objective is enabling appropriate sharing of major research facilities and resources available across the country. It also provides the right organisational link between ISRO and the researchers to mutual benefit. In framing the functions and the role of ADCOS considerable freedom of action is given to the Committee to identify and pursue its own strategies in the best interest of promoting excellence in research.

In general, the programmes promoted by ADCOS are national in character, requiring participation of many scientific groups from different Organisations. With the seed money provided by ISRO, the Committee acts as a catalystic agent in bringing scientists together for indepth studies, makes presentations to other funding agencies and gets the activities initiated. The agencies with which ADCOS has fostered a very profitable relation are the Department of Science & Technology, University Grants Commission, Departments of Electronics, Environment and Defence, the Council of Scientific and Industrial Research and the India Meteorological Department. ISRO also provides its share of funding and often acts as the nodal agency for programme implementation. The organisational structure of ADCOS provides for close monitoring and periodic reviews to ensure planned progress.

Among the projects coordinated by ADCOS are the Indian Middle Atmosphere Programme (IMAP), the MST Radar Project, selection of scientific experiments for the Indian satellites SROSS-III and SROSS-IV, Comet Halley observations and a number of studies relating to the Cosmic Evolution. ADCOS also played a key role in the manufacture of a 1000 small (3"), low-cost refractor telescopes in 1985 for distribution among students, in an effort to popularise astronomical observations and stimulate scientific interest in the young. Since its formation ADCOS has also taken over the responsibility of organising the biennial national Space Science Symposium jointly sponsored by several national agencies

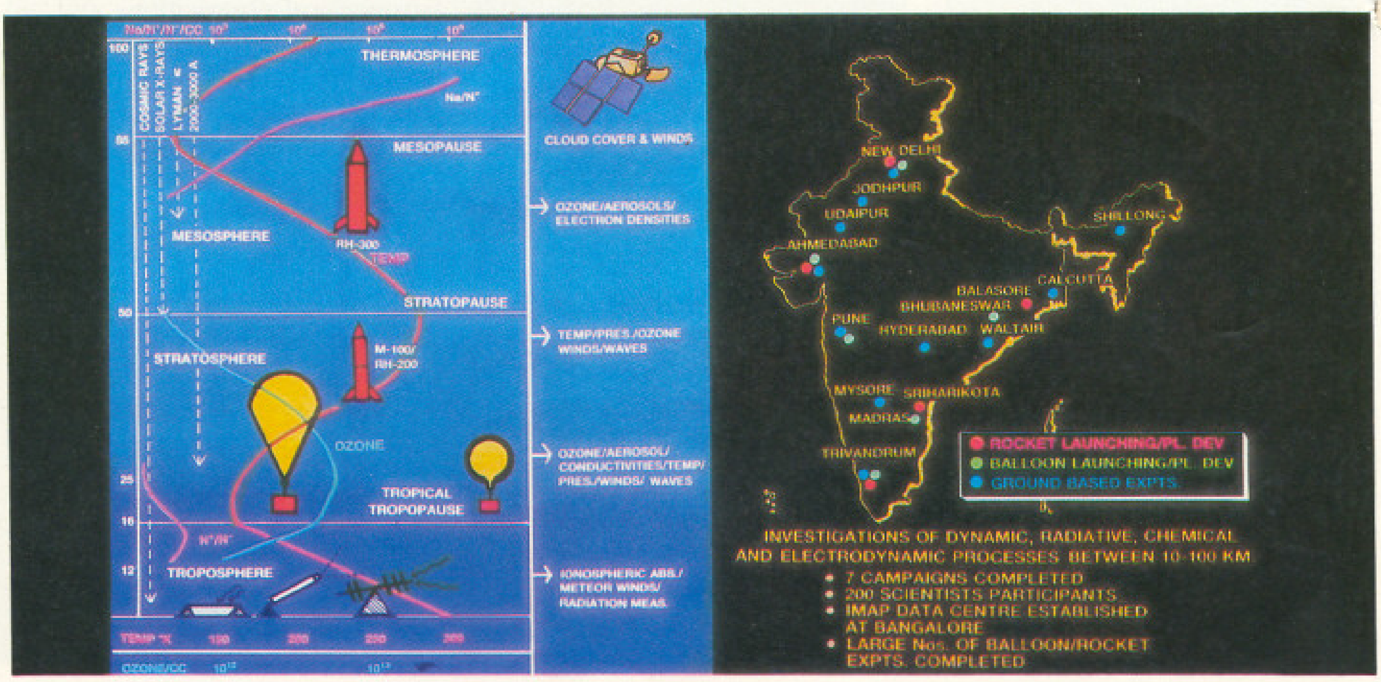
The activities of the Committee have led to encouraging results in many areas. In the process ADCOS has been very successful in providing a dynamic link between the research scientists, ISRO and other scientific agencies □

Indian Middle Atmosphere Programme

What is Middle Atmosphere? A simple answer, of course, is that it is the region between the lower and upper atmosphere! By 'lower atmosphere', we refer to that region of the atmosphere which is closest to the earth's surface; it extends from the ground level to an altitude of about 15 km It is the region where all weather processes take place and hence, has been traditionally the domain of interest to the meteorologist. The upper atmosphere, on the other hand, refers to that region where free electrons and ions exist in sufficient numbers to affect radio wave propagation. It is precisely this influence on radio waves which originally stimulated world-wide interest in the study of this region. The region above 60 km or so can be described as the upper atmospheric region.

It is convenient to designate the atmospheric region between 10 and 90 km as the Middle Atmosphere. Scientists have further divided the Middle Atmosphere into different 'spheres' — the upper troposphere, stratosphere, mesosphere and the lower thermosphere. This sort of nomenclature is based on the behaviour of certain physical parameters in those regions — for example, temperature. Thus, as we move up from the ground the temperature decreases in the troposphere, but in the stratosphere the temperature increases with height.

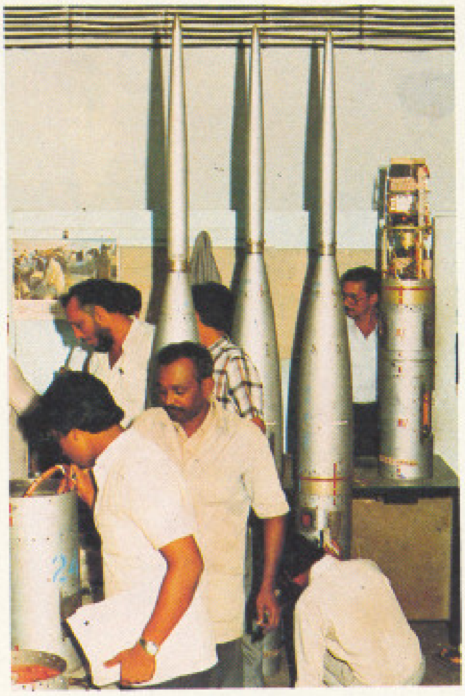
Middle Atmosphere, it is believed, holds the key to an understanding of the sun-weather relationship. Inspite of its obvious importance, the Middle Atmosphere had somehow been ignored largely by scientists till recently. It was only in the late seventies that scientists all over the world felt



Exploded view of the Soviet gasphase chemiluminescent ozonesonde used during the intercomparison experiments.

keenly the need to launch a comprehensive and well-coordinated campaign to collect data on the various physical and chemical processes that occur in the middle atmosphere. In January 1982 the international Middle Atmosphere Programme (MAP) was officially launched. The Indian Middle Atmosphere Programme (IMAP) is the Indian counterpart of the MAP. Though IMAP was initially planned only for four years the studies are continued under a continuation programme called IMAP-C.

IMAP serves as a banner for a large number of scientific groups in our country, specializing in atmospheric sciences to rally around and plan their strategy for a scientific assault on the mysteries of the Middle Atmosphere. In this endeavour the scientific community is supported by a host of Government Departments and Agencies such as: the Department of Space, the Department of Science and Technology, the Department of Electronics, University Grants Commission and the Department of Environment, Forestry and Wildlife□



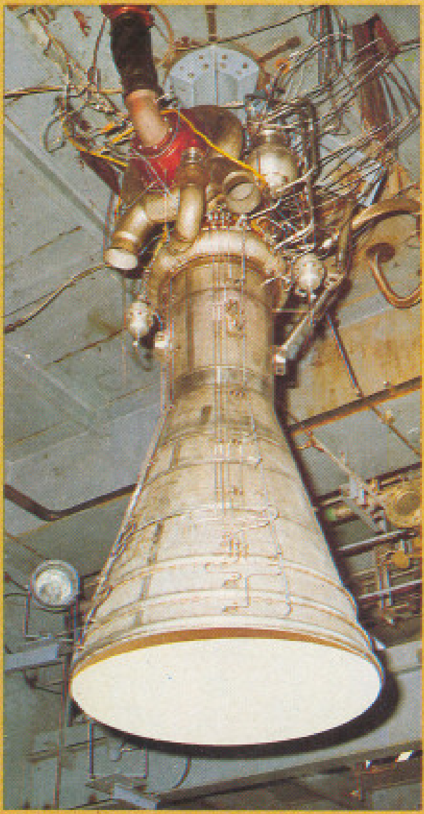
Indian Ozonesonde payloads being assembled for the 'Ozone Campaign

IMAP Data Centre

Systematic acquisition, storage and dissemination of a large amount of data generated in the scientific campaigns are important components of the IMAP programme. Data obtained from the balloon, rocket, satellite and ground-based experiments are archived in a comprehensive data base at the IMAP Data Centre in Bangalore. The Centre also publishes periodically data catalogues in the IMAP Bulletin. Processed data from the Data Centre is available on request to all users.

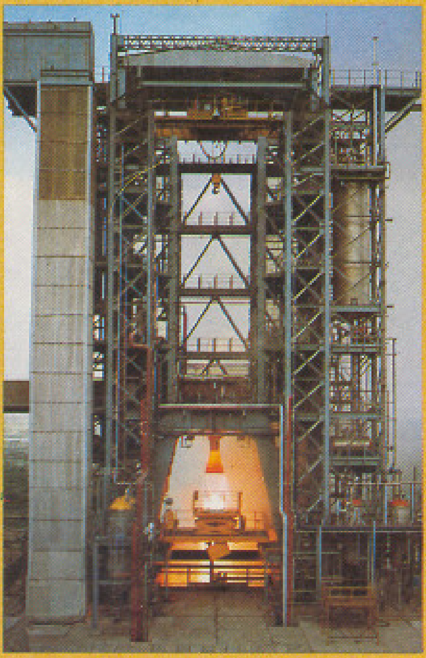
Vikas for PSLV

VIKAS engine being assembled at the Principal Test Stand for a static test.



Vikas engine fully integrated and getting ready for static tests.

Vikas engine undergoing a long duration test.



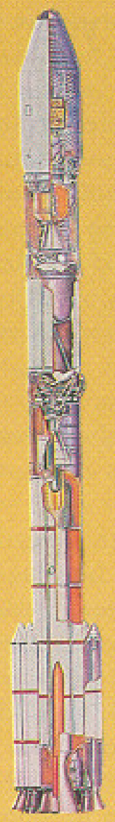
The Polar Satellite Launch Vehicle (PSLV), currently under development in ISRO, will make use of both solid and liquid propulsion rocket stages. While the strap-on-boosters, the first stage and the third stage use solid propellants, the second and the fourth stages use liquid propellants. The second stage of PSLV will be powered by the 'Vikas' engine developed by the Liquid Propulsion Systems Centre (LPSC) of ISRO.

Named after the founding father of the Indian Space Programme, Dr. Vikram A. Sarabhai, the technology of this high thrust liquid propellant engine was acquired from SEP (Societe Europeene de Propulsion), France under an international collaborative progrmame. The engine uses turbo-pump-fed storable liquid propellants with a film cooled thrust chamber. The Liquid Propellant Comprises N_2O_4 as the Oxidiser and UDMH as the fuel. Though the basic technology of the engine was acquired from abroad, the entire fabrication and testing of the engine are carried out indigenously using the infrastructure available at ISRO and the Indian Industries.

Vikas Engine requires precision fabrication techniques. It uses a variety of special alloy materials such as Cobalt based alloys, low alloy steel, special stainless steel and several aluminium alloys. The fabrication tolerances are very stringent and meet international aerospace standards. Some of the very special and new fabrication techniques used are: drilling of precise orifices in predetermined axial and circumferential locations of the injector, three dimensional reproduction of double curvature impeller vane profiles, special measurement techniques to measure the profiles, welding of cobalt based alloys, anodisation meeting aerospace standards etc. Nearly ten public and private sector Indian industries extended their full fledged support to realise the engine, developing enthusiastically all the above mentioned techniques for the first time in the country.

January 12, 1988 was a red letter day for LPSC. Years of development work on the engine and its test facilities culminated into a successful full-duration test of the Vikas engine this day at Mahendragiri. Preceded by a year-long series of tests on the gas generator, turbo-pump and the engine itself, the successful 150 sec hot test of January marked an important milestone in the PSLV programme.

Subsequently on April 5, 1988 a 180 sec. endurance test was also conducted. □



The Polar Satellite Launch Vehicle (PSLV) whose second stage will be powered by the Vikas engine.

FROM: PRIME MINISTER, NEW DELHI.

TO: PROF U.R.RAO,
SECRETARY
DEPARTMENT OF SPACE
BANGALORE

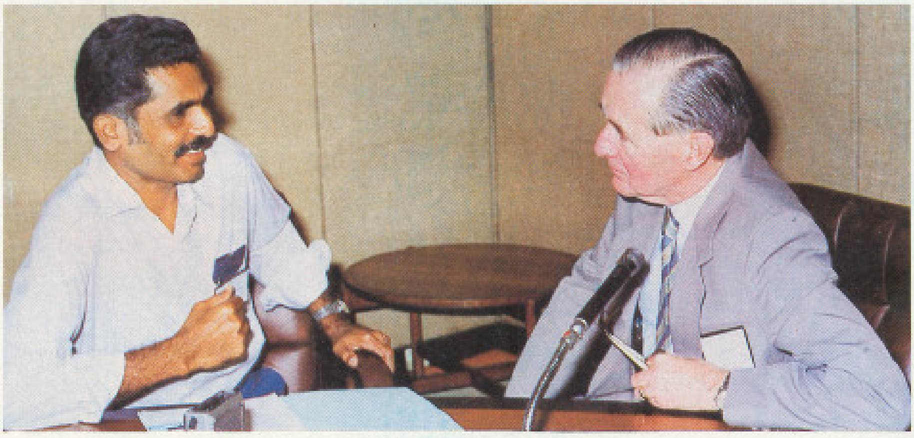
--

CONGRATULATIONS TO YOU AND YOUR TEAM ON SUCCESSFUL TESTING OF THE SECOND STAGE ENGINE OF PSLV(.)

PRIME MINISTER

======

"In the year 2005 the launchers will take-off Horizontally."
— Roy Gibson



Mr. R.M. Vasagam (left), Director, Advance Technology Programmes, ISRO HQ, interviewing Mr. Roy Gibson.

Roy Gibson talks to SPACE India

Recognising the immense potential of an international civilian satellite system for Communication, Navigation and Surveillance (CNS), the Indian Space Research Organisation (ISRO) and the European Space Agency (ESA) jointly sponsored in Bangalore a meeting of experts from various spacefaring nations during December 14-16, 1987. Held in an informal atmosphere, the meeting saw the experts discuss the mobile CNS needs of various transportation sectors like civil aviation, shipping and road transport; also discussed were the ways and means of configuring satellite-based systems to meet those needs.

One of the colourful personalities to attend the meeting was Mr. Roy Gibson, Special Advisor to the Director General, INMARSAT. Mr. Gibson hit the headlines the world over when he resigned from the post of Director General of the British National Space Centre (BNSC) in August 1987, in protest against the UK Government's refusal to augment the Space Budget. Before joining the BNSC, Mr. Gibson was an independent aerospace consultant to British and other Governments. He contributed significantly to framing their Space policies. Between 1967 and 1980 he played a leading role in the European Space affairs, becoming the first Director General of the ESA (1975-80).

In a gesture typical of him, Mr. Gibson readily agreed to be interviewed for SPACE India. Excerpts:

Q: *We believe you are here to attend a meeting on satellite-based navigation systems. Could you tell us something about this meeting?*

A: Yes. The importance of the meeting is that it is informal and it allows people to say things they would not normally be able to say in a very formal meeting, with interpreters etc. It is very good to have the Americans, Russians, the French, the Indians, all there to see what we could find for a commonsense solution for navigation. That is to say, how can we help solve the problems of aviation, navigation, ship navigation, even railways and trucks navigation by using existing technologies; finding solutions which are cost effective. This is a very practical affair which is going to affect the lives of a lot of people.

Q: *You have come for the meeting as a representative of the INMARSAT organisation. Kindly tell us something about INMARSAT.*

A: INMARSAT is an inter-governmental organisation which has 53 member-states at the moment and India is one of the signatories. It started its life purely for communication between ships and the shore, and between ships themselves. It is now going to be responsible also for communications between aircraft and the ground. There is also a suggestion that it should go one stage further and take up communications with lorries and the trucks also, land mobiles as we call them. It is a very interesting organisation because it is a little United Nations Organisation and to that extent is a very rewarding work.

Q: *We were very happy that you were taking up the stewardship of the British National Space Programme. But we have now come to know that you have quit the post recently. What really made you to take such a drastic action?*

A: Well, I was asked in November 1985 to form the new British National Space Centre. At that time my understanding from the Ministers, who were then in office was that the UK intended to put more money into Space. The British National Space Centre was asked to produce a plan — a national Space plan, like India has already done; on how much money we should spend every year, until the year 2000. We spent one year in the new Centre (about 300 people) building up and writing the plan. Then we presented the plan to Government and I was very surprised that the Ministers to whom we presented it were not at all sympathetic about Space. The Ministers had changed since I arrived; they had other priorities and they wanted to leave the money at the same level that it was before. I consider them as very wrong and so I decided to leave.

Q: *Could you tell us something about the contents of the plan and what was envisaged for the next 15 years?*

A: Yes. The centrepiece, of course, has been the cooperation with the European Space Agency. But we wanted to change the balance between our contribution to the ESA and our own national programme. For many years we have been spending about 80% of our money on the ESA programmes and only 20% outside ESA. And I wished to change the balance to about 60% in ESA and 40% on the national programme. Now the national programme would not all be in UK, there would also be bilateral cooperation with India, with China, with the Soviet Union, with Canada, and you need money to do this. This was number one priority. The number two thing that we were trying to do was to get an appropriate balance between the development of large programmes like rocket programmes and space station on the one hand and user programmes on the other — meteorology, telecommunications and microgravity. I have been very worried that increasingly in Western Europe, and in the USA, too much money is spent on the infrastructure and not enough money is reserved for the actual utilisation. So we wanted to be very careful to maintain this balance. The third is that we wanted to try to integrate the private sector — private industry — into the programmes at a much earlier stage. Instead of having completely Government funding, we tried to have a mix of Government and private funding. It called for an increase (gradually but in the end of the third year) of from £100 million a year to £300 million a year. An increase by about a factor of two, so to say, in the third year; because you cannot spend the money straightaway. This had the full approval of the Ministers in the previous Government but although they are in the same political party now they have different Ministers and different priorities.

Q: *In the present scenario, can UK continue to take some lead role in the ARIANE-5, COLUMBUS and the HERMES Programme?*

A: It will not be able to play any role in these programmes because it has no money.

Q: *Will it not hurt the British industry and its long term role?*

A: Yes, enormously. There is no, what we call, free money. All the money is committed for the £110 million in this year's budget. Most of it in the next year is already committed on programmes which are ongoing, like the OLYMPUS telecommunication satellite, or ERS-1. So without new money, without additional money, the British Space Agency is not able to take part in the ARIANE-5, in COLUMBUS or in HERMES.

Q: *Where does that leave the British HOTOL Project?*

A: Well, it does not directly affect it, because this is not an ESA project. We had an arrangement for HOTOL whereby 50% would be funded by the British National Space Centre and 50% by industry. This was an arrangement that I had negotiated with the industry. However our Government money ran out in July. So from July until December, the industry agreed to pay 100%. But what they will do from January next year (1988) nobody knows. Because, in my view, they are unlikely to want to pay 100% indefinitely. They will expect to have some contribution from Government also.

Q: *Do you think there will be any rethinking from the UK Government side?*

A: You know Ministers are always right. Even when they are wrong, they are right! They must gradually see that this was a mistake and perhaps gradually change it. But this is very difficult to do. But the effect on industry will be quite dramatic. It means that they will go from an expanding situation to a declining situation. For example with no new money we would be paying only about 6% of the ESA programme, whereas we pay at the moment 14%. You see, ESA programme grows bigger and we do not increase our contribution. It is a shrinking percentage.

Q: *You said that you had envisaged major collaboration programmes with the Soviet Union and Japan, and probably with India too. Do you think some of those programmes can still survive?*

A: It is very difficult because cooperation, like everything else, needs some money. We have managed to preserve some small programme with the Chinese mainly on solar cells, testing of solar cells and of radiation covers for solar cells. With the Russians the cooperation was only for scientific satellites and some of this can proceed because the scientific money remains constant each year. We will not be able to take new cooperations for atleast 2 years, unless the money comes from the industry.

Q: *We also read that there were separate proposals for the HERMES, the HOTOL and the SANGER. They are all good ideas and probably worthwhile in a particular time frame. As you had been advocating that if you are building probably HERMES with the ARIANE-5 it is going to be obsolete even before it is born.*

A: This is my view. I think that the HERMES with ARIANE-5 makes ARIANE-5 more expensive, because it has to be bigger to accommodate HERMES. And HERMES is only a short term solution. It is not a long term solution. One of the worries that I have is, as we were saying a few minutes ago, you must start on the next generation, whether it is HOTOL or SANGER, it does not matter. But in the year 2005 the launchers will take off horizontally. They won't take off vertically. What will be written on its side, I don't know; whether it will say HOTOL or SANGER or something else. Unless we start putting some money now into that next generation, we will again be overtaken by the Americans.

Q: *You are familiar with the Indian Space Programme as well. Do you think we are on the right track?*

A: I think you have been on the right track a long time. I am always full of admiration for the Indian programme. I hope that in the next years you will be able to save some money for the future. This is what people are always trying to do. Then they get short of money and they steal money from the future studies and this is very short sighted. It is like the rice for the next year's harvest. We must keep some of this pack. If we spend all our money on this generation, then when we come to the next generation, we are not prepared. I hope that India will keep on looking 10 or 15 years ahead.

Q: *We have come to a reasonable stage of building satellites for meeting our needs. But we also find that the users are hesitant to go for a satellite system initially. Then all of a sudden they come to us with multiple requests which we are unable to accommodate quickly. In the case of Europe atleast the industry is harnessed from the beginning. But in India, we are making an effort to bring in the industry. Do you think the European industry has a role in helping the Indian industry?*

A: It should have a role I think, particularly in electronics and in the development of advanced software. These are two areas in my view, where there should be tremendous

synergy between the resources in India and the capability in the West. I am very surprised that we have not been able to start some new cooperation in these industrial areas.

Q: *You mentioned about the Americans overtaking Europe unless something like a horizontal takeoff is achieved. But we also read in the papers that you have been opposed to, what they call 'a bullish view of French' that Europe should be autonomous in space. Could you tell us something about your views on this?*

A: My view basically is that nobody can afford to be 100% autonomous. Space is one of the few areas where international cooperation has a good reputation. We have done a lot through international cooperation. If one goes too bullheaded at more autonomy, it means to me, that you sacrifice something in cooperation. I think that in the first instance cooperation is necessary, even if you build up in parallel your own capabilities as you do in India, but you sacrifice a lot if you sacrifice the cooperation.

Q: *Talking about cooperation, it is generally conceded that the existence of ESA itself has contributed to the political integration of Europe. Do you think so?*

A: Absolutely Yes. I think one should look back, may be 20 years. There has been some disagreement inside ESA during these 20 years and even now at the November Ministers' conference, with the rather disgraceful position taken by the UK. Even if you integrate all of that, the balance is very positive. It is still helping to integrate people. I think it was Churchill who said: it doesn't matter how boring an international meeting is, atleast they are talking to each other not shooting at each other.

Q: *You have been at the helm of affairs in ESA from the day it was started. What in your view were the achievements of the organisation during those years?*

A: Well, we first of all managed to integrate the two organisations — ESRO & ELDO — which were in existence before, and this was quite a difficult task. And then we started most of the application programmes — the communication programmes, the METEOSAT programme, the ARIANE programme and the SPACELAB programme. It was a time of building, of increasing staff and trying to increase the reputation of the ESA. People were respected and I think by and large we had quite a lot of success.

Q: *Do you feel that India should be doing something more positive in the INMARSAT. Ofcourse, we are a member in the INMARSAT organisation and we are also trying to do something in a small way. Do you think that India's role can be enhanced?*

A: Oh, yes! I really do. I think that the role of INMARSAT for a nation like India is very important because if you integrate your ISRO capability together with your INMARSAT representation you can, in my view, be very much more influential, and have very much more industrial flow back than you had upto now. And I think there is a lot of room for you to become an active, rather than a passive, member of INMARSAT.

Q: *May we come back to your personal experience. you started your career as an administrator and then came to manage science and scientists, and technologists. How did you like this change from bureaucracy to technocracy?*

A: Well, even when I was an administrator I wasn't a very good bureaucrat. I was always a little unorthodox. I think with scientists and engineers & technologists, you have to remember that they spend a long time studying; they are experts in their fields. But if you approach them with a certain humility, most of them will take time to explain their problems in terms which a reasonable intelligent person can understand. And I have always found it possible to understand the basic problems in the science or in the technology. It takes me longer to understand than a scientist. But provided that you and those you are talking to have patience, I think it is possible.

Q: *We hear that you were in India in the early years of your career. Did you like your stay in India in those days?*

A: If I may say so, India is my second home. My son was born in India, in Madras. I feel very much at home in India.

Q: *You may be glad to know that the International Astronautical Federation Congress will be held at Bangalore in October, 1988. It also will be the 25th year of India's Space Programme, probably a fitting occasion to bring the conference to India.*

A: Excellent, If God allows me to remain on the earth that longer I propose to come and join□

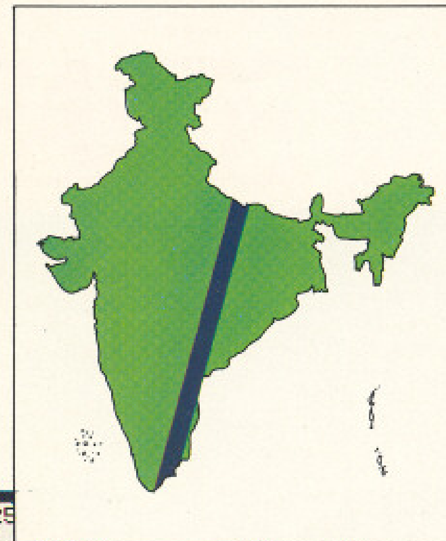
Vigyan Mahotsav in USSR

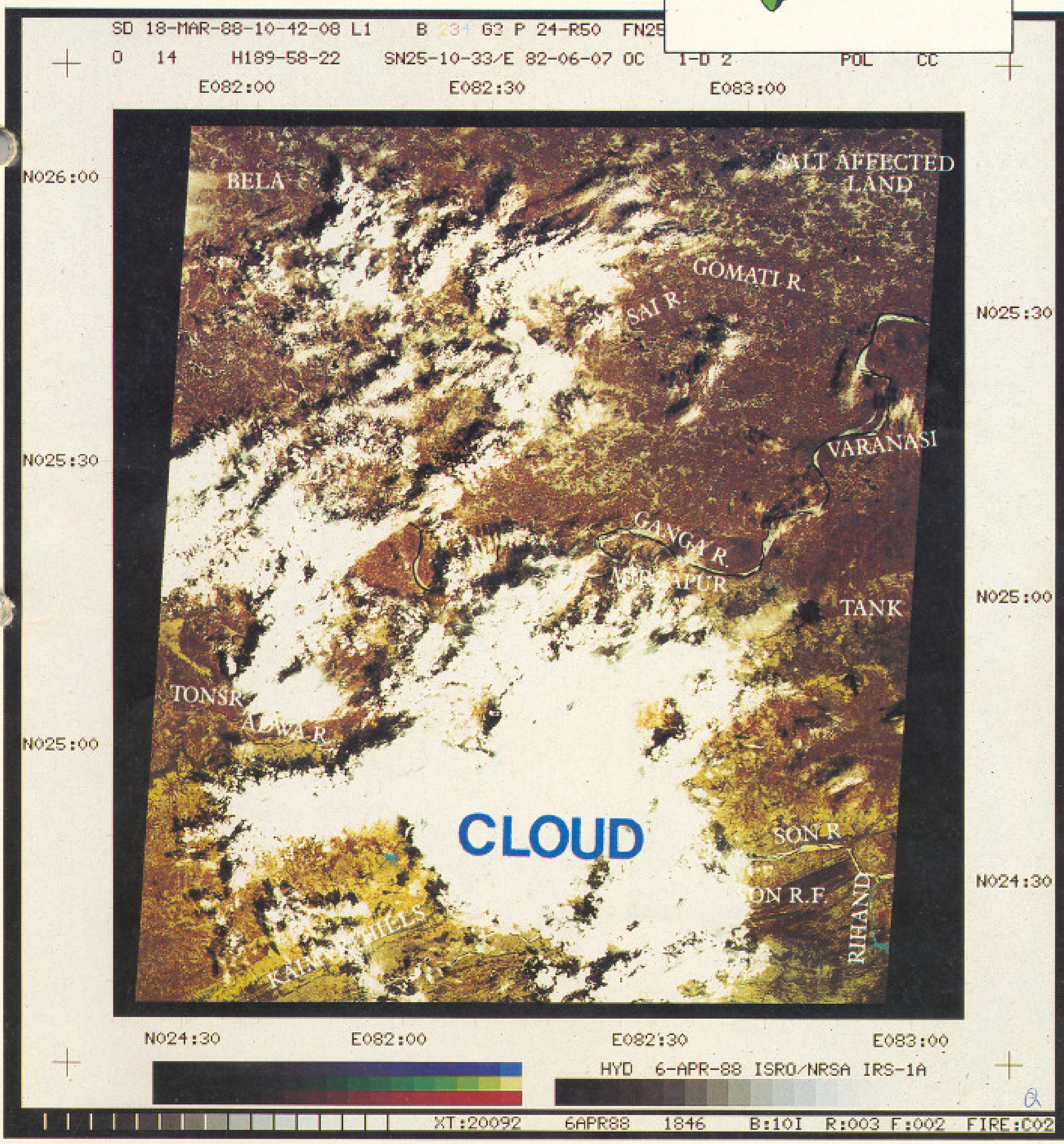
Bharatiya Vigyan Mahotsav, the Indian Science and Technology Exhibition is an important segment of the Festival of India in the Soviet Union. Inaugurated in Leningrad on August 20, 1987 this month-long show depicted the march of science in India from ancient to the modern day. The Exhibition highlighted the bold and ambitious path the country has chosen. Later it moved to Moscow and Tashkent where it was on show during November-December, 1987 and February-March 1988 respectively.

As one would expect, the Indian Space Programme found an important niche in this general Science and Technology panorama. Supported by specially prepared photopanels and scaled-down models of ISRO satellites and rockets, the exhibition protrayed how the space effort is oriented towards national development. It was visited by more than 3000 people each day. The emphasis laid on remote sensing and satellite communications elicited good response from the visitors. The Indian approach to the use of space impressed the citizens of a country which pioneered the space age thirty years ago□

A section of the Science & Technology exhibition at Leningrad.

At 10.42 AM on March 18th, less than 24 hrs after the launch, the LISS-I camera on-board IRS-1A was switched on. Much to the delight of the engineers at the NRSA data reception station at Shadnagar, this very first picture over the Ganges jumped on the monitoring screens. Fourteen such scenes were recorded on the first path of the satellite (inset) over the country covering Bijapur, Raipur, Godavari and Krishna rivers, the Sriharikota island, Tirupathi hills and upto the Kanyakumari tip.





RH-200 Sounding Rocket lifting off from the launch pad at the Thumba Equatorial Rocket Launching Station (TERLS) on the shores of the Arabian sea.