WORLD OF WORK SERIES

CAREERS IN SPACE TECHNOLOGY

CAREER STUDY CENTRE
CENTRAL INSTITUTE FOR RESEARCH AND TRAINING
IN EMPLOYMENT SERVICE (D.G.E. & T.)
MINISTRY OF LABOUR
PUSA, NEW DELHI - 110012

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CAREERS IN SPACE TECHNOLOGY

1. Introduction

1.1 India has an impressive arrary of achievements in the development and application of space technology in vital areas such as telecommunications, television broadcast, disaster warning, meteorological services and for providing information related to natural resources, agriculture, forestry, water resources ocean and marine resources, minerals and environmental monitoring. Reliable and substained operations in space of many Indian-built satellites, IRS and INSAT series, stand testimony to the technological excellence achieved in this field by the Indian Space Research Organisation (ISRO). Significant progress made in the realisation of launch vehicle technology through successful launch of PSLV represents yet another complex feat in realising the rockets needed for launching satellites.

1.2 India embarked on its ambitious space programme under the leadership of Prof. Vikram Sarabhai who is known as the father of the Indian Space Programme after his untimely demise in 1971. The space activities were reorganised. Later, the mantle of leadership fell on Prof. S. Dhawan who became the Chairman, Space Commission/Secretary, Department of Space and Chairman, Indian Space Research Organisation in 1972. On his retirement in 1984 Prof. U.R. Rao succeeded him. With Prof. Rao's retirement, Dr. K. Kasturirangan has assumed the leadership since 1994.

2. Organisational Setup

2.1 In 1972, the Government of India established the Space Commission and the Department of Space (DOS) for providing space services, in a self-reliant manner. The space programme is quite broad in scope with its activities ranging from development of space launch systems and sophisticated satellites, their operations in-orbit, to the conduct of extensive applications oriented research and execution of large scale application missions. The programme is integrated to realise operational and practical applications with emphasis on achieving self-reliance.

2.2 ISRO and DOS, play a key role, through centres/units in planning and execution of national space activities. The DOS also supports three grant-in-aid institutions/autonomous bodies viz., the Physical

Research Laboratory at Ahmedabad, the National Mesosphere-Stratosphere-Troposphere Radar Facility near Tirupathi and the National Remote Sensing Agency at Hyderabad.

3. Space Centres and Units

3.1 **Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram,** is the lead centre providing technology base for satellite launch vehicle development. It is the pioneer in planning and execution of launch vehicle projects. The Space Physics Laboratory and an Inertial Systems Unit also functions under the umbrella of VSSC.

3.2 **ISRO Satellite Centre (ISAC), Bangalore,** is responsible for the design, fabrication, testing and management of satellite projects for scientific, technological and application missions. A laboratory for Electro-Optic Sensors has also been established here.

3.3 **Space Applications Centre (SAC), Ahmedabad,** is the research and development centre for conceiving, organising and building satellite-payload systems for applications of space technology in areas such as satellite communications, broadcasting, remote sensing, meteorology and geodesy.

3.4 **SHAR Centre, Sriharikota (SHAR),** located on the east coast of Andhra Pradesh, is the main launch complex with rocket launching facilities. SHAR also undertakes large scale production of solid rocket propellant as well as ground testing of solid fueled rocket stages of launch vehicles.

3.5 **Liquid Propulsion Systems Centre (LPSC),** with its facilities located at Thiruvananthapuram, Bangalore and Mahendragiri (near Nagercoil) undertakes design, development and testing of liquid propulsion systems for launch vehicle and satellite projects.

3.6 **Development and Educational Communication Unit (DECU),** Ahmedabad, is involved in conception, definition, planning and socio-economic evaluation of space applications programmes, besides programme production with themes of developmental and educational oriented communications.

3.7 **ISRO Telemetry, Tracking and Command Network (ISTRAC),** with its headquarters and Spacecraft Control Centre at

Bangalore and a network of ground stations at Bangalore, Lucknow, Car Nicobar, Sriharikota, Thiruvananthapuram and Mauritius, provides telemetry, tracking and command (TTC) ground support for launch vehicle and satellite missions as well as in-orbit operations of low earth orbiting satellites.

3.8 **INSAT Master Control Facility at Hassan (MCF)** is responsible for all post launch operations of INSAT satellites including orbital manoeuvers, station-keeping and in-orbit operations.

3.9 **Physical Research Laboratory (PRL),** Ahmedabad is a premier national centre for research in space and allied sciences and in autonomous institution supported by the DOS. It is also entrusted with the management of the Udaipur Solar Observatory. Astronomy and astrophysics, planetary atmosphere and aeronomy, earth sciences and solar system and theoretical physics are the major areas of work.

3.10 **National Remote Sensing Agency (NRSA),** Hyderabad is an autonomous institution supported by the DOS, responsible for acquisition, dissemination and archiving data from remote sensing satellites and application of remote sensing technology for harnessing natural resources. NRSA also provides training through the Indian Institute of Remote Sensing at Dehra Dun.

3.11 **National Mesosphere, Stratosphere & Troposphere Radar Facility (NMRF),** Gadanki (near Tirupati) is an autonomous national facility for conducting atmospheric research.

3.12 Amongst other units, five regional remote sensing centres located at Bangalore, Dehra Dun, Jodhpur, Kharagpur and Nagpur are the prominent ones.

4. Objectives

4.1 The primary objectives of the Indian Space Programme is to establish operational space services in a self-reliant manner. The main thrusts of the programme are :

- Satellitebased communication for various applications including broadcasting.

- Satellite-based resources survey and management and environmental monitoring.
- Meteorological applications and disaster warning systems.
- Development and operationalisation of indigenous satellites, launch vehicles and associated ground segment for providing these space-based services.

4.2 The indigenous development of application satellites, their payload and the capability to launch and operate these satellites is integral to these objectives.

5. Glimpses of Achievements

5.1 **Indian Space Programme** began with the launching of first Indian rocket from Thumba Equatorial Rocket Launching Station near Thiruvananthapuram, in 1963. Mastering the rocket technology through SLV, ASLV, PSLV and GSLV has been a continuous saga. Concurrently, efforts were on to develop, build, launch and operate our own satellites. Major achievements of ISRO are briefly explained as follows :

5.2 **Satellite Instructional Television Experiment (SITE),** hailed as one of the world's largest experiments of its kind, was conducted during 1975-76 using USA's Application Technology Satellite (ATS-6). It demonstrated the potential of satellite technology as an effective mass communication media for India.

5.3 **Satellite Telecommunication Experiments (STEP),** conducted during 1977—79 using the Franco-Geman satellite, symphonie, provided experience in the operation of geo-stationary satellite system for domestic telecommunication and in designing and building ground infrastructure.

5.4 **ARYA BHATA,** the first Indian built satellite, was launched on April, 19, 1975, on-board the USSR Intercosmos rocket into a near earth orbit for conducting scientific experiments in space and gain experience in design, fabrication and operation of a complete satellite system. It carried, three payloads, one each for X-ray astronomy, solar physics and aeronomy.

5.5 **Bhaskara-I and Bhaskara-II,** earth observation, satellites, were built and launched on June 7, 1979 and November 20, 1981,

respectively, both by the Intercosmos rockets of USSR. Each satellite carried two TV cameras, one in visible and the other in near-infrared band, and a 3-frequency passive microwave radiometer, heralding an era of remote sensing satellites.

5.6 **APPLE,** (Ariane Passenger Payload Experiment), an experimental geostationary communication, satellite, was built and launched on June 19, 1981 by the ARIANE lauch vehicle of the European Space Agency (ESA). Used for conducting several communication experiments, it opened up possibilities towards designing and building INSAT class of satellites.

5.7 **Rohini Series** of technological/scientific satellites were designed and developed for launch by the Indian satellite launch vehicle, SLV-3. While the first Rohini satellite was used to measure the performance of the launch vehicle, the second and third satellites carried landmark sensor payloads. Two Stretched Rohini Series satellites, SROSS-C and SROSS-C2, were launched by India's Augmented satellite Launch Vehicle (ASLV) on its third and fourth developmental flights of ASLV-D3 and ASLV-D4 on May 20, 1992, and May 4, 1994, respectively. Both the satellites provided good platform for scientific explorations through the scientific payloads, namely, Retarding Potential Analyser and Gamma Ray Burst Experiment.

5.8 **SLV-3 :** launched on July 18, 1980 demonstrated India's capability in the launch vehicle technology by placing 40 Kg Rohini satellite into a near-earth orbit. The 22.7 m tall SLV-3 was an all-solid four stage vehicle with a lift-off weight of 17 tonne. Two more Rohini satellites were launched by SLV-3 on May 31, 1981 and April 17, 1983.

5.9 **ASLV** : The Augmented Satellite Launched Vehicle (ASLV) was successfully launched twice from Sriharikota Range (SHAR) on, May 20, 1992 and May 4, 1994. ASLV injected SROSS-C and SROSS-C2 satellites into a near earth orbit. ASLV, 23.5m tall, was a five-stage, solid-propellant launch vehicle, capable of putting 150kg class payloads in near-earth orbit. Intended for proving several technologies required for PSLV and GSLV missions, all the objectives of ASLV programme have since been realised.

5.10 **PSLV :** The 280 tonnes, 44 m tall, Polar Satellite Launch Vehicle (PSLV), is capable of putting 1,000 kg class satellite into 900 km

polar sun-synchronous orbit. The vehicle has four stages. The first stage is a 2.8 m diameter, 125 tonne, solid propellant motor at the core with six motors, derived from SLV-3, strapped around it. The 2.8m diameter second stage is based on the liquid engine technology and uses 37.5 tonnes of liquid propellant. The third stage is a 7.2 tonne solid propellant motor and the fourth stage is again a liquid propellant stage with 2.0 tonne of propellant. A closed-loop guidance system with on-board processor is employed for the vehicle. The first developmental flight of PSLV took place on September 20, 1993. Though it could not place the IRS-1E satellite, on-board, into the intended polar orbit, it proved in flight almost all the sub-systems. The second and third developmental launches, PSLV-D2 on October 15, 1994, and PSLV-D3 on March 21, 1996 successfully placed the IRS-P2 and IRS-P3 satellites in the desired polar sunsynchronous orbit. Continuation flights of PSLV will fly advanced technological satellites for remote sensing and for scientific experiments.

5.11 Successful completion of the above mentioned projects enabled our country to embark on a satellite era. Culminating from this, two major national satellite systems evolved, the INSAT system (Indian National Satellite System) and the IRS system (Indian Remote Sensing Satellite System).

5.12.1 **INSAT :** The Indian space programme began providing vital services to the nation with the commissioning of the multipurpose geostationary satellite, INSAT-1B in August 1983, for telecommunication, TV broadcast and meteorological applications. INSAT is a joint venture of the Department of Space, Department of Telecommunications, India Meteorological Department, All India Radio and Doordarshan. INSAT-1 satellites, designed by ISRO and procured from abroad, carried 12 C-band telecommunication transponders, two high-power S-band TV broadcast trasnponders, a Very High Resolution Radiometer (VHRR) for meteorological earth imaging and a data relay transponder for relay of meteorological, hydrological and oceanographic data from unattended land and ocean-based platforms. INSAT-1D, launched on June 12, 1990, is the last of the INSAT-1 series.

5.12.2 The second generation INSAT-2 series of satellites are designed, developed and built indigenously. These have 50 per cent higher capacity and better capabilities compared to the first generation

INSAT satellites (INSAT-1). The first satellite in the series, INSAT-2A, was launched on July 10, 1992 the second, INSAT-2B, on July 23, 1993, both from Korou in French Guyana on-board the European launch vehicle, Ariane. These two satellites carry, on-board, 12 C-band and six extended C-band telecommunication transponders, two high-power S-band TV broadcast transponders, a VHRR instrument with better resolution than that on-board the INSAT-1, a data relay transponder for relay of meteorological, hydrological and oceanographic data from unattended platforms and a transponder for satellite-aided search and rescue operations. Third and fourth satellite in INSAT-2 series, INSAT-2C and INSAT-2D, were launched on December 7, 1995 and June 4, 1997 with better capabilities such as Ku-band transponders. All the three satellites are now providing the required services. One more satellite in the INSAT-2 series INSAT-2E is being built for launch in 1998. 36 Mhz equivalent units of C-band transponder capacity on INSAT-2E will be leased to International Telecommunications Satellite organisation, on commercial considerations. On-orbit control, health monitoring and maneuvers of INSAT are done from the ground station at Master Control Facility at Hassan.

5.13.1 **IRS :** The launch of the first operational Indian Remote Sensing Satellite, IRS-1A, on March 17, 1988, on-board a Soviet Vostok rocket, ushered in a new era in the country's resources survey and management system. The second satellite in the series. IRS-1B, identical to IRS-1A, was launched on August 29, 1991. IRS-1C, the third satellite in IRS-1 series, with better capabilities than IRS-1A/1B, in terms of spatial resolution, spectral band stereo imaging was launched on December 28, 1995, on-board Soviet Vostok rocket IRS-1C has an improved camera operating in three spectral bands in visible and near-infrared regions with a ground resolution of about 20 m and in the middle infrared region with a ground resolution of 70 m. It also has a camera in the panchromatic band with a resolution of 5.8 m. Besides, a wide field sensor operating in visible and near-infrared region with a resolution of 188 m and swath of 774 km is incorporated. Today, IRS-1C is the world's best in terms of civilian remote sensing capabilities. IRS-1A, IRS 1B and IRS-1C together have become the mainstay of the National Natural Resources Management System (NNRMS) for effectively managing the country's natural resources. Further satellites in

IRS series are being built of which IRS-1D is getting ready for launch by end 1997.

5.13.2 The payloads on-board IRS satellites include advanced imaging sensors operating in four spectral bands in the range of 0.45 to 0.86 micrometers. IRS-P2, launched by India's own PSLV on October 15, 1994, followed by IRS-P3 launched again by PSLV on March 21, 1996 carrying LISS-II payload, X-ray astronomy payload for scientific exploration as well as a German Space Agency's remote sensing Modular Opto-electronic Scanner has joined IRS-1A, IRS-1B and IRS-1C in enhancing the remote sensing services.

5.13.3 The satellite control centre located at Bangalore, along with ground stations at Lucknow and Mauritius, regularly tracks and monitors IRS satellites. The data reception station of the National Remote Sensing Agency (NRSA) at Shadnagar near Hyderabad receives the satellite data. Processing and distribution of the data is carried out by NRSA at its facilities in Hyderabad.

5.13.4 Data from IRS satellites are used for several applications such as agricultural crop acreage and yield estimation, drought monitoring and assessment, flood mapping, landuse and land cover mapping, wasteland management, water resources management, ocean/marine resources survey, urban planning, mineral prospecting, forest resources survey, etc. A unique application project, Integrated Mission for Sustainable Development (IMSD), which integrates remote sensing data obtained from satellites with data obtained from conventional methods and collateral socio economic information, has also been launched which will mainly use IRS data for rural development at microlevel.

5.14.1 **GSLV :** Development of the Geosynchronous Satellite Launch Vehicle, GSLV, capable of launching 2,500 to 3,000 kg class communication satellites into geostationary transfer orbit, is now under way. GSLV is derived largely from PSLV by replacing the six solid propellant strap-on motors with four liquid propellant strapon motors (derived from the second stage of PSLV) and replacing the upper two stages of PSLV with a single cryogenic stage. The first developmental flight of GLSV is planned in 1998.

5.14.2 Development of Cryogenic Engine is one of the crucial technological elements of GSLV. ISRO has already developed one tonne

cryogenic engine and has successfully tested it on-ground. Further developmental work in realising full scale cryogenic engine is in progress.

6. Space Science Activities

6.1 Active research in a number of space science areas is being pursued at several Universities, research institutions and organisations in the country. Space science research is being carried out by the Physical Research Laboratory (PRL), Ahmedabad, in a major way and by the Space Physics Laboratory (SPL) at Thiruvananthapuram. The Space Applications Centre (SAC) at Ahmedabad and the ISRO Satellite Centre (ISAC) at Bangalore and at National Mesosphere-Stratosphere-Troposphere Radar Facility (NMRF), Gadanki near Tirupati.

6.2 Space science activities relate to four broad disciplines, i.e. Astronomy and Astrophysics, Planetary Atmospheres and Aeronomy, Earth Sciences and Solar System studies and Theoretical Physics. Research in the area of astronomy and astrophysics ranges from the solar phenomena like solar flares, their relationship with the magnetic field, propagation of their effects in the interplanetary space, etc. Research activities in the planetary, atmospheres and aeronomy are broadly in the areas of middle atmospheric studies, upper atmospheric studies of the planetary atmospheres and astrophysics.

6.3 Earth sciences and solar system studies cover oceanography and climate studies and the solar system and geochronology. Research activities in theoretical physics are related to macroscopic and microscopic physics. Macroscopic physics includes studies in astrophysics, meteorology, climate studies and plasma physics whereas microscopic physics includes research in atomic and molecular physics, foundations of classical and quantum mechanics, nuclear physics and particle physics.

6.4 Researchers conduct studies in certain important areas which may include near-earth environment, the upper atmosphere and sun earth relationship, cosmic rays, astrophysics, infrared astronomy, space astronomy, meteorites, lunar samples, solar physics, geocosmophysics and plasma physics. Space science research activities in India have received great impetus from increased international cooperation, establishment and augmentation of major research facilities, enhanced research funding by various government agencies and emergence of new research programmes in several areas.

7. Commercial Benefits from Space Technology

7.1. Achievement of indigenous technological capability in satellite building and satellite applications as well as the launch vehicle technology has encouraged India to exploit its capabilities, on a commercial scale. Already, Indian Remote Sensing Satellites' data reception and its commercial distribution all over the world has been contracted out to EOSAT Company of USA. The Company is already receiving the IRS data at its ground stations. More and more stations are also proposed to be augmented for IRS data reception in due course. With the impending launch of further satellites in IRS series, enhancement of this contract has also been worked out based on the long term target of obtaining a lion's share in the anticipated world wide remote sensing commercial market of one billion dollars over a 10 years period.

7.2 Leasing of 11 transponders on INSAT-2E Satellite to be launched in 1998, to the Washington based INTELSAT organisation has been agreed for a consideration of US $ 100 million over a period of 10 years. INTELSAT, an international inter-governmental cooperative organisation with 133 member nations, providing telecommunication services for different regions of the world, owns and operates the world's most extensive network of global communications satellite system and it is the first time in its history to lease the services of another satellite outside its own fleet. Alliance with the India by both INTELSAT and EOSAT is a testimony to the maturity and potential of India's space programme.

7.3 ISRO Centres are also undertaking contracts from International Space Agencies like INMARSAT, Hughes, etc., for undertaking studies and also supply of some special hardware items. Several other initiatives are in the offing for harnessing commercial potential of space.

8. Space-Industry Co-operation

8.1 In the process of execution of space projects and for building the necessary infrastructure for its Research and Development the Indian Space Programme has been actively seeking the support of the Indian Industry. The space programme and the Indian Industry have a two way linkage :

* Transfer of advanced technologies developed in the space programme to Industry; and
* Utilisation of industry's own technological potential and expertise by the space programme.

8.2 ISRO's technology transfers cover a wide range technologies/ applications. It promotes and supports commercialisation of technologies developed in the space programme for several applications. Under this scheme ISRO has been providing expertise and consultancy to Indian Industries and Research & Development institutions in a wide range of disciplines.

8.3 Indian industries actively participate in the national space programme. More than 200 large, medium and small scale industries undertake work on fabrication and supply of various systems, sub-systems, components, materials, etc., and services required for INSAT, IRS, PSLV, GSLV, etc. projects/programmes. In many cases technologies developed under space programme are transferred to industries for large scale production to support various space projects as well as to promote space application's market development, and also to realise spin-off uses of space technologies in other economic sectors.

8.4 In the process of implementation of the space programme, about 225 technologies developed by ISRO have been transferred to Indian industries for use both in space programme as well as for commercial exploitation. Indian industries play a major role in the space programme by undertaking supply of hardware and services. This has also enabled industries to provide employment to technically qualified and skilled manpower.

9. The ISRO Team

9.1 Complexity of the technology, relative newness of the field, closely held and tightly guarded technology regime of the developed nations and other relevant factors have thrown up a big challenge to Indian Scientists, Engineers, Technicians, Managers, Administrators and others in experimenting, developing and operationalising space technology in our country. An ISRO team has emerged with well worked out strategies and is imaginatively executing an effective and successful space programme. ISRO employs over 16,000 men and women, of whom 5,000 are Scientists/Engineers. Remaining staff consists of Tech-

nicians, Tradesman, Technical Assistant, Scientific Assistant, Administrative personnel and others.

9.2 High technology oriented multi-disciplinary space programme calls for highly dedicated, talented and well qualified personnel. Recruited from various Universities and other educational institutions of our country, ISRO has trained and developed its own team. This team has produced the state-of-the-art, world class satellites such as IRS-1 series and INSAT-2 series as well as the PSLV launch vehicle. There is continuous induction of staff in ISRO, Scientists/Engineers in particular.

10. Employment Opportunities

10.1 Besides Centres of Department of Space/Indian Space Research Organisation, certain sectors of Indian Industry too, offer employment opportunities to those who are technically, professionally and otherwise qualified and possess relevant skills and knowledge. ISRO activities span a wide range of disciplines. Talents in several fields of science and technology can find a place in ISRO. The following is only an indicative list of some of the disciplines highly relevant in ISRO's activities for Scientists/Engineers.

Aeronautical Engineering
Atmospheric Sciences
Chemical Engineering
Civil Engineering
Computer
Control Systems
Electrical Engineering
Electro-optics
Electronics
Material Science
Mechanical Engineering
Metallurgy
Power Systems
Remote Sensing
Structural Engineering
Telecommunication

10.2 Scientists/Engineers are recruited with M.Sc/B.E./M.E. or Ph.D., depending upon the specific requirements of each job. Meritorious performers become Project Managers/Division Heads/Project Directors/Group Directors/Deputy Directors/Directors of verious Centres/units of ISRO, depending upon individual capabilities and excellence, in course of time.

10.3 ISRO also employs B.Sc. degree holders and Engineering Diploma holders. Job opportunities are also available for those who possess industrial training certificate in various trades/skills such as electronics, instrumentation, computer, air-conditioning, electrical, mechanical trades and others.

10.4 Promotions for all such Scientific and Technical staff are regulated by a merit oriented system. Under this scheme, merit alone, as demonstrated by on-the-job performance is the criteria for promotion. Unlike normal promotions in Govt. there is no need for a vacancy for promotion. As and when the individual is found to be suitable for promotion, he/she is promoted without the need for a vacancy in the higher grade, the post held by the individual will be automatically upgraded for the purpose of promotion.

10.5 All vacancies of Scientists/Engineers are advertised in the newspapers. Other vacancies are filled generally through employment exchange. This include administrative staff such as Clerks, Stenographers, and so on. However, posts of Assistant-B in administration are advertised for those who possess Degree with high percentage of marks. Assistant-B, recruited as such, are promoted directly to officer category on a merit based system. All promotions for administrative staff are vacancy-based.

10.6 In order to enable taking up a career in space science, space technology or space applications, study of science subjects such as Mathematics, Physics, Chemistry, and so on at the undergraduate level is necessary. Thereafter, further academic pursuits in one of those disciplines as are indicated in para 10.1 or other allied areas is advisable. Several Indian Universities and other institutions offer graduate/post-graduate/doctorate courses in the disciplines of relevance to space science/space technology and space applications.

11. Employment Outlook

11.1 Plans for the future include launching of more powerful satellites, both for communications and remote sensing, and development of commensurate launch vehicle capabilities. With such challenges ahead, Indian Space Programme is on a firm foundation to provide space based services to the nation on a continuous and assured basis.

11.2 The review of the progress made in the field of space technology over the last two decades indicates an increasing trend in employment opportunities for scientific and technical personnel, largely in Computer, Electronics, Mechanical, Remote Sensing areas. Relevant industries will also generate employment opportunities in relation to space technology and its applications. Recruitment in ISRO on a regular mode is anticipated for Scientists/Engineers and others.

11.3 Salary in ISRO is regulated based on the scales of pay in Central Govt. The existing pay scales are as recommended by the Fifth Central Pay Commission for Qualifications & Pay Scales. Pl. refer to Annexure-A

12. Staff Benefits and Welfare Measures

12.1 ISRO ensures good basic service conditions as are available in the rest of the Government of India. In addition, several other facilities are also available, some of which are indicated below.

12.2 **Medical Facilities :** Excellent medical facilities are available to all the employees and their families. The contributory health scheme enables employees and their families to receive both out-patient and in-patient treatment in various hospitals both in Government and Private Sector with the aid of medical experts, good infrastructure and facilities. Departmentally run hospital is available in SHAR. Qualified Medical Officers are employed in VSSC, LPSC, ISAC and SAC to provide medical services while at work.

12.3 **Housing :** Large housing colonies exist in Bangalore, Ahmedabad, Sriharikota, Thiruvananthapuram and Hassan with limited housing facilities elsewhere. In addition, hostel for freshly recruited Scientists/Engineers is being provided at Ahmedabad and Bangalore. In order to encourage employees to own their own house, House Building Advance is also available for purchase of a site/flat and construction of houses.

12.4 **Others :** Employees are generally provided with **transport facility** to work place and back. **Canteen facility** is available in all major Centres/Units. Cost on transport and Canteen is generally subsidised to some extent. Schools on the pattern of Kendriya Vidyalaya exists at Sriharikota, Tiruvananthapuram, Bangalore and Ahmedabad for imparting education to the children of employees of ISRO. Facilities such as children education allowance and reimbursement of tuition fees are also available. Facilities and benefits such as Leave Travel Concession and all other benefits enjoyed by Central Government employees are extended.

12.4 Opportunities are provided for higher education for existing employees. Sponsorship for higher education and facilities for study leave are also available.

13. Challenges in ISRO

13.1 'Space' offers virtually unlimited opportunities for its exploitation and utilisation for the good of the mankind. With 'Space' as its mandate, ISRO provides excellent opportunities to young men and women to develop, exhibit and apply their capabilities and potential to reach greater and greater heights for both the individual and ISRO.

13.2 By its very nature, space technology is multi-disciplinary involving hi-technology. Scientists/Engineers/Technicians/Managers/Administrators have to work together as a team to conquer space. Several hundreds of such teams work in ISRO at various locations all over our country. Sixteen thousand staff with their deep commitment to the cause of space have turned ISRO into a successful venture. ISRO will happily receive more and more enthusiastic persons in its fold to further the objective of providing space based services to our nation and to the world at large.

13.3 Excellent facilities in terms of computers, communications, library books, national and international journals, etc., are available for use of ISRO staff. The informal work culture, coupled with adequate freedom to pursue work in one's own area of strength, makes ISRO an ideal abode for hard working young men and women. In particular, Scientists/Engineers whose career goals are targeted in hi-tech ventures, like space and are desirous of becoming experts and specialists, would find the ambience in ISRO an ideal one to fulfill their wish.

13.4 ISRO's organisational framework is guided by the philosophy that it should free from all non-essential restrictions or needlessly inelastic rules of the government. This has enabled ISRO to provide administrative/logistics/welfare services to the staff in good measure. The executive support system, providing for procurements of materials/equipments/services, human resources management, financial management, infrastructure build-up, etc., is also appropriately tuned to meet the goals which are schedule critical and cost conscious. Professional freedom and administrative flexibility, the sinequanon of the space programme, are ensured. All these together contributed towards an harmonious and happy working atmosphere in ISRO.

14. Towards Further Information :

14.1 For any further information, please contact :

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ANNEXURE-A

Posts in the Scientific and Technical Area with Pay-Scales, Qualifications and Experience required

S. No.	Posts	Scale of Pay	Qualifications & Number of years of experience
1	2	3	4
1.	Tradesman A	Rs. 3050-4590	Non-Matric, ITI
2.	Lab. Asstt. A	Rs. 3050-4590	Inter Sc./SSLC+6 years experience
3.	Lab. Technician	Rs. 3050-4590	Dip. in Lab. Technology
4.	Radiographer A	Rs. 3050-4590	Dip. in Radiography
5.	Draughtsman A	Rs. 3050-4590	Matric, ITI
6.	Tradesman B	Rs. 3050-4590	Matric, ITI, Non-Matric-ITI+3 years experience
7.	Tradesman D	Rs. 4000-6000	Inter Sc. in Natural Science with Botany
8.	Draughtsman C-II	Rs. 4000-6000	Matric-ITI+3 years experience
9.	Lab. Asstt. C	Rs. 4000-6000	Inter Science+3 years experience, SSLC+9 years experience
10.	Radiographer B	Rs. 4500-7000	Dip. in Radiography+7 years experience
11.	Pharmacist A	Rs. 4500-7000	Dip. in Radiography+7 years experience
12.	Draughtsman C-I	Rs. 4500-7000	Matric ITI+6 years experience
13.	Tradesman E	Rs. 4500-7000	Matric ITI+6 years experience
14.	Tradesman F	Rs. 5000-8000	Matric ITI+9 years experience
15.	Tech. Asstt. B	Rs. 5000-8000	Diploma
16.	Scientific Asstt. B	Rs. 5000-8000	B.Sc. Fresh. B.Sc.+Diploma
17.	Scientific Asstt. C	Rs. 5500-9000	MSc. Fresh. B.Sc.+3 years Experience

1	2	3	4
18.	Technical Asstt. C	Rs. 5500-9000	Diploma+3 years experience
19.	Scientist Engineer (SB)	Rs. 6500-10500	BE/B. Tech./B.Sc. Engg. or Diploma Engg./B.Sc. +6 years of relevant experience/ M.Sc.
20.	Scientist/Engineer (SC)	Rs. 8000-13500	BE/B. Tech./B.Sc. (Engg.)+1 year experience. M. Tech./M.Sc. Engg./M.E./ M.Sc.+1 year experience
21.	Scientist Engineer (SD)	Rs. 10000-15200	Ph.D. Fresh. M.Sc.+5 years experience. BE/B.Tech./ B.Sc. (Engg.)+5 years experience M.Tech./M.Sc. Engg./M.E./M.Sc.+4 years Experience
22.	Scientist Engineer(SE)	Rs. 12000-16500	
23.	Scientist Engineer(SF)	Rs. 14300-18300	Norms are not specifically
24.	Scientist Engineer(SG)	Rs. 16400-20000	provided. Whenever appointment to such posts are to be made,
25.	Scientist Engineer(G)	Rs. 18400-22400	norms are prescribed.
26.	Scientist Engineer(H)	Rs. 18400-22400	
27.	Outstanding Scientist	Rs. 22400-24500	
28.	Distinguished Scientist	Rs. 26000 Fixed.	

The above scales are as per the Report of the Fifth Pay Commission. Vol. II (Please refer to Annexure-43.1, page 459)

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