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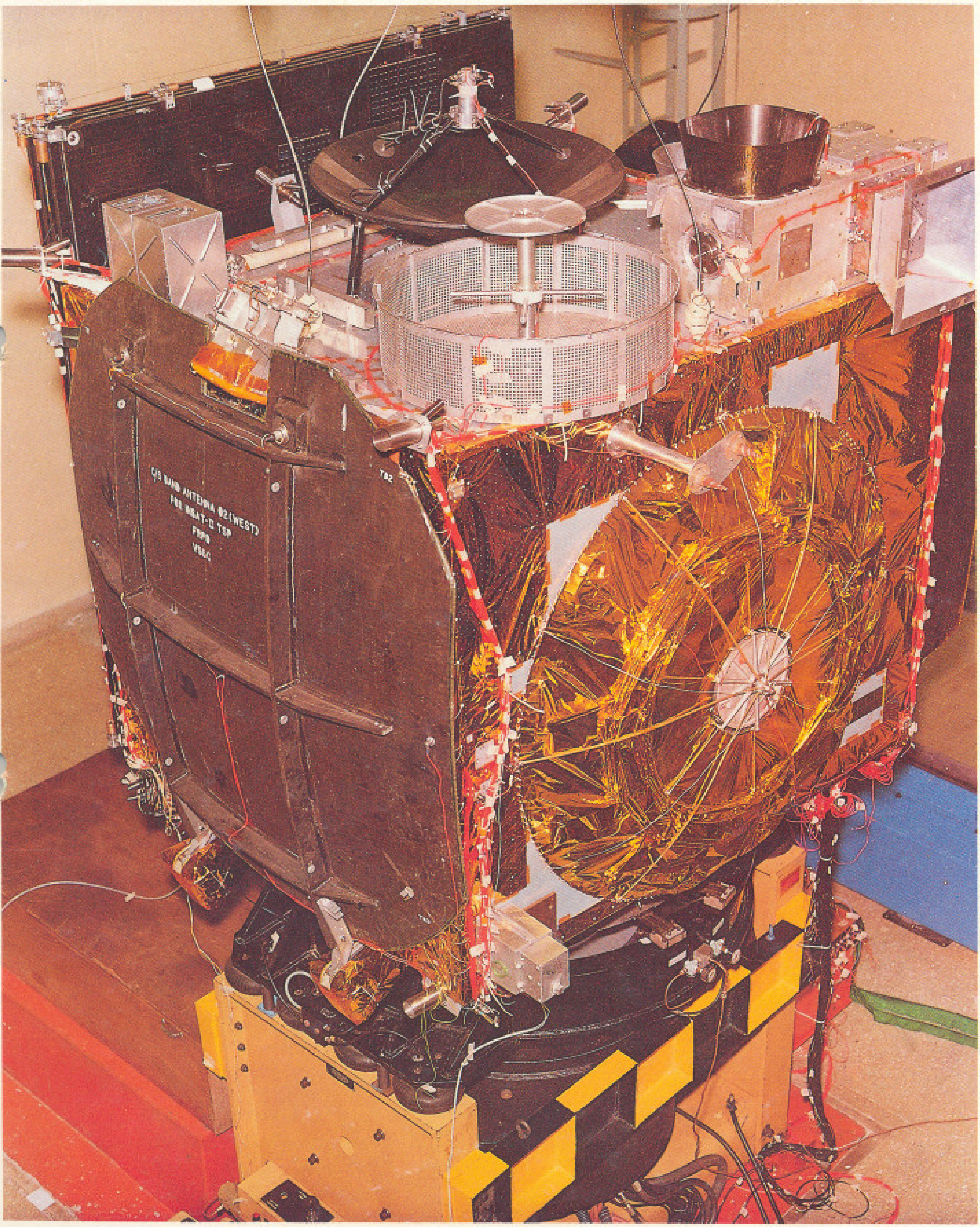
SPACE india



INDIAN SPACE RESEARCH ORGANISATION

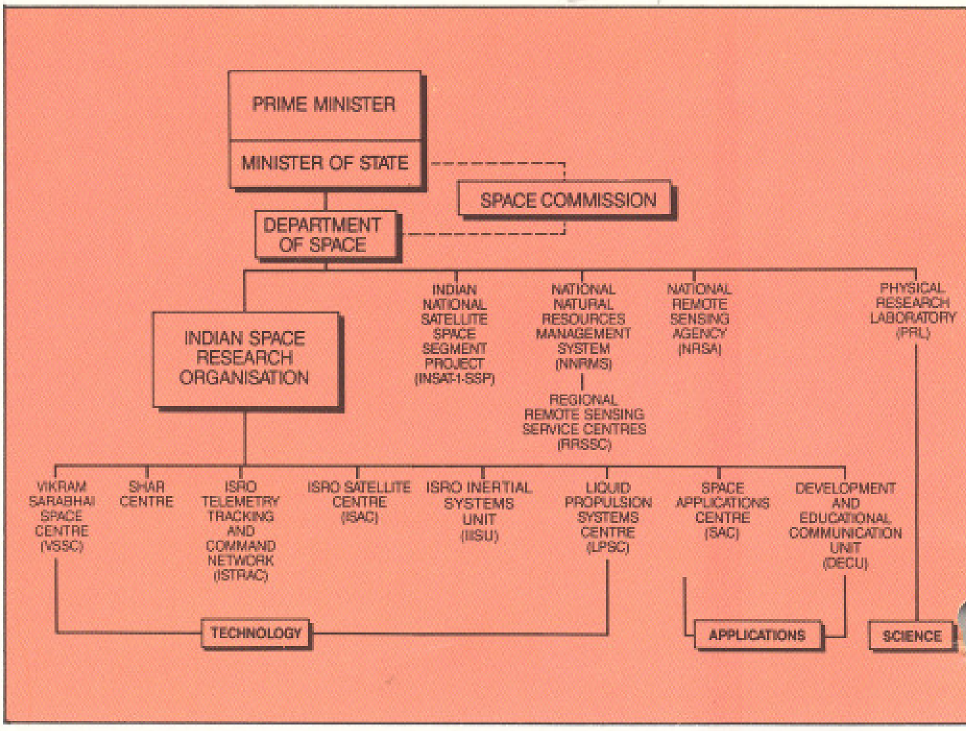
The Indian Space Programme

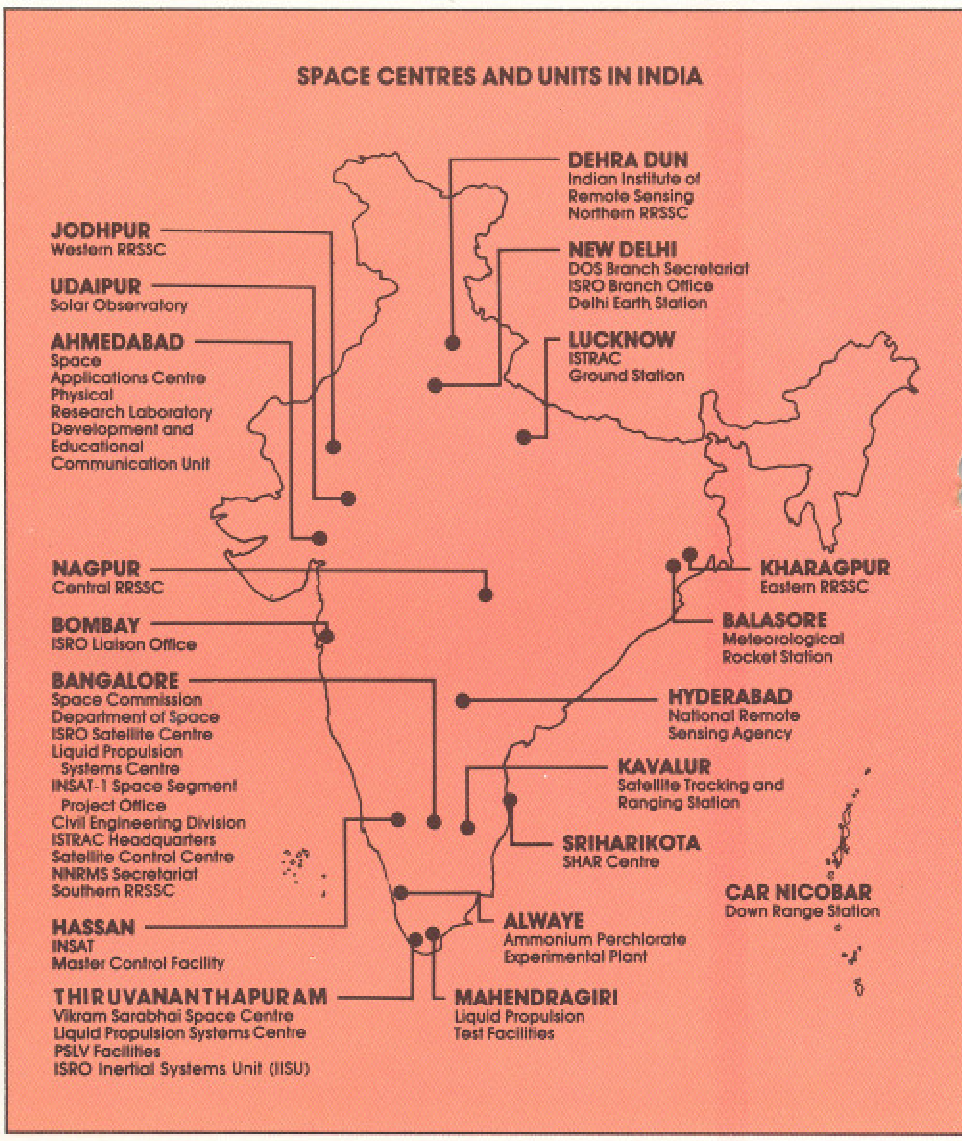
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science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

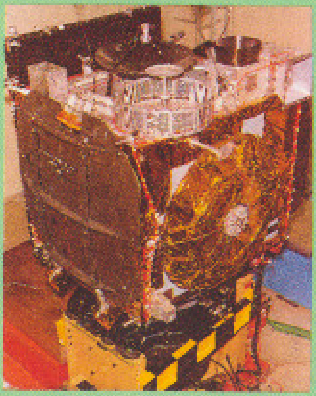
The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological 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 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
Integrated INSAT-2 Structural Model on vibration table.

EDITORS
S Krishnamurthy
Manoranjan Rao

EDITORIAL ASSISTANCE
S. K. Dutta

PRODUCTION ASSISTANCE
B. Chandrasekhar

Contents

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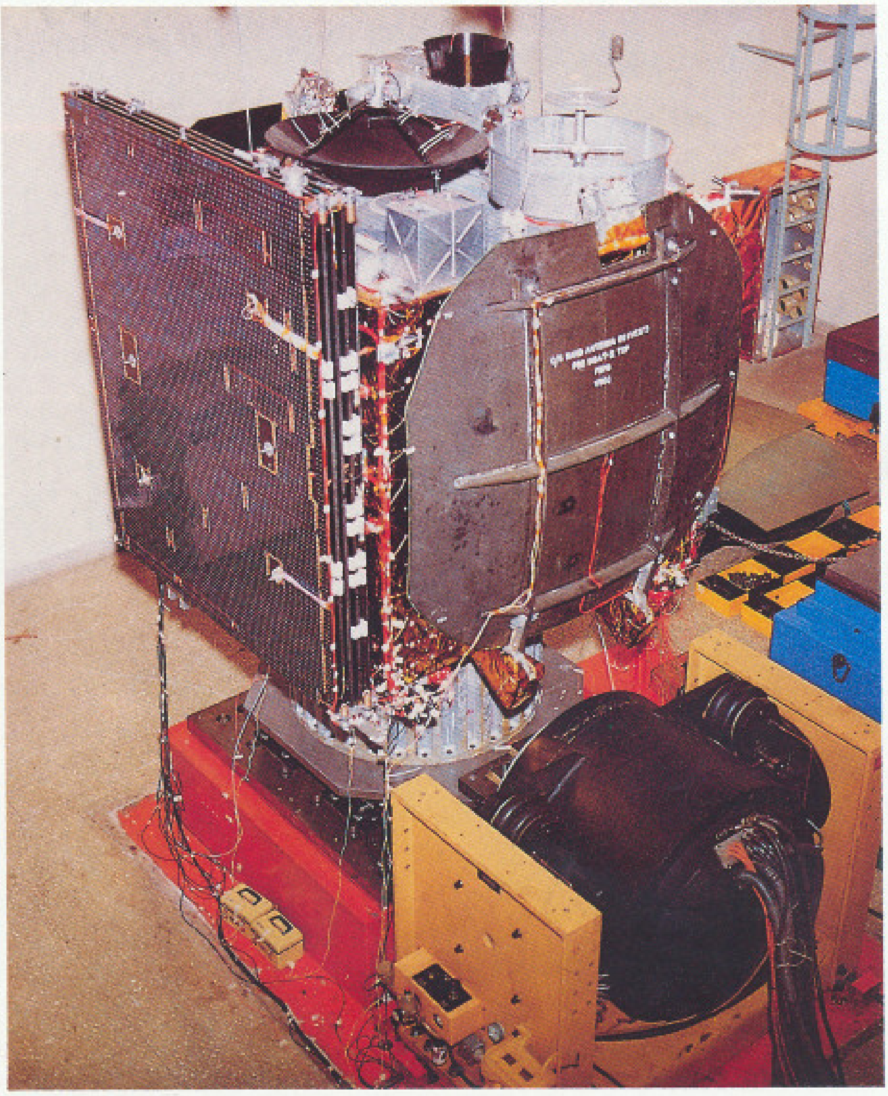
INSAT - 2 Undergoes Dynamic Qualification Tests

A major milestone in the realisation of indigenous INSAT-2 spacecraft has been crossed recently with the successful completion of dynamic qualification tests on the spacecraft structural model. The test results indicate that all structural design specifications have been met.

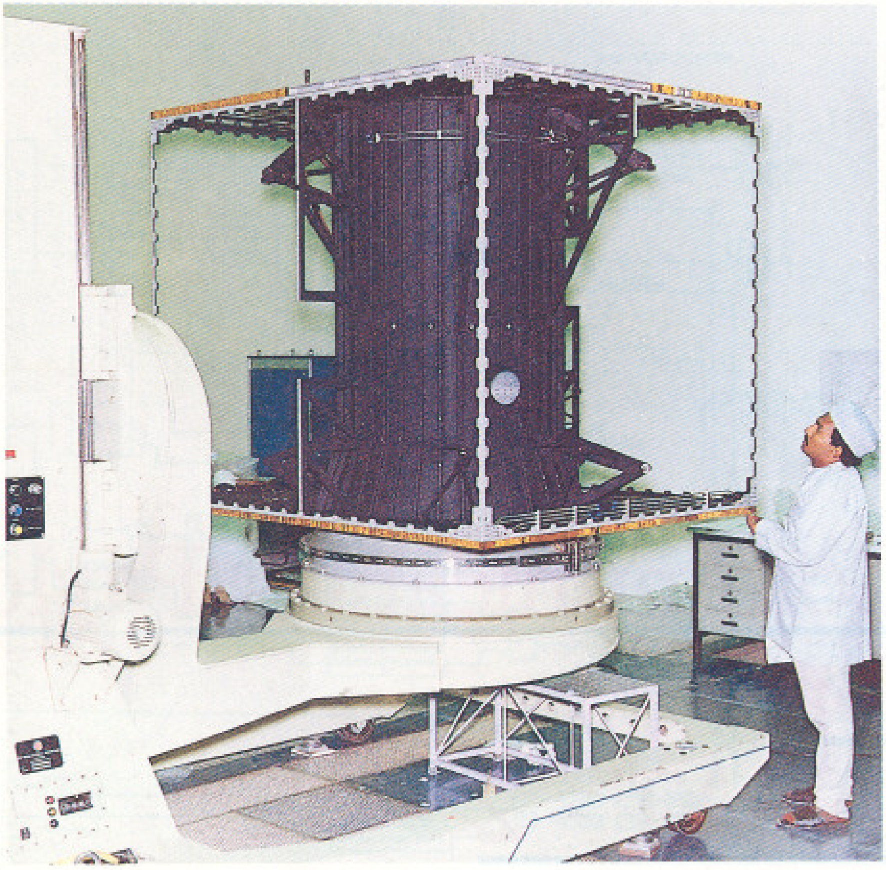
Vibration and acoustic tests are critical to the development of a spacecraft, as the results of these tests can affect not only the design of many of the spacecraft subsystems but also the time schedule. INSAT-2 poses a number of challenges because of its complexity. The 1906 kg satellite, with liquid propellant contributing to nearly half of its mass, is the largest spacecraft, both in terms of mass and size, built by ISRO till date. Qualification of large, delicate and flexible appendages such as solar array, antennas, solar sail and associated deployment mechanisms, developed for the first time by ISRO, is the main objective of the tests. The structure, apart from being mass efficient, incorporates new types of support systems for the large titanium tankages of the spacecraft propulsion system. The support system is designed to achieve structural decoupling of the tankages and spacecraft structure and has rotational and translatory freedoms with highly loaded joints.

The vibration test on the INSAT-2 structural model was conducted at three levels – low level test for characterisation and signature analysis, intermediate level test and qualification level test along the three axes of spacecraft. The vibration test was followed by a series of acoustic tests, again, at all three levels.



On the vibration table.

The vibration test facility at ISAC was specially augmented for INSAT-2 tests with the addition of a special load bearing platform to take increased static load. A vibration test fixture was fabricated out of magnesium casting supplied by the Defence Metallurgical Research Laboratory (DMRL), Hyderabad and a machined aluminium ring with a thick inner layer of damping material. The vibration test required monitoring of about 120 channels simultaneously. The input excitation was controlled, based on the responses measured at 8 critical locations on the spacecraft, using a newly developed multi-channel automatic notching and abort system. Four 32 channel tape recorders were used for data recording.

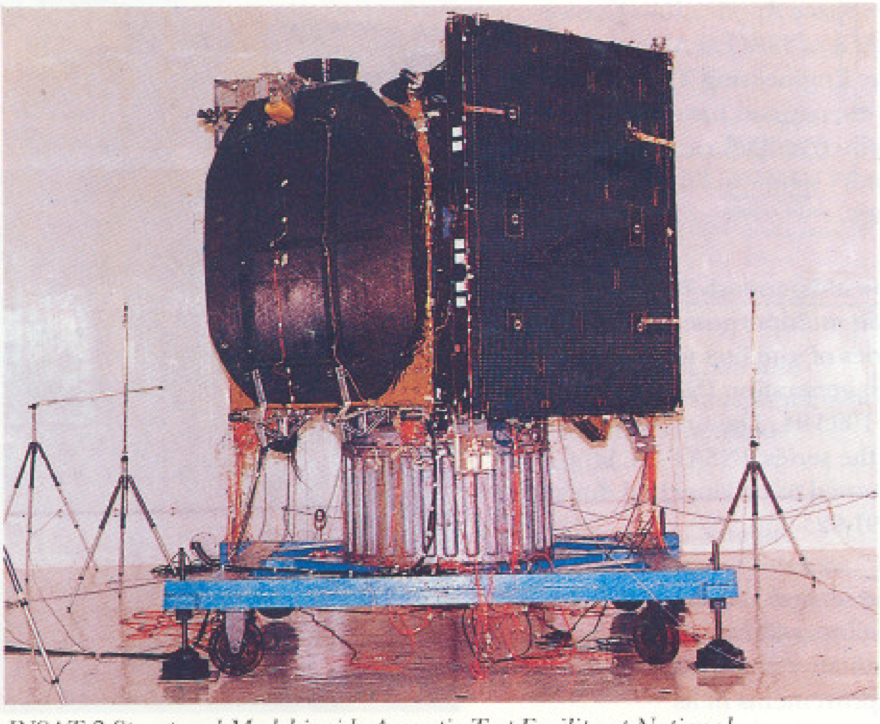


The basic structure - starting point for integration.

The vibration test results have established that the structure has met the design specifications for INSAT-2, including those imposed by the launch vehicle.

The acoustic test, critical for flexible appendages, also produced good results. The functional tests, following the dynamic tests on the spacecraft, proved that both the dimensional stability of critical elements and the performance of deployment mechanisms were well within the specifications.

The dynamic qualification tests on INSAT-2, the culmination of the efforts put in towards the design and development of various components, were a complete success. The positive results of the tests justify the confidence reposed in the original design and the decision to initiate flight model structure fabrication much earlier. □



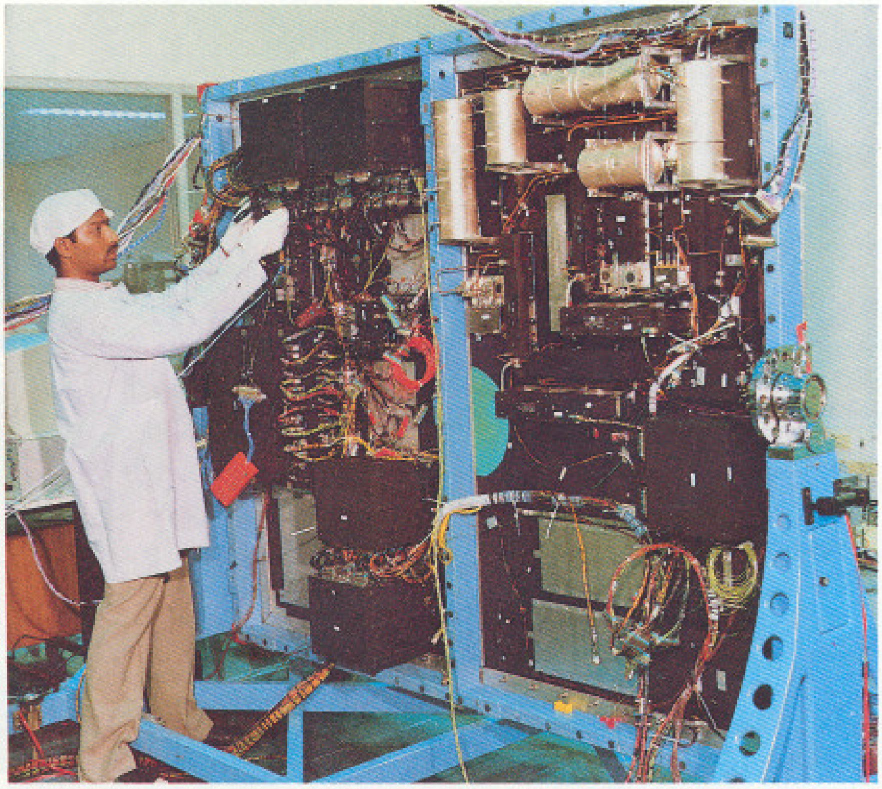
INSAT-2 Structural Model inside Acoustic Test Facility at National Aeronautical Laboratory, Bangalore.

Communication Payload for INSAT - 2

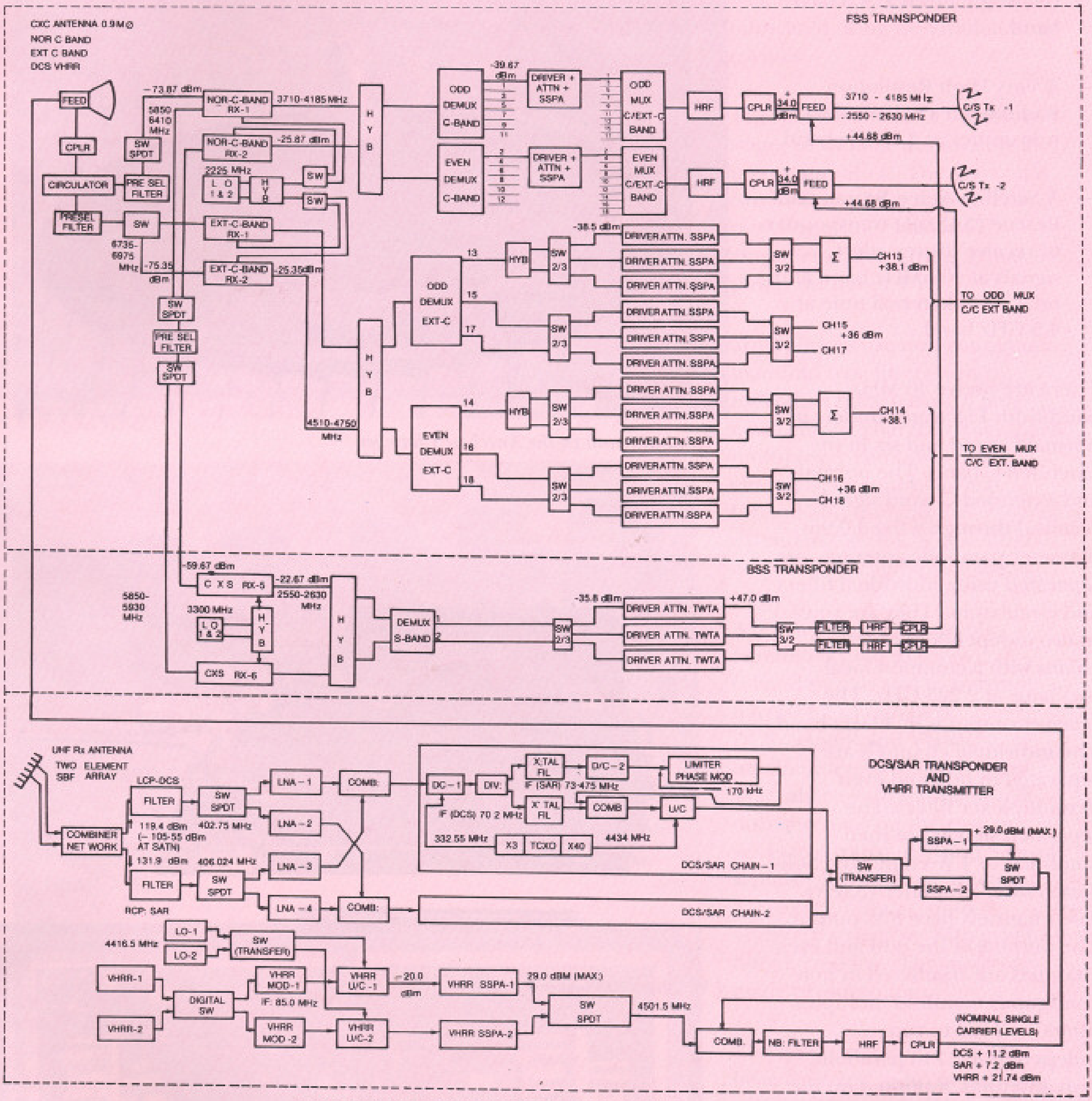
The communication payload for INSAT-2 has been developed by the Space Applications Centre (SAC) of ISRO at Ahmedabad. The Engineering Thermal Model of the payload has already been realised and fabrication of Flight Model is now in an advanced stage.

The indigenously designed and built multipurpose INSAT-2 series of satellites will replace the first generation INSAT-1 satellites by 1993-94. The first test satellite in the series, INSAT-2A, is planned to be launched during 1991-92.

The second generation, INSAT-2, satellites will have both qualitative and quantitative improvements in its communication payload capability compared to INSAT-1.



Electrical Thermal Model of Communication Payload being integrated on the north panel.



BLOCK SCHEMATIC OF INSAT-2 COMMUNICATION PAYLOADS

It also caters to new classes of services. For the first time, the satellite will exploit the upper portion of the C- band frequency, referred to as extended C-band, (4.5-4.8 GHz) besides normal C-band used in INSAT-1. The payload uses advanced solid state power amplifiers. Two of the 18 C-band transponders have higher power to cater to roof-top business communication terminals. A new addition in the communication payload of INSAT-2 is the satellite-aided search and rescue transponder to do the geo-stationary alert function. Another improvement over INSAT-1 is the provision of a fixed C-band antenna to minimise loss of services in the event of any problem in deployment of C/S antennas.

The communication payload for INSAT-2 comprises the following:

— Eighteen Fixed Satellite Service (FSS) transponders in normal and extended C-bands.

— Two Broadcast Satellite Service (BSS) transponders receiving signals in normal C-band and transmitting in S-band.

— A Data Collection System (DCS) transponder receiving data at 402 MHz band and relaying it down at 4.5 GHz band.

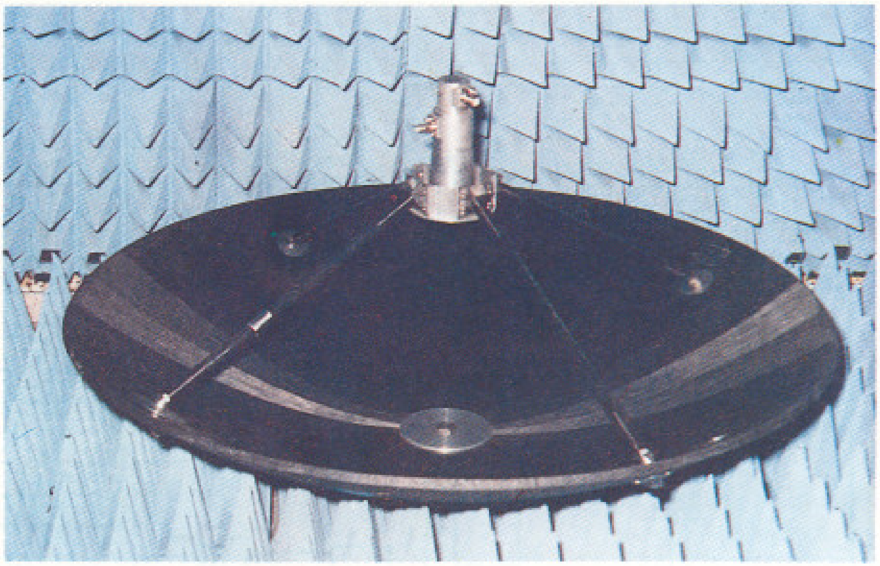
— A Very High Resolution Radiometer (VHRR) data transmitter at 4.5 GHz band.

— A Satellite Aided Search and Rescue (SAS&R) transponder to receive distress alert signals at 400 MHz band and relay it back in real time at 4.5 GHz band.

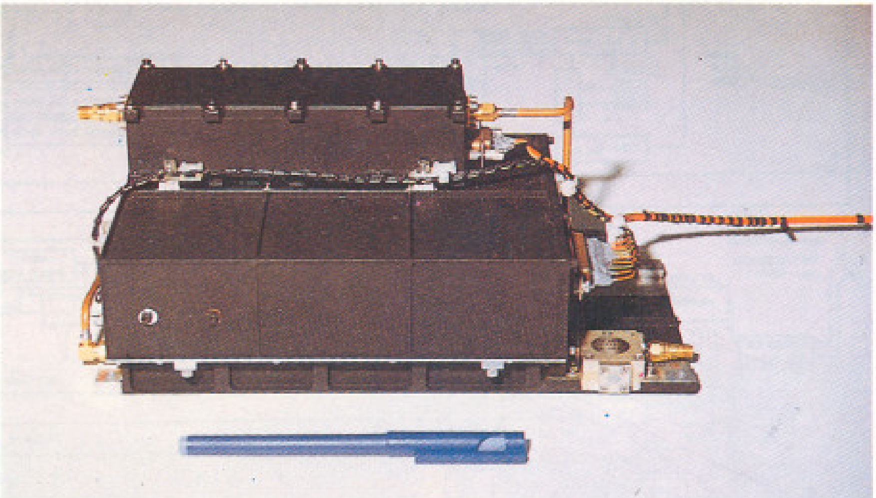
There are twelve 40 MHz bandwidth FSS transponders in normal C-band and six in the extended C-band. The normal and extended C-band signals, received through a fixed 0.9m diameter parabolic antenna, are separated using individual filters and circulators. They are routed to two independent receive chains with a common local oscillator at 2.225 GHz. The receiver output is in 4 GHz band. The individual channels are separated in odd and even demultiplexer filters. The separated signals are then amplified to 4 W employing Solid State Power Amplifier (SSPA). Two channels have 8 W output. The outputs of the odd and even channels are combined in non-contiguous manifold multiplex filters and fed to two independent 1.7 m parabolic dish antennas, mounted on the east and west faces of the satellite.

The C-band receiver consists of Low Noise Amplifier (LNA), down converter, local oscillator and post amplifier. All the stages except the final stage have Ga-As Field Effect Transistor (FET) and the final stage has bi-polar transistors. The receiver has an overall noise figure of 5 dB.

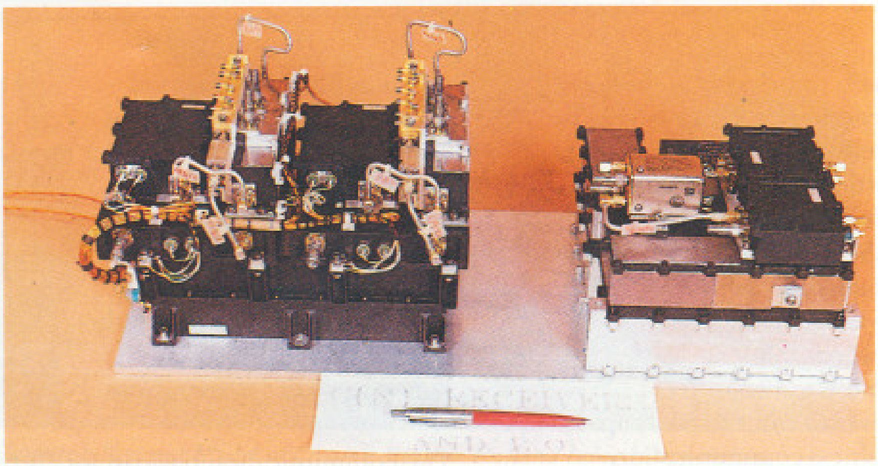
The demultiplexer uses a set of contiguous type, 8-pole, dual mode, longitudinal waveguide



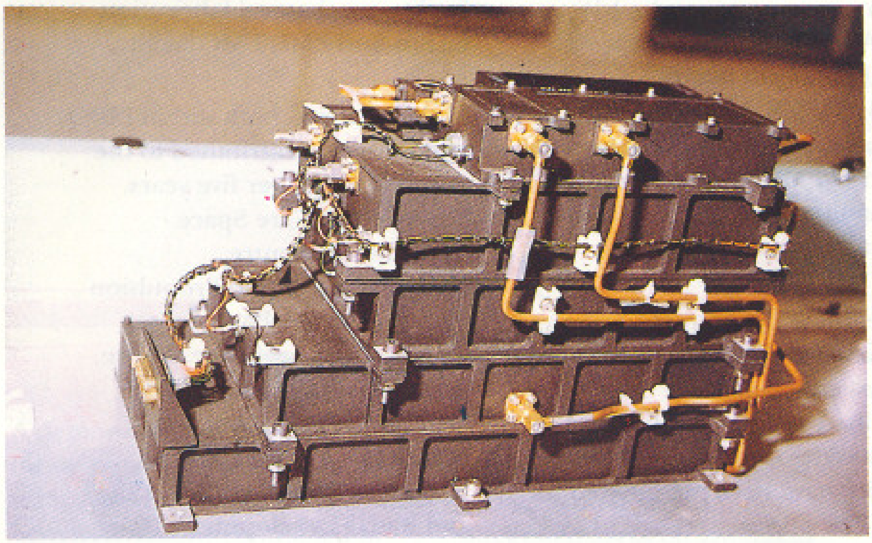
C-band antenna in the Anechoic Chamber.



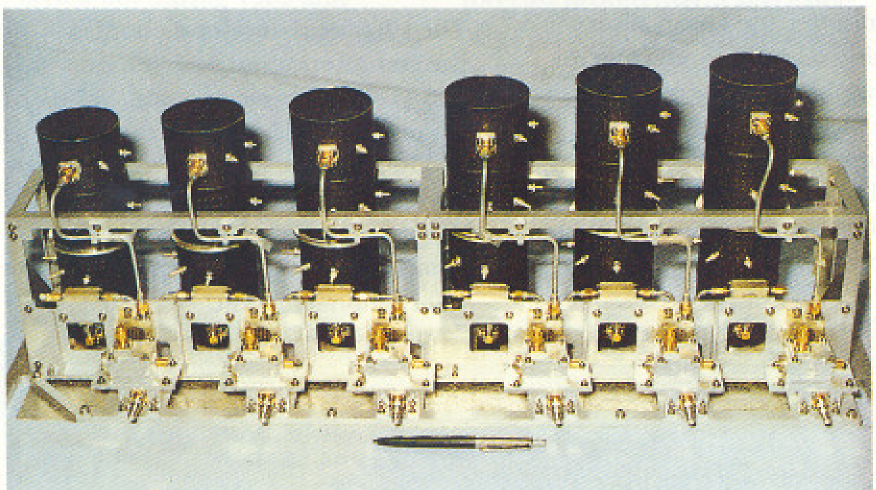
4 W solid state power amplifier.



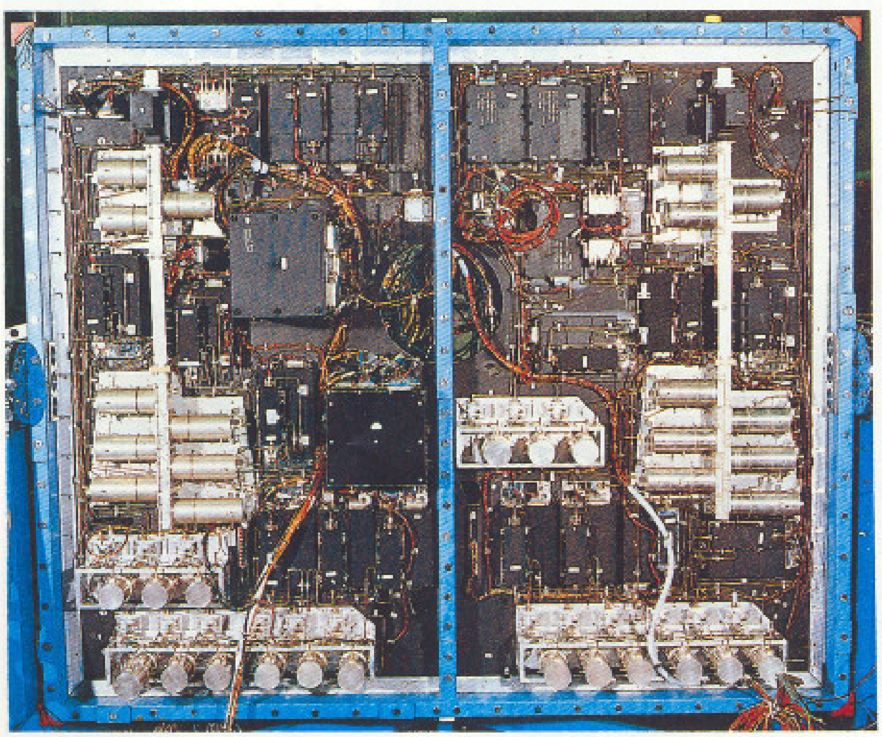
C-band receiver and local oscillator.



DCS and SAS&R Payload.



Invar DEMUX filters.



Communication Payload integrated on the south panel.

filters with quasi-elliptic characteristics. The filters are fabricated using thin-walled invar cavities.

The SSPA consists of driver, two stages of variable attenuators and power amplifier. The driver has two FET amplifier stages. The power amplifier has six FET amplifier stages, giving a final power output of 4 W.

Multiplexers use non-contiguous manifold type filters with individual filter having 6 pole quasi elliptic characteristics. Each multiplexer combines nine channels, six in the normal C-band and three in the extended C-band. These filters are also fabricated using invar.

A 0.9 m diameter parabolic antenna is used to receive all C-band signals and to transmit narrow band signals of DCS/SAS&R and VHRR transponders at 4.5 GHz band. The other two 1.7 m parabolic dish antennas on the east and west faces transmit C and S band signals. All the three antennas are made of honeycomb sandwich structures with graphite fibre face skins. The feeds are made of aluminium.

The BSS transponder for TV broadcast and radio networking consists of two 40 MHz band-width transponders. The uplink is common with the FSS transponder while the BSS signals are separated after LNA in the normal C-band receiver using a hybrid coupler. The signal in S-band is divided into two parts and passed through individual demultiplexer filter, driver amplifier and 50 W TWTA. The output of the TWTA is combined with the C-band signals before transmission through east and west antenna.

The DCS and SAS&R transponders have many common elements between them. The uplinks consist of low level signals at frequencies close to each other, but in opposite polarisations. The signals received at the single element short backfire antenna are passed through a hybrid connected to the cross dipole elements. The Right Circular Polarisation (RCP) and Left Circular Polarisation (LCP) outputs are passed through individual LNA, down converter and narrow band crystal filter in 70 MHz band. The SAS&R signal is further down- converted before feeding to a phase modulator. The modulator output and the IF signal of the DCS chain are fed to a 1 W SSPA after upconversion.

The VHRR transmitter has a modulator at 85 MHz, followed by an upconverter and a 1 W SSPA. The SSPA output is combined with that of DCS/SAS&R SSPA in a 3 dB coupler, passed through a narrow band (12 MHz) filter and then transmitted through the 0.9 m diameter antenna.

In realising the communications payload for INSAT-2, a number of new processes have been qualified and new facilities set up. Besides, some of the existing facility have been augmented. The new processes relate to Microwave Integrated Circuits (MIC), gold plating on aluminium and kovar, silver plating on invar, anodizing on aluminium and thermal painting. The facilities, both new and augmented, include MIC facility, near-field antenna test facility, communication systems laboratory, environmental test facility, mechanical fabrication facility and EMI/EMC facility.

Many agencies, both within ISRO and outside, contributed to the efforts spread over five years. Some of these are Space Applications Centre, Ahmedabad, Liquid Propulsion Systems Centre, Bangalore, Vikram Sarabhai Space Centre, Thiruvananthapuram, ISRO Satellite Centre, Bangalore, Hindustan Aeronautics Ltd, Hyderabad and the Electronics and Radar Development Establishment, Bangalore.

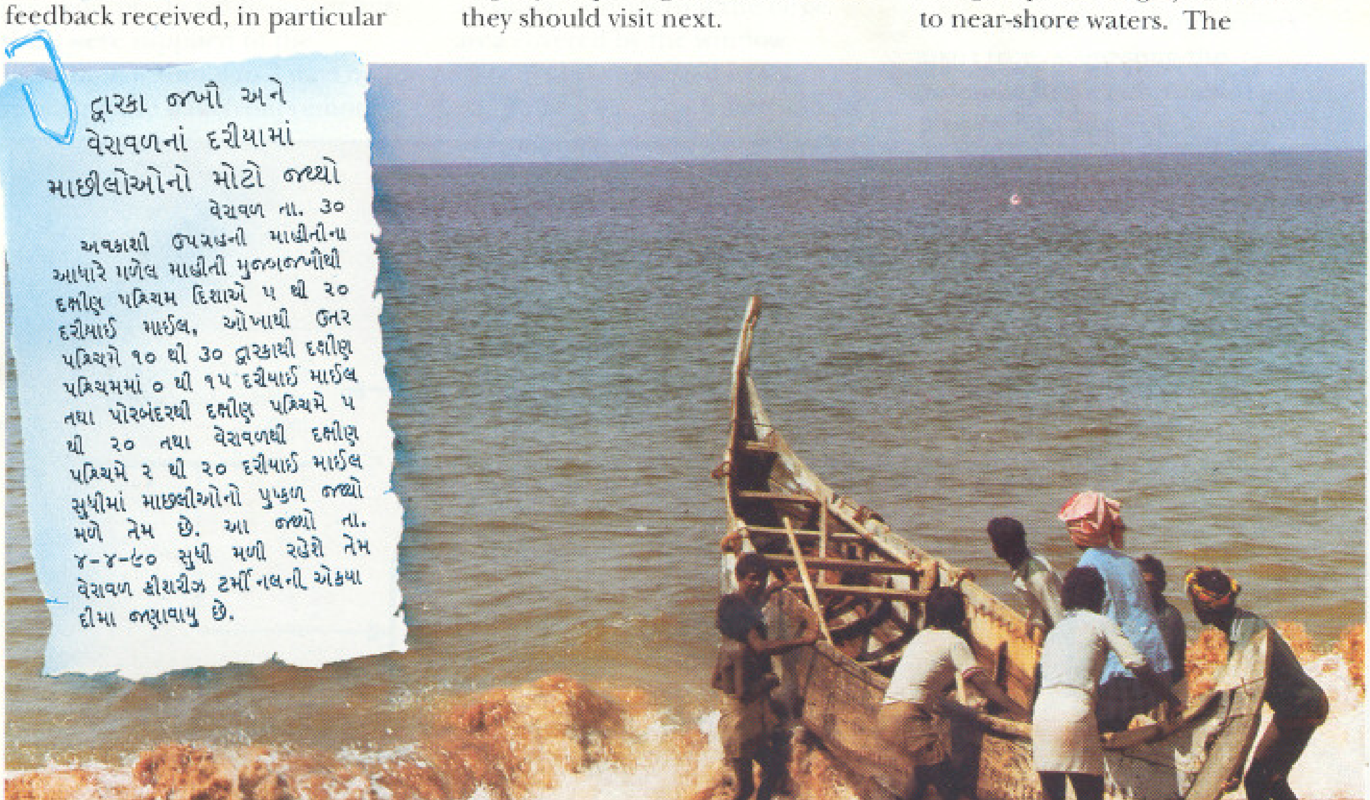
The successful development of the communication payload for INSAT-2 is a major stepping stone for ISRO for taking up production of not only advanced payload systems for the Indian space programme but also for competing in the fast expanding international market. □

Satellite Data for Fish School Location

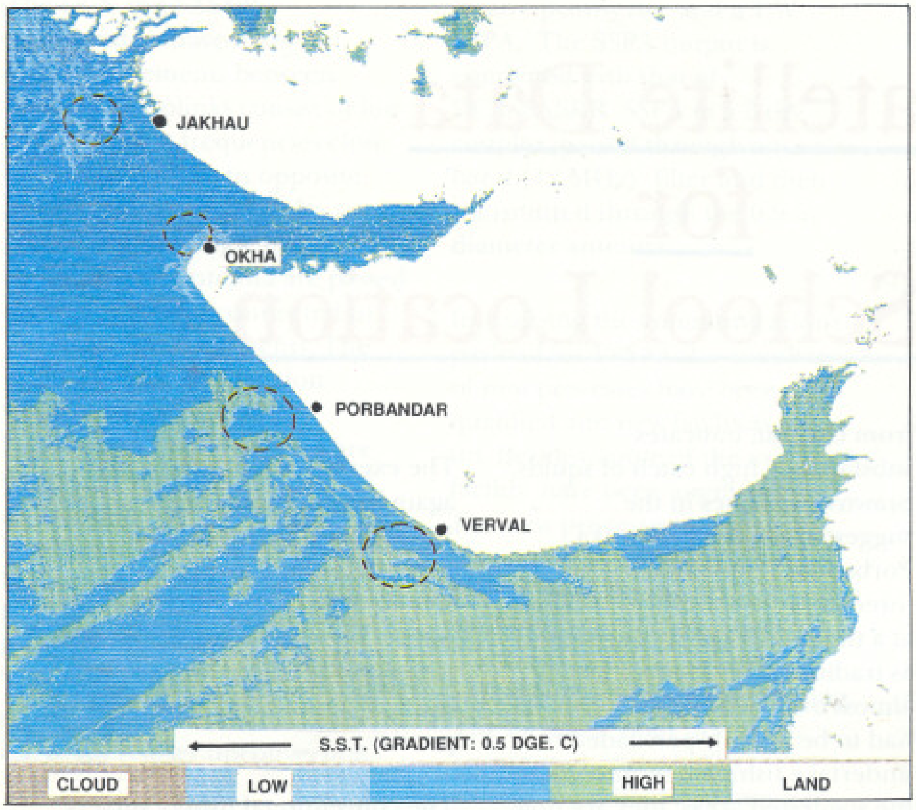
A demonstration project to locate potential fishing grounds using satellite remote sensing has been successfully conducted by ISRO. A validation exercise was carried out during 1989 and information about the potential fishing grounds, based on the mapping of temperature fronts derived from satellite data, was sent to three maritime states, namely, Gujarat, Maharashtra and Andhra Pradesh. The feedback received, in particular from Gujarat, indicates substantially high catch of squids, prawns and fishes in the suggested areas off Dwaraka, Porbandar and Veraval. The forecast proved useful as it came at a time when the fishing season, as traditionally followed, was almost over. Though fishermen had to be initially persuaded to undertake fishing operation in the suggested areas, they are now eagerly enquiring about the areas they should visit next.

The exercise was conducted again for the fishing season 1989-90 and the location of potential fishing grounds was sent to most of the maritime states. The very first forecast sent to Gujarat reported an excellent catch of about 350 kg per boat per day.

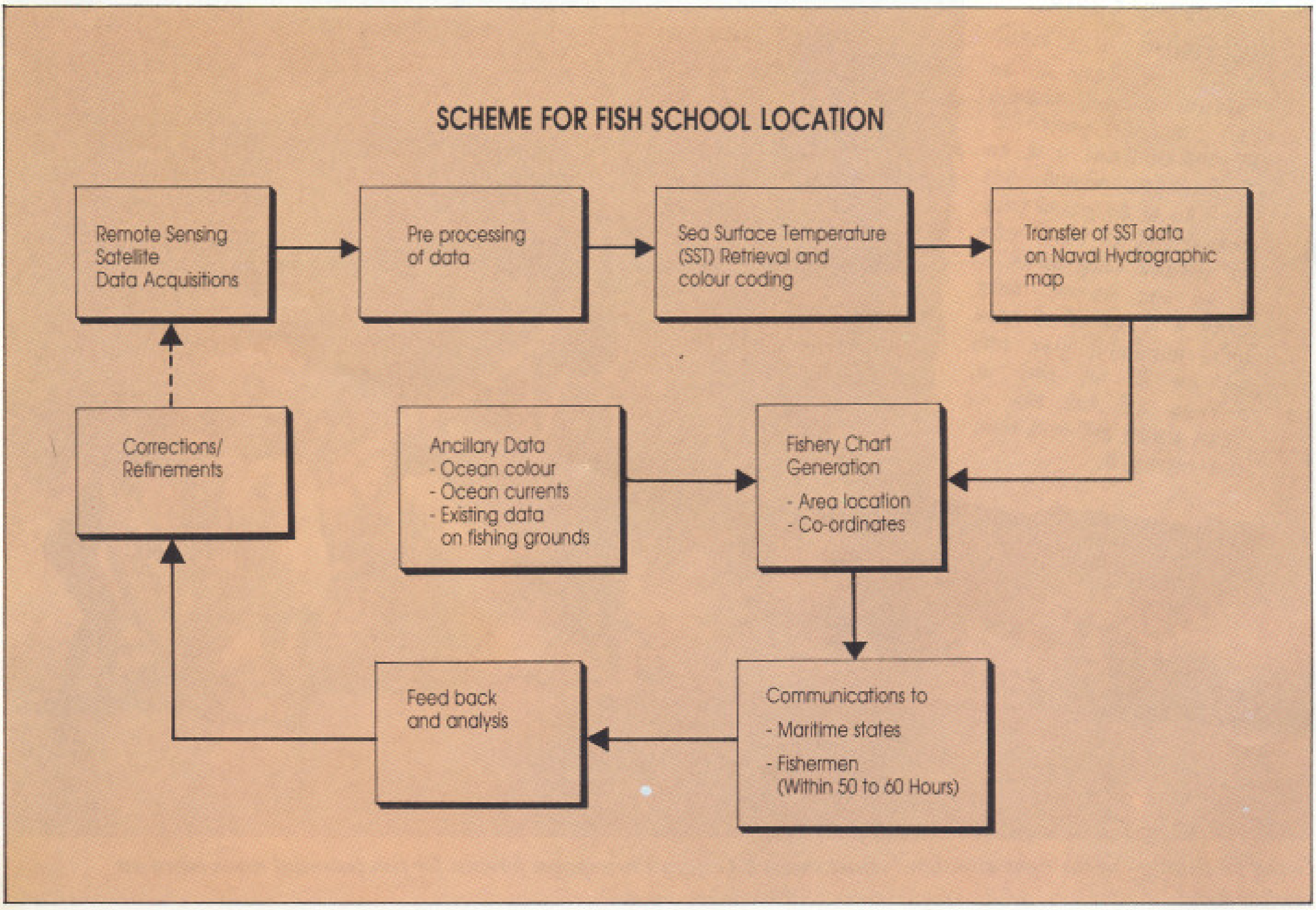
The conventional fishery surveys using ships are largely confined to near-shore waters. The



Going for fishing - in the right direction ! Inset shows a Gujarati newspaper forecast for fish potential areas based on satellite data.



Colour coded fishery map.



conventional techniques cannot provide a synoptic picture of the ocean environment to attempt profitable fishing operation. Techniques have now been developed for determining sea surface temperatures using data from remote sensing satellites such as the Indian Remote Sensing Satellite, IRS-1A, NOAA and Landsat. From the satellite data one can determine the fluctuations in abundance of fish. Under the demonstration project, fish catch data obtained from the Fishery Survey of India was correlated with satellite-based colour-coded sea surface temperature images. In general, high fish catch points are found in the vicinity of temperature fronts and low catch points are away from the fronts in areas with uniform temperatures. The coordinates of potential fishing grounds, predicted from satellite data, were supplied to the fishermen within 2 to 3 days of receiving the data from remote sensing satellites.

The fishery prospect charts were generated by digital analysis and image processing of satellite data using multichannel sea surface temperatures. At present, the satellite data analysis is carried out on a stand-alone, low cost, image processing system - ISROVISION, developed by ISRO and configured around IBM compatible personal computer. The sea surface temperature images were produced at 0.5 degree C interval in the validation exercise. Temperature fronts were marked from the sea surface temperature images on a map. Areas across the fronts having sinuous, meandering patterns, considered as favourable for fish abundance, were identified. The location of potential fishing grounds on the map to within 15 km accuracy was possible. This is a reasonable accuracy considering the large area covered by the window (90x90 km) suggested as fish potential area. The fishery charts were generated on 1:3.5 million scale using the Naval hydrographic map. In addition to area bounds suggested as potential fishing grounds, areas falling in the uniform temperatures and expected to be non-potential were also indicated. The area bounds of selected windows were conveyed to the concerned agencies, namely, Fishery Survey of India, Central Marine Fisheries Research Institute and all the maritime states for follow-up operations.

It is planned to operationalise the project and extend the services to all maritime states. It is also planned to reduce the time lag between reception of satellite data and making available the forecast to users to less than a day using faster communication techniques like facsimile transfer.

In the next phase of the project, apart from suggesting the potential fishing grounds, it is proposed to attempt quantification of the fish catch. □

Inaugural address by Prof. U. R. Rao, Chairman, ISRO.

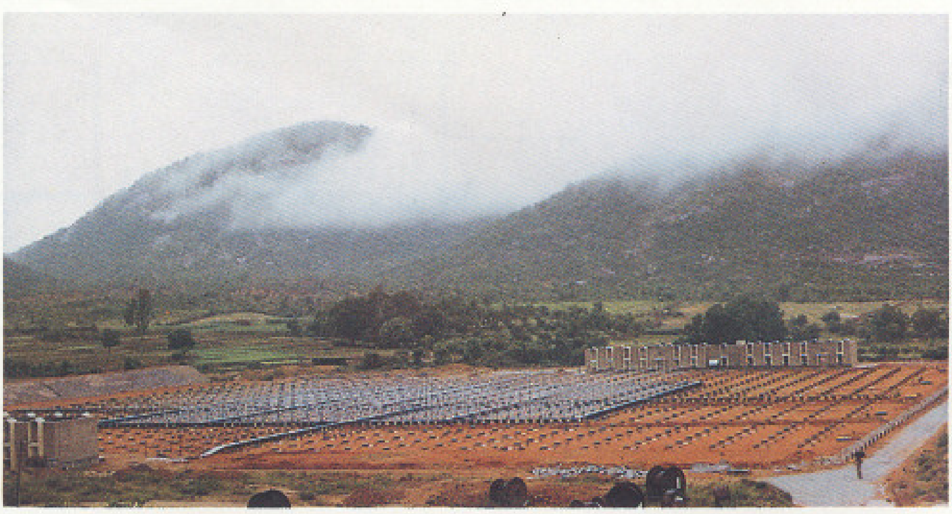
MST Radar Inaugurated

The Mesosphere, Stratosphere and Troposphere (MST) Radar was inaugurated by Prof U.R.Rao, Chairman, ISRO on October 29, 1990 at Gadanki village near Tirupati in Andhra Pradesh. The establishment of this national facility is an important step in advancing the progress of atmospheric research in the country. The facility is jointly funded by the Department of Electronics, Defence Research and Development Organisation, Department of Science and Technology, Department of Environment and Council of Scientific and Industrial Research besides the Department of Space which is the nodal agency.

The Society for Applied Microwave Electronics Engineering Research, Bombay is the prime contractor for the Radar. The MST Radar will be available to all the scientists working in any university/scientific institution in the country.

MST Radar will be used for the study of atmospheric dynamics, atmospheric turbulence and diffusion measurement, study of atmospheric pollutant dispersion, detection of wind shear, cloud physics, etc. MST Radar is a high power, coherent, pulse Doppler Radar operating in VHF band and is capable of probing different regions of the atmosphere (see Space India 2/87 for details). The Radar is currently operational in the Stratosphere-Troposphere mode. The Mesosphere mode is expected to be operational in about a year.

On the eve of the inauguration of the Radar, an international workshop was also organised in which experts from Sweden, Peru, Japan and U.K. participated besides India. Dr.A.P.Mitra, Director General, Council of Scientific and Industrial Research, delivered the keynote address. □



A view of MST Radar at Gadanki near Tirupati.

Geosphere-Biosphere Programme Initiated

A Geosphere-Biosphere programme with themes related to minor constituents, land-air interactions, ocean-atmosphere interactions and climate modelling has been initiated by ISRO. The first phase of the programme will be for a period of six years.

As part of this programme, a 1,00,000 cubic metre, high altitude balloon carrying diffusion and spherical probe payloads, was launched at 0535 hours on December 22, 1990 from Hyderabad. The diffusion payload consisted of canisters with titanium tetrachloride, methanol and water. The canisters were burst open at different altitudes and the traverse of the chemical puffs photographed from Hyderabad, Nagarjuna Sagar and adjacent areas. The results of the experiment are being analysed for the study of transportation of pollutants in the stratosphere, wind profiles, electrodynamics and the processes of energy transfer from sun to earth.

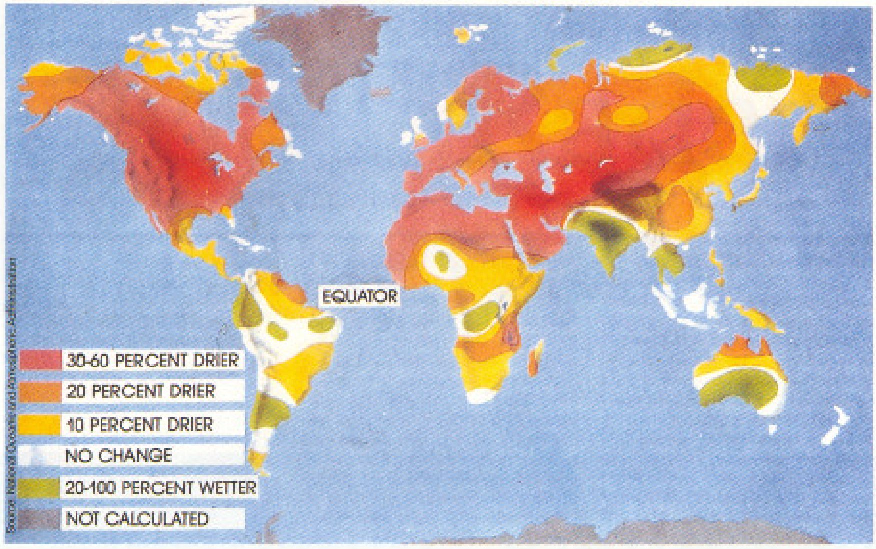
There has been a growing concern about the global environment in recent times, especially its possible degradation due to increasing human influence. The impact of anthropogenic activities is likely to result in global warming, reduction in ozone levels, adverse effects on ecosystems and large scale climatic changes. The environment of earth in its present form, is the result of continuous evolution over millions of years through interaction of physical, chemical and biological processes. While the technological capabilities of human beings in recent years have given rise to tremendous possibilities to understand and exploit the environment, the present pace and scale of industrial activities have given rise to serious concerns about their adverse impact on the global environment. The implications of such effects on our planet and its fragile atmosphere raise the question of sustainability of human race in the long run. The problem is compounded by the growing population and economic disparities around the globe.

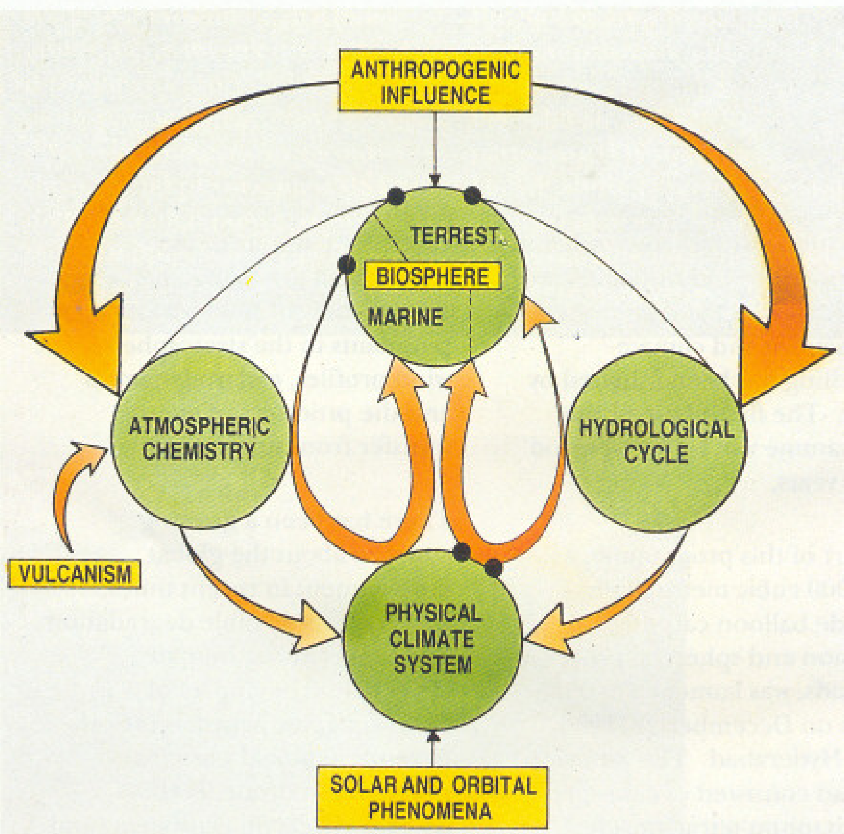
Considering these aspects, the United Nations, under the aegis of International Council of

Scientific Unions, initiated International Geosphere Biosphere Programme (IGBP) in 1986 to "understand the interactive physical, chemical and biological processes that regulate the total earth system and its unique environment to sustain life and the possible impacts of human interactions and anthropogenic effects". IGBP has, as one of its main objectives, generation of concrete recommendations regarding human econo-cultural practices so as to minimise/avert any disastrous consequences. Examples include reducing the emission of carbon monoxide and other greenhouse gases to avert global warming and avoiding the use of Chloro Fluoro Carbons (CFC's) and other ozone-destroying gases so as to prevent penetration of harmful ultraviolet radiation.

India, with its diverse environmental conditions and ecological systems and with its economy closely linked to the monsoon performance, has several urgent problems which need to be addressed. Drought, flood, deforestation, pest infestation, land degradation, etc, are linked with the weather and climatic changes on the one hand and the environmental and ecological effects and interactions on the other. In order to mitigate these problems, it is necessary to have information on the various processes related to atmosphere and earth resources. With the increasing population and consequent pressure on various resources, it becomes imperative to take up studies on regional processes and their linkages with the global processes. For example, it is necessary to know the Pacific ocean temperature anomalies, pressure anomalies over the southern hemishere, etc, to forecast the monsoon

GREEN HOUSE FUTURE: WET AND DRY



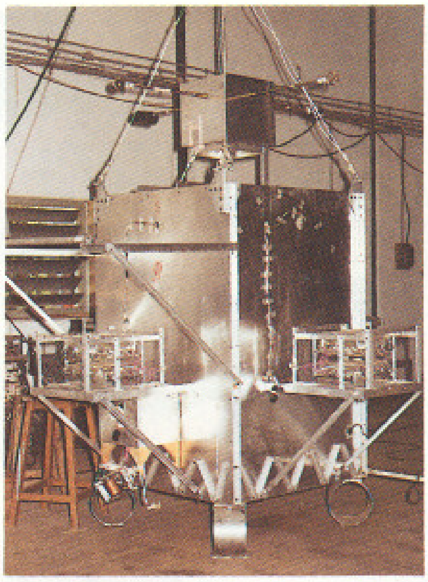


GEOSPHERE-BIOSPHERE INTERACTIONS

performance over India. But the monsoon itself may be affected by large scale deforestation, albedo changes, greenhouse gases, etc.

ISRO has, over the years, set up a number of facilities relevant to the study of global changes and has acquired the capability for reception and analysis of data from space-based observation systems such as IRS, INSAT and NOAA satellites. Major programmes have been managed by ISRO which are relevant to the study of changes in forest cover, vegetation index, albedo, marine productivity, soils, hydrology, etc. They include National Natural Resources Management System (NNRMS), Indian Middle Atmosphere Programme (IMAP), Mesosphere, Stratosphere and Troposphere Radar (MST) and Sponsored Research programme (RESPOND). Balloon borne measurements of aerosols and boundary layer structure have been conducted. Efforts in climate modelling which can be tuned suitably to the study of local/global changes, have also been initiated.

Specific projects identified under the ISRO Geosphere-Biosphere programme include studies in climate modelling and sensitivity, atmospheric minor constituents and aerosols, land-air-ocean interactions and past climate using ground, balloon and space-based experiments in co-ordination with other scientific institutions in the country. □



Integrated Balloon Payload.

Spherical Probe.

ISRO – Bharat Electronics Co-operation

Shri. N. Pant, Dy. Chairman, ISRO handing over Technology Transfer documents of PSLV to Wing Comm. Menon (right), Executive Director, B E.

September 27, 1990 was an eventful day for the ISRO - Bharat Electronics co-operation programme. On that day Shri N. Pant, Deputy Chairman, ISRO handed over to Space Electronics Division (SED), Bharat Electronics (BE), the technology transfer documents for fabrication of electronics packages for ISRO's PSLV class of launch vehicles. This is a recognition of the success of ISRO-BE co-operation programme for fabrication of complex space hardware. The day also coincided with the fourth anniversary of the formal inauguration by Prof.U.R.Rao, Chairman, ISRO, of the new

Inspection of wired assemblies after conformal coating.

Servo System for antenna pointing.

complex of the Space Electronics Division of BE,

The initiative taken by ISRO for co-operation with Indian industry has not only resulted in a steady growth in the volume of work handled by the industries for the space programme, but also in upgradation of the technologies. The co-operative efforts between ISRO and industry involve the transfer of advanced technologies developed by ISRO on the one hand and utilisation of industry's own technological potential and expertise for the space programme on the other. Premier industries in the field of aeronautics, communications and electronics have since started setting up their own specialised divisions and exclusive manufacturing lines for the space products. These include motor cases for rockets, spacecraft structures, electronic packages, etc.

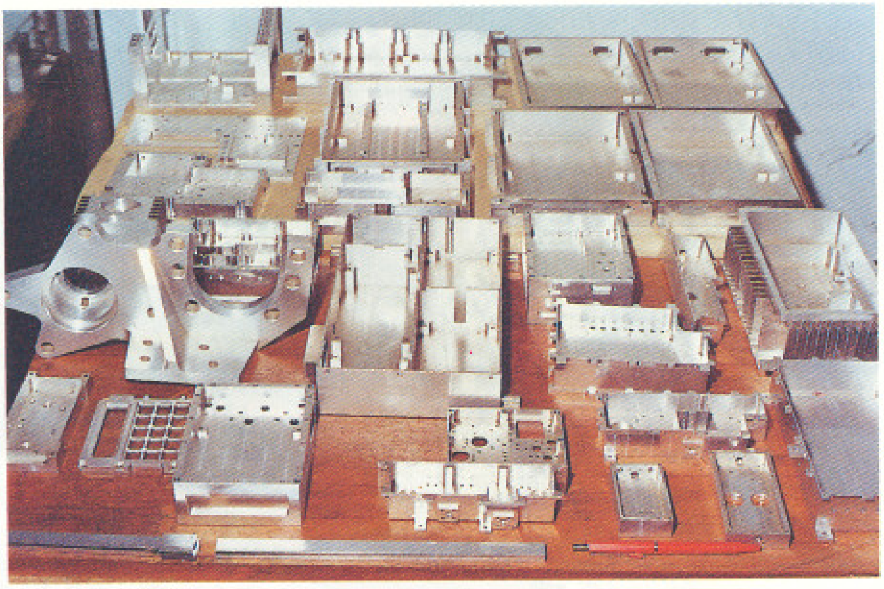
Bharat Electronics is a premier industry in the public sector for the manufacture of electronics systems. BE evinced keen interest for co- operation with ISRO and established its Space Electronics Division in

1982, to meet ISRO's requirements exclusively.

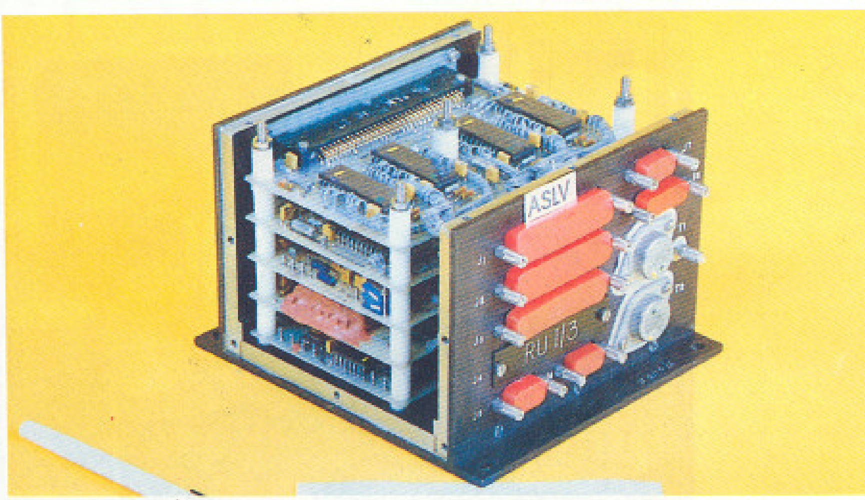
In the first year itself, SED supplied space hardware worth about Rs 24 lakhs to ISRO. Within two years, SED moved to a new complex with sophisticated facilities for high quality and high reliability electronics. The work force increased from 30 to more than 100 persons. Since then the production in terms of both volume and value has been steadily increasing.

During 1985, ISRO placed order on SED for producing a number of systems for ISRO Telemetry, Tracking and Command ground stations based on the technology transferred from ISRO. These included servo systems for antenna pointing, PCM decommutators, VHF telemetry receivers, tracking receivers, time code generators, reader and display units, count down readers, C-band up and down converters, TV modulators, demodulators, etc. SED has reengineered the ISRO designs for volume production and prepared good documentation for operation and maintenance. These equipment are extensively used in launch campaigns and for pre-launch and post-launch data analysis.

SED has further augmented its infrastructure to take up production of flight packages for satellites and launch vehicles. ISRO and SED jointly evaluated and qualified the facilities for flight packages production and SED is supplying regularly flight packages for the Rohini Sounding Rockets of ISRO. The products include FM telemetry flight packages such as voltage controlled oscillator, voltage regulator, pre-amplifier, interstage digital timer, magnetic aspect sensor, PAM commutator,



CNC milled boxes for electronic packaging.



PCM remote unit for ASLV fabricated by SED.

CNC Machine Centre.

Bonded Stores.

Space Electronics Division complex of Bharat Electronics, Bangalore.

telecommand decoder and tone range receiver.

In 1989, SED produced more than 400 packages for ASLV programme including PCM remote unit, telecommand decoder, tone range receiver, signal conditioner and power module. SED also produced DC-DC converters for INSAT-2 spacecraft.

Quality and reliability aspects are regularly discussed between ISRO and SED for improvement. The wiremen and inspectors of SED undergo special training at ISRO's soldering school for handling space products. Any new process is introduced only after critical analysis jointly by ISRO and SED and the production documents are changed appropriately.

Over the years, bonded stores, mechanical fabrication shop, PCB inspection facility, etc., have been added to SED to take up independently production of electronic packages from parts to subsystem level.

Thus, the ISRO-BE co-operation has demonstrated the viability of the Indian electronic industry to take up high-technology production such as space hardware. The handing over of technology transfer documents to SED for the production of complex electronic packages for PSLV affirms ISRO's policy of farming out the production of space hardware to Indian industry. □

XXXXI. CONGRESS OF THE IAF

6-13 OCTOBER 1990 DRESDEN GDR

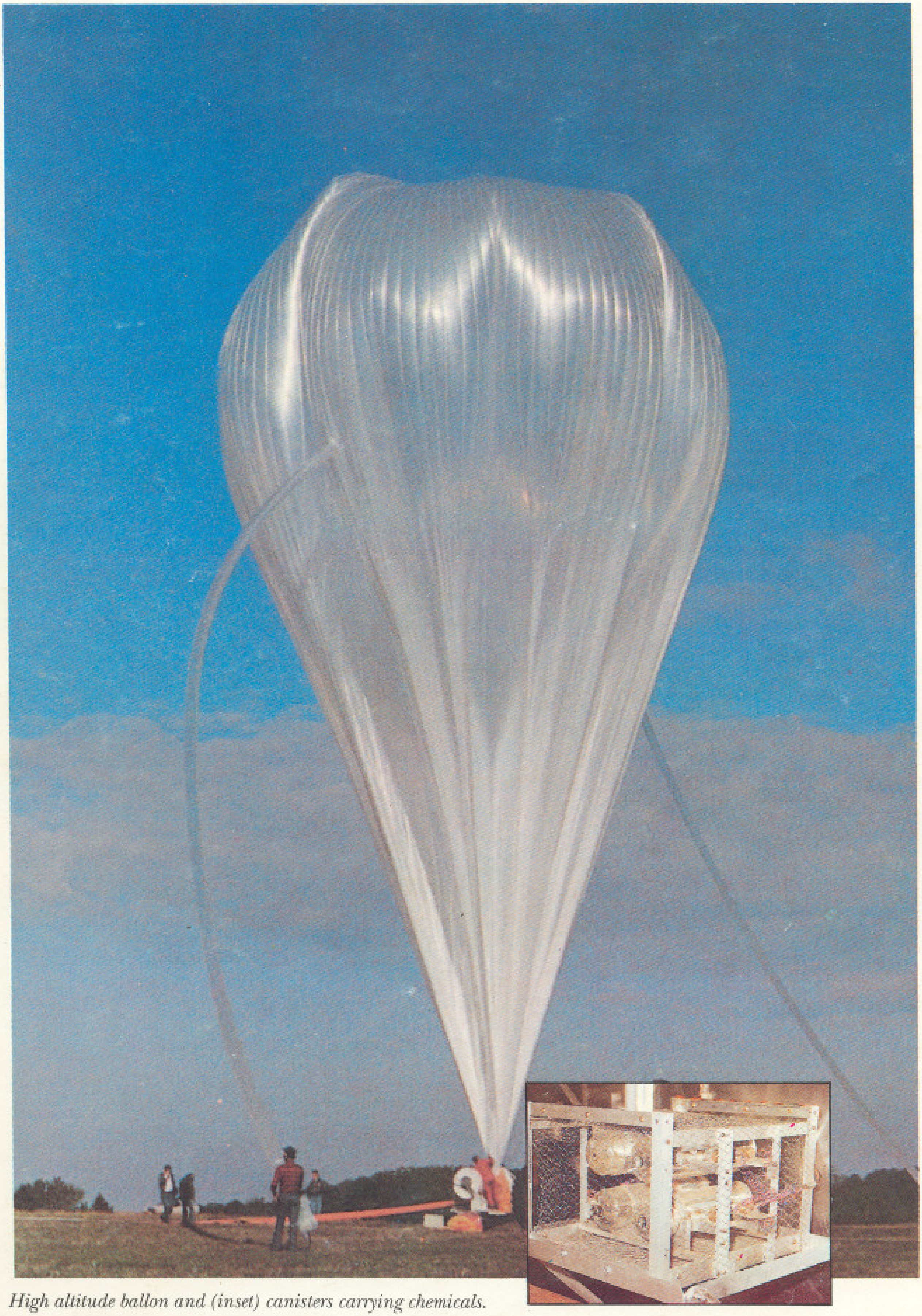
41st IAF Congress held at Dresden, Germany

The 41st Congress of the International Astronautical Federation (IAF) was held from October 6 to 12, 1990 at Dresden, Germany. The main theme of the Congress was 'Space for Peace and Progress'. The Congress was hosted by the Society for Space Research and Astronautics of Germany. More than 400 papers were presented during the Congress.

Under the aegis of the Committee for Liaison with International Organisations and Developing Nations (CLIODN), a special Current Event Session for developing countries was conducted with the theme Space and Forest Management. Experts from China, Jamaica and Nigeria presented papers on the theme. ISRO Chairman Prof.U.R.Rao, Vice President of IAF, and Chairman CLIODN, made several important suggestions during the session for enabling wider participation from developing countries. As suggested by CLIODN, the United Nations will be holding a special workshop on priority areas of application of space technology for developing nations, in Montreal in co-operation with the Canadian Government just prior to the next IAF Congress to be held there. □

Palace of Culture - Venue of 41st IAF held at Dresden, Germany.

Single Element Yagi array for MST Radar



High altitude ballon and (inset) canisters carrying chemicals.