National Space Activities Program

PNAE

1998-2007

President of the Republic

Fernando Henrique Cardoso

Vice-President

Marco Antônio de Oliveira Maciel

Minister of Navy

Mauro César Rodrigues Pereira

Minister of Army

Zenildo Gonzaga Zoroastro de Lucena

Minister of Foreign Relations

Luiz Felipe Palmeira Lampreia

Minister of Finance

Pedro Sampaio Malan

Minister of Agriculture and Supply

Arlindo Porto

Minister of Education and Sports

Paulo Renato Sousa

Minister of Aeronautics

Lélio Viana Lôbo

Minister of Industry, Commerce and Tourism

Francisco Oswaldo Neves Dornelles

Minister of Mines and Energy

Raimundo Mendes de Brito

Minister of Planning and Budget

Antônio Kandir

Minister of Communications

Sérgio Roberto Vieira da Motta

Minister of Science and Technology

José Israel Vargas

Minister of the Environment, Water Resources and the Legal Amazon

Gustavo Krause Gonçalves Sobrinho

Minister of the Joint Chiefs of Staff

Benedito Onofre Bezerra Leonel

Secretary of Strategic Affairs

Ronaldo Mota Sardenberg

President of the Brazilian Space Agency

Luiz Gylvan Meira Filho

PRESIDENCY OF THE REPUBLIC

1998-2007

National Space Activities Program

PNAE

PRESIDÊNCIA DA REPÚBLICA
AEB
AGÊNCIA ESPACIAL BRASILEIRA

Brasilia - 1998

The ***National Space Activities Program (PNAE)*** was drawn up by the Brazilian Space Agency (AEB) with the collaboration of the organizations participating in the National System for the Development of Space Activities (SINDAE), and its updating was approved by the Superior Council of the AEB during its 23rd Regular Meeting, on December 17, 1997.

Updating and Revision: Lauro Tadeu Guimarães Fortes (DPL/AEB)

Eduardo Dorneles Barcelos (DPL/AEB),

Telma de Oliveira Jabur (DPL/AEB)

Renato José de Sousa (DPL/AEB)

Editing: Regina Célia França (MT 2279)(CCS/AEB)

Graphics design: Carlos T. D. Brasil (CCS/AEB)

English Language Version: Barclay Robert Clemesha

Note on the English language version: This document was translated into English in October, 1998, nearly one year after the approval of the original Portuguese version. During this period the scheduled dates for a number of events, such as satellite launches, have changed. Wherever appropriate, these changes have been included in the form of translator's footnotes.

Circulation: 2000 copies

Brazil, Presidency of the Republic, Brazilian Space Agency.

National Space Activities Program: 1998-2007, - 2nd edition – Brasília: AEB, 1998.

76 p.

1. Space Technology – Brazil 2. Space R&D - Brazil 1. Title.

CDU 629.7

Brazilian Space Agency (AEB)
Setor Bancário Norte, Quadra 2, Bloco J
Ed. Engenheiro Paulo Maurício, 5º andar
CEP 70040-905 – Brasília – DF, Brazil
Tel.: +55-61-323.5106 Fax: +55-61-323.3948

Directors of the Brazilian Space Agency

President

Luiz Gylvan Meira Filho

Director-General

Ajax Barros de Melo

Legal Department (PJR)

Antônio Temóteo dos Anjos Sobrinho

Department of Space Programs (DPE)

Múcio Roberto Dias

Department of Technical-Scientific Development (DTC)

Raimundo Nonato Fialho Mussi

Department of Space Cooperation (DCE)

Carlos José Prazeres Campelo

Department of Administration (DAD)

Gessé Martins Borges

Planning and Coordination Department (DPL)

Lauro Tadeu Guimarães Fortes

Members of the Superior Council of the Brazilian Space Agency

President

Luiz Gylvan Meira Filho

Deputy President

Ajax Barros de Melo

Director General of the Brazilian Space Agency

Ministry of Navy

Effective: *R. Adm. Júlio Saboya de Araújo Jorge*

Deputy: Cpt. *Edmur Guimarães dos Santos*

Ministry of Army

Effective: *Gen. Frederico Faria Sodré de Castro*

Deputy: *Col. (QEM/CDEM) Fernando Antonio Veloso Manguinho*

Ministry of Foreign Relations

Effective: *Amb. Antônio Augusto Dayrell de Lima*

Deputy: Sec. *Christian Vargas*

Ministry of Finance

Deputy: *Marco Aurélio de Melo Vieira*

Ministry of Agriculture and Supply

Effective: *Augusto Cesar Vaz de Athayde*

Deputy: *José Mauro de Rezende*

Ministry of Education and Sports

Effective: *Cid Santos Gesteira*

Deputy: *Ruy Carlos de Camargo Vieira*

Ministry of Aeronautics

Effective: *Maj. Brig. Reginaldo dos Santos*

Deputy: *Col. Carlos Augusto Leal Velloso*

Ministry of Industry, Commerce and Tourism

Effective: *Rigobert Lucht*

Deputy: *Ronaldo Almeida Melo e Silva*

Ministry of Mines and Energy

Effective: *José Mário Miranda Abdo*

Deputy: *Demóstenes Barbosa da Silva*

Ministry of Planning and Budget

Effective: *Ariel Cecílio Garces Pares*

Deputy: *Luís Hiroshi Sakamoto*

Ministry of Communications

Effective: *Ronaldo Rangel de Albuquerque Sá*

Deputy: *João Carlos Fagundes Albernaz*

Ministry of Science and Technology

Effective: *Marcio Nogueira Barbosa*

Deputy: *Antônio Maria Amazonas Mac Dowell*

Ministry of the Environment, Water Resources and the Legal Amazon

Effective: *Júlio Sérgio de Maya Pedrosa Moreira*

Deputy: *José Seixas Lourenço*

Ministry of the Joint Chiefs of Staff

Effective: R.*Adm. Roberto da Silva Legey*

Deputy: *LTC. Geraldo Antonio Diniz Branco*

Secretariat of Strategic Affairs

Effective: *Amb. Carlos Alberto Pessôa Pardellas*

Deputy: Cpt. *Alvaro Luiz Pinto*

Scientific Community

Luiz Bevilacqua

Industrial Sector

Ozires Silva

INTRODUCTION

The law creating the Brazilian Space Agency (AEB) makes provision for the National Space Activities Program (PNAE), establishing, amongst other attributes, responsibility for elaborating and maintaining the national program. The scope, the basic content, and other definitions pertinent to the establishment of the program, together with its ten-year extent and the frequency of its revision, are the result of decisions taken by the AEB's Superior Council.

The first edition of PNAE was approved in August, 1996, covering the period 1996 to 2007.

It is important to emphasize that PNAE, being a *program* rather than a *plan*, should not enter into the sort of operational detail to be expected from the latter but, on the other hand, should offer a more integrated and strategic view of the set of initiatives which it establishes. It should also be emphasized that it covers not only the projects and activities to be financed directly by the AEB but the complete set of Brazilian space activities, including initiatives financed by the Ministry of Science and Technology, by the Ministry of Aeronautics, by government organizations supporting space research and by other possible sources of funding.

The programs constituting PNAE, especially those involving systems development and space technology, create unique conditions for the development of expertise in processes and products with a high level of technological content, both in Brazilian universities and research institutes and in industry. It would be true to state that the space program is an excellent agent for the development of future technologies, and for the qualification of Brazilian companies to the point where they are able to compete at the international level.

This document tries to present an integrated picture of the activities being developed in Brazil, together with a proposal for the continuation of these efforts over the next ten years. Following the orientation of the National Policy for the Development of Space Activities (PNDAE), PNAE groups Brazilian space activities in major programs, covering science, applications and technological development, together with other activities aimed at implanting, maintaining and extending operational infrastructure for research and development. These programs define the actions aimed at realizing the PNDAE objectives, maintaining coherence between them in both the short and long terms. They also contemplate more general activities, including the maintenance and strengthening of space-oriented research and development teams in Brazilian institutions, international cooperation at various levels, and interaction between Brazilian universities and local industry.

PNAE also presents executive guidelines and funding indicators for the universe of Brazilian space activities. In this way it constitutes a basic reference for annual and pluri-annual planning, as well as for strategic and program-related decision taking by the organizations forming the National System for the Development of Space Activities (SINDAE).

LUIZ GYLVAN MEIRA FILHO

President of the Brazilian Space Agency

CONTENTS

Part 1
FUNDAMENTALS

1. A BRIEF HISTORY

Starting from the first successes of the Soviet and American space programs in the late fifties, several countries started to organize activities aimed at the exploration of outer space. These activities included scientific programs, research and development in space systems and technology and, later, the application of services and products resulting from the new technologies to the solution of the day-to-day problems of humanity.

Brazil was one of the first developing countries to institutionalize space activities, with the establishment of government organizations by the early sixties.

The Organizing Group of the National Commission for Space Activities (GOCNAE)[1] was created in 1961 as an organ subordinated to the National Research Council (CNPq). In 1971 GOCNAE became the Institute of Space Research (INPE). Starting 1985, INPE, whose name was changed to the National Institute for Space Research in 1990, has been directly subordinate to the Ministry of Science and Technology.

In 1966 the Ministry of Aeronautics created the Executive Group for Space Project Activities and Studies (GETEPE) which, in 1969, gave rise to the Institute of Space Activities (IAE). IAE, part of the Aerospace Technical Center (CTA), became the Institute of Aeronautics and Space in 1991. The universe of government organizations dedicated to space activities was consolidated in 1971 with the formation of the Brazilian Commission on Space Activities (COBAE), an inter-ministerial coordinating organ presided over by the Head of the Joint Chiefs of Staff of the Armed Forces (EMFA).

INPE's activities, initially research in space and atmospheric sciences, gradually expanded to include space applications, notably in the areas of remote sensing and meteorology, and space technology, with special emphasis on satellites and ground systems.

IAE, right from the start, has concentrated mainly on the development of sounding rockets, and, more recently, launch vehicles.

The block of institutions dedicated to space activities in Brazil also includes the Barreira de Inferno Launch Center (CLBI) and the Alcântara Launch Center (CLA). The CLBI, inaugurated by the Minister of Aeronautics in 1965, in Natal, in the state of Rio Grande do Norte, is dedicated to providing facilities for the launch and tracking of both Brazilian and foreign sounding rockets. These activities have been of fundamental importance in the development of the nation's capacity in the area of rockets and launch vehicles, and for research in space and atmospheric sciences.

Brazil's initiatives in the space sector gained new impetus in 1979 with the implantation of the Complete Brazilian Space Mission (MECB). This program, the country's first major long-term project in the field, established as its goals the development of small applications satellites (environmental data collection and remote sensing) and a launch vehicle compatible with the launch requirements of the satellites, together with the necessary basic infrastructure. The major infrastructure complex provided for by MECB is the Alcântara Launch Center (CLA), in Alcântara, in the state of Maranhão, already in use for suborbital launches. The CLA, because of its privileged location, close to the equator, is well placed to become an internationally competitive center for satellite launches.

At the beginning of the nineties, internal changes together with the international situation, led to the substitution of COBAE by a new organization, designed to exert a more ample role in the country's space activities, and to emphasize their purely pacific nature. The Brazilian Space Agency (AEB)[2] was created in 1994, as a civilian organization attached to the Presidency of the Republic, with a wider range of attributes than COBAE. After the creation of the Space Agency, COBAE was made extinct[3].

---

[1]A civilian organization, GOCNAE received the support of the Ministry of Aeronautics, which provided a site in São José dos Campos, in the state of São Paulo, and ceded personnel to form part of GOCNAE's initial staff.
[2]Law No. 8854, February 10, 1994.
[3]Decree No. 1292, October 20, 1994.

2. SUMMARY OF THE BRAZILIAN SITUATION

Brazil has, at the present time, approximately 300 scientists, 800 researchers and engineers and 2000 technical workers of different disciplines, dedicated to space activities under the general coordination of the AEB. The major concentration of resources is in the development of space technology and systems and in the implantation of infrastructure, which constitute programs intrinsically more costly than scientific research and the application of existing technologies.

Over the past three decades Brazil has succeeded in consolidating an internationally recognized scientific community, competent researchers in remote sensing and meteorology, and a strong base in space technology and engineering. It has also succeeded in implanting basic infrastructure: in addition to the Alcântara (CLA) and Barreira de Inferno (CLBI) launch centers, there are the Integration and Tests Laboratory (LIT), the Satellite Tracking and Control Center (CRC), and the Col. Abner Propellants Utility (UCA). Significant infrastructure has also been implanted in the form of technological niches in Brazilian industry.

Amongst others, the Brazilian scientific community in the space area is working in the areas of space sciences, meteorology, oceanography, Earth sciences, thematic applications in remote sensing, global change, materials science, plasma, combustion and propulsion, orbital mechanics and control, mathematical modeling and computational science. This community is characterized by a high level of productivity, with publication indexes compatible with those to be found in the developed countries, and by an active program of international interchange.

In the area of space applications, in a long-term program aimed at the implantation of basic infrastructure, creation of human resources, and the development of adequate methodologies and tools, the country has already achieved significant results. As a result, the techniques of remote sensing from orbit have already been incorporated into a series of day-to-day activities of high socio-economic importance, and have spawned the startup of a number of firms providing services in this area. In the area of weather prediction, operational five-day forecasting has been successfully implanted. The use of this sort of information will no doubt expand greatly in the immediate future, with the availability of rapid means of data dissemination such as the Internet.

In the area of space engineering and technology, in spite of adverse circumstance, the country has already launched the first satellite conceived, designed, developed and manufactured in Brazil.[4] It has also developed and successfully tested a series of sounding rockets[5], and is in the final phase in the development of its first launch vehicle.[6] Also in progress is a program for the development of remote sensing satellites in cooperation with the People's Republic of China. The competence acquired qualifies the country for more complex projects with greater potential return on investment. Among the proposals under study or negotiation, of particular importance are the Brazilian participation in the International Space Station (ISS), the development of the satellite launch vehicle VLS-2, probably in international partnership, and the development of a constellation of low equatorial orbit communications satellites (the ECO system, see item 2.4).

A growing participation by Brazilian industry in space systems and projects can be observed.[7]The founding of the Brazilian Aerospace Industries Association (AIAB), an association of companies working in aerospace engineering, is indicative of the growing importance of the area in Brazil. The

---

[4]The SCD-1 - the first Brazilian data collection satellite - was successfully placed into orbit on February 9, 1993, and is still operational. *Translator's Note: The second satellite of that series, SCD-2, was also successfully launched on October 22, 1998.*

[5]Launches of the Sonda II, III and IV vehicles, designed and integrated by IAE, with a major contribution from Brazilian industry, have enabled both Brazilian and foreign scientists to carry out important suborbital scientific experiments. More than 30 payloads designed by INPE for scientific research of importance to the country, as well as a similar number of technological payloads developed by IAE, have been flown with success.

[6]The Satellite Launch Vehicle VLS-1 was designed for the MECB program of launches; more specifically, the launch of satellites of up to 200 Kg into 700 - 800 km orbits.

[7]The participation by Brazilian industry, computed as the ratio of the cost of industrial contracts to the total system cost, started at 9% in the case of the SCD-1 satellite, is in the region of 42% of the Brazilian segment for the first CBERS satellite, and is expected to reach 90% during the continuation of the series. In the case of the development of the VLS-1 vehicle, the Ministry of Aeronautics estimates industrial participation at around 70%.

AIAB, founded on March 18, 1993, is formally associated with the National System for the Development of Space Activities (SINDAE).[8]

3. INTERNATIONAL TENDENCIES

The changes which have occurred in the international economic scene since the late eighties, allied to the profound political transformations resulting from the end of the Cold War, have led to changes of course in space programs all over the world. Efforts directed at modernizing government policies have led to frequent revisions of projects under way, as well as changes in plans for the future. On the other hand, the international entente resulting from the end of the cold war has led to greater availability, to civil programs, of technology developed for military applications.[9]

A characteristic of these changes in direction is the adoption as a fundamental principle of a policy of emphasizing initiatives which produce immediate benefits to society - the so-called applications programs. Major beneficiaries of this policy have been Earth observation programs and telecommunications[10]and, to a lesser extent, programs which use the space environment (microgravity, for example) for the development of new processes[11]. The special emphasis on Earth observation must be considered a response to the world-wide concern over the environment.

Another aspect of the new course that space programs are taking all over the world, is the tendency to substitute extremely costly missions by a larger number of smaller and shorter ones, using standardized designs[12]. The present-day tendency for government to reduce its participation in certain areas of activity has also lead to the simplification, or even canceling of some more grandiose projects[13].

The foregoing remarks can be corroborated by analyzing the space programs in progress or planned in various countries, with the following main characteristics:

- strong emphasis on the applications area, specially in telecommunications (underlining proposals for low-orbit systems), remote sensing (often using microwaves), meteorology and microgravity;
- resumption of the International Space Station (ISS) project and of projects aimed at providing space infrastructure for scientific and technological experiments;
- resumption of the development of non- or partially-reusable launch vehicles, in parallel with continuity in the development of reusable vehicles, bearing in mind the need to reduce launch costs;

---

[8]SINDAE was instituted on July 10, 1996, by decree No. 1953.

[9]Important examples are high resolution images and imaging systems, which have opened up new and promising market opportunities for applications in remote sensing from orbit, and the conversion of deactivated missiles into launch vehicles for small satellites.

[10]In the USA, NASA gives priority to the "Mission to Planet Earth" program, of which the EOS (Earth Observation System) constitutes an important element, involving a large number of satellites. In Europe, the European Space Agency (ESA) is emphasizing the development of a polar orbit platform to be used for radar remote sensing and meteorological missions, as well as technologies aimed at data transfer between low orbit satellites and earth stations. Japan, with a satellite based Earth observation program already under way, is planning 16 new satellites to be launched by the year 2010 within its global environmental monitoring program. Russia already has its first commercial remote sensing satellite, and has significantly increased its investments in telecommunications satellites, especially in the area of low orbit systems. Canada, Germany and India are giving emphasis to the development of systems and technology for orbital remote sensing, an area which comes second only to communications satellites in the case of China.

[11]The German TEXUS and MAXUS microgravity programs, and the Swedish MASER, are outstanding in this context, as is the use by several countries of the Russian and Chinese recoverable satellites and the Russian space station MIR, to which the International Space Station will offer an important alternative in the near future.

[12]Examples of this tendency are the simplifications in the American remote sensing satellite LANDSAT 7, and the use of the French SPOT 5/ SPOT 6 platform for the HELIOS 1 and 2 military satellites.

[13]In this context can be included the canceling, by ESA, of the development of the HERMES manned space vehicle, substituted by simpler and less costly alternatives, and the substantial simplifications imposed on the design of the American space station, which was internationalized in the same context.

- more extensive use of mini- and micro-satellites, recoverable or not, for scientific and technological experiments.

The present climate of international agreement and economic expansion, favoring joint projects, has also led to an international tendency for cooperative programs of space activities.

4. PANORAMA FOR THE FUTURE

Over the next decade, Brazilian space activities will be carried out within programs, including research, applications and technological development, which seek to provide, direct and indirectly, an augmented return to society of the resources invested in them. Efforts should be made both to exploit to the maximum the potential of space applications - the use of systems and techniques to which the country has access - and to carry out research and develop space technology.

Two points of fundamental importance should be remembered for a correct understanding of the context in which space programs exist. Firstly, with the exception of communications systems, these programs do not normally generate direct results capable of raising commercial interest to the point of covering all the costs of design, development, construction, launch and operation of the satellites involved. This assertion is true even for the technologically advance nations such as the United States and the European Community countries. On the other hand, these programs are still long from exhausting their potential which, in some areas, such as microgravity, could produce results of significant economic benefit. It is these potential benefits which today, all over the world, provide the drive for a major part of the investment in space programs.

Secondly, it should be pointed out that the results of space programs, especially those related to Earth observation, mainly satisfy the needs of government programs. This is a result of the very nature of space platforms, which cover extensive areas, and are mainly suitable for monitoring large areas and large-scale phenomena. In this context, environmental monitoring, data collection for use in weather and climate prediction, evaluation of mineral resources, geological and cartographic surveys are, amongst others, examples of space applications of direct benefit to society. Although these activities, in general terms, promote the well-being of society, and can even generate financial returns, it is not to be expected that non-government organizations and individuals should pay for them on a regular basis.

In the case of Brazil - whose specific programs are presented in the second part of this document - a number of basic principles underlie the lines of activity to be followed during the next decade, all of which are recognized explicitly or implicitly in the National Policy for the Development of Space Activities (PNDAE).

The first of these principles is to seek to exploit unfilled niches of interest to Brazil, wherever these still exist, in the context of space activities. These niches appear both as a result of the peculiarities of the country, especially with respect to its geographical location, and because of its internal needs, which are often of little interest to the developed countries. Amongst others, the following examples can be cited:

- a constellation of small, low-cost communications satellites in low equatorial orbit, aimed at integrating remote regions to the rest of the country, attractive not only to Brazil, but also to a large number of countries situated in the equatorial belt;
- small, low-cost, low-orbit, remote sensing satellites, with a capacity for transmitting images directly to small ground stations located within the coverage of each satellite, with applications, for example, in real-time monitoring of land use, including deforestation or, where high resolution is available, in frontier surveillance and supervision of the Amazon region[14];
- educational TV systems using direct broadcasting satellites, mainly with a view to providing services to remote regions.

As examples of niches in scientific research, resulting from the country's geographic position, one can cite studies of the equatorial electrojet[15] and of the South Atlantic Magnetic Anomaly[16]. Other areas of

---

[14]It is to be expected that the SIVAM project will depend heavily on space technology within the next decade.

[15]The equatorial electrojet is a current which flows around the Earth in the upper atmosphere, approximately over the geographic equator. Since this phenomenon is restricted to the equatorial zone,

major importance in basic research are the ocean-atmosphere interaction in the South Atlantic, of great importance for climate modeling, and studies of the effects of agriculture on global and regional climate in the Amazon.

The second principal is to seek greater integration with international programs in the form of scientific and technological cooperation with other countries.

Finally, recognizing the fact that space activities, in all their principal ramifications, involve potential of significant impact, not yet adequately exploited, or even perceived, the objective of PNAE is that the country should enjoy, over the next decade, wide ranging activities in the space sector, including increased participation by both industrial and non-industrial organizations. In this way one may foresee national progress in the area of space applications (especially in remote sensing, meteorology, oceanography, communications, geodesy and navigation), in the development of space systems and associated technologies (particularly with respect to satellites and launch vehicles), and in space sciences.

---

of little interest to the developed countries, it has not been the subject of extensive research. Nevertheless, it involves significant economic impact; it affects, for example, the results of petroleum prospecting using geomagnetic surveys. This effect has already distorted the results of expensive surveys carried out by foreign firms under contract to Brazil.

[16]The South Atlantic Magnetic Anomaly, or Brazilian Magnetic Anomaly, is an area where the Earth's magnetic field is weaker than in any other part of the globe. As a result of this the precipitation of energetic particles from the Van Allen radiation belts is unusually strong, producing radiation which can be harmful to astronauts, and perhaps even to human beings and animals living in the Brazilian South Atlantic region.

Part 2
TEN-YEAR PROGRAM

The activities which, over the next ten years, will attempt to fulfill the objectives of the National Policy for the Development of Space Activities (PNDAE), are presented in the following sections, organized in major programs. It should be emphasized that, in harmony with the directives of the PNDAE, all the proposals take into account the interests of the various sectors involved, and are consistent with the policies of the ministries responsible for the country's positions vis-à-vis the relevant international organizations.

1. SPACE APPLICATIONS

This program is aimed at creating the means by which Brazilian society can best take advantage of the resources provided by applications satellites, mainly in the areas of remote sensing, meteorology, oceanography, telecommunications, geodesy and navigation.

The major objectives are:

a) To guarantee Brazil the capacity to take advantage of the full potential of images and data obtained by Earth observation satellites, especially in the areas of surveying, cataloging and monitoring of forest resources; mapping, evaluation and control of mineral and water resources; territorial surveillance; characterization, prospecting and monitoring of marine resources, including the Brazilian continental shelf; monitoring of land use; support for the establishment of policies related to rational occupation and sustained development of remote regions.

b) To establish and maintain, in the principal sub-areas to which space systems are applicable, centers of excellence able to keep up with the state of the art, so as to furnish the country with the means of defending its interests in the international forum, in the context of legislation concerning subjects such as pollution and control of the environment, rational use of natural resources, preservation and exploitation of biodiversity, global change, and other related themes.

c) To establish and maintain a competence and the physical means for making weather forecasts of an international standard within Brazil, and to effectively disseminate such forecasts and ensure their maximum use by Brazilian society.

d) Maintain scientific and technical competence in the principal areas of knowledge related to the dynamics of the South Atlantic Ocean.

e) Conceive and make feasible systems which will allow new uses of satellite communications, especially those of recognized social importance, but reduced commercial return, such as tele-education and tele-medicine.

f) Equip the country to make effective use of international high precision satellite positioning and navigation systems, and to specify, design and develop equipment or subsystems which provide increased opportunities for Brazilian participation in such systems.

g) Develop applications areas as yet inadequately exploited in the country, and which show themselves to be attractive and compatible with available financing.

The program is subdivided into 5 subprograms as follows.

1.1 Remote Sensing

The remote sensing subprogram is aimed at providing the country with the capacity to make effective use of images of the Earth's surface obtained in different spectral bands, obtained by cameras and other sensors on board remote sensing and Earth observation satellites. With this objective in view, it is intended to consolidate the use of orbital remote sensing techniques as tools for the survey, monitoring and evaluation of natural resources and the state of the environment, and for planning purposes related to the rational use of the latter.

This program's research and development activities can be divided into three areas as follows.

The area of *Thematic Research and Applications* aims at the development of methods for the survey and monitoring of natural resources and environmental processes, using remote sensing data, together with the further development of these methods via the use of new sensor systems. Included in this area, amongst others, are projects aimed at geological research, evaluation of soil and water resources degradation, studies of flood areas, the study of plant diseases and crop estimation.

In the area of *Image and Geo-Processing* the activities involved include the design, development dissemination and implantation of computer systems for image processing, and Geographical Information Systems (GIS), based on technology developed in Brazil. Also included is work aimed at data integration and the maintenance of large space data bases, essential for modeling studies and GIS, and at dominating methodologies for manipulating radar images.

The third area is that of *Microwaves and New Technologies.* Remote sensing using microwaves is a tool of tremendous potential for Brazil because the technique is independent of cloud cover. The process of radar imaging, being completely different to its optical counterpart, requires a considerable effort in research and development before it can be used in practical applications. Research in this area is directed towards understanding the interaction between terrestrial targets and microwave radiation on the basis of data from radar satellites.

1.2. Satellite Meteorology and Weather Forecasting

This subprogram is aimed at promoting the development of new knowledge, methodology and techniques which will allow the communities and organizations which use meteorological data, as well as the general population, to benefit from weather forecasts and climate predictions made possible, directly or indirectly, by space systems. In this context the space systems in question are typically meteorological satellites or environmental data collection satellites.

In numerical weather prediction, the major goal for the coming years is to achieve accuracy indexes for the South America predictions, better than those achieved for the same region by major meteorological centers in other countries.

In climate prediction the main objectives are to implant ocean and coupled ocean-atmosphere models, and to consolidate the use of these models for climate prediction on the seasonal scale (1 month to 1 year) for South America. With respect to global climate change, a capacity to carry out studies on the regional impacts of these changes (resulting from the greenhouse effect, for example) is sought after, together with possible alternatives which would minimize the adverse consequences of global change.

Most specifically in satellite meteorology, the overall objective is to achieve a growing autonomy in the technologies and means needed for meteorological monitoring of the Brazilian territory.

1.3. Satellite Oceanography

This subprogram is aimed at improving knowledge of the dynamics of the South Atlantic via the use of information supplied by space systems, seeking to benefit activities such as fishing, offshore industrial activities, tourism, coastal management and monitoring of the environment. It is also aimed at setting up and maintaining highly trained interdisciplinary teams for monitoring the South Atlantic. Amongst the initiatives already under way should be mentioned the international project which, under Brazilian leadership, is setting up a network of oceanographic buoys anchored between Brazil and the African continent. With the support of data collection by satellite, this network will make possible the measurement of oceanographic parameters in the South Atlantic, filling a serious gap in the global coverage.

1.4. Satellite Telecommunications

The telecommunications subprogram is aimed at achieving qualification and development in applied systems which make use of telecommunications via satellite. Examples of such systems, whose product is basically information generated, processed and received in digital form, include: messaging and data collection networks associated with intelligent exchanges; virtual offices; both public and restricted access data networks; teleconferencing; on-demand TV and multi-media. This field can be divided into three distinct segments: generation of the product, reception and utilization of the product by the end user, and the logical data distribution system. The scope of the subprogram covers both the development of the basic elements, which provide the means for the operation of each of the three segments, and the conception and dimensioning of complete systems. The intermediate infrastructure components, such as satellites and network elements, are covered by the Satellite Program and by the Research and Development Program.

1.5 Satellite Geodesy and Navigation

This subprogram is aimed both at developing techniques to take advantage of international satellite-based high precision positioning and navigation systems, and at specifying and designing equipment and subsystems which provide increased opportunities for Brazilian participation in such systems.

The continuous fall in the price of receivers, allied to the expectation of new international systems, which should increase the precision and guaranteed availability of satellite positioning for civilian purposes, is expected to result in increases in both the sophistication of such systems and the scope of their applications.

The transport sector is most certainly a major potential beneficiary of this technology, which makes increasingly possible the optimization of systems such as public transport, goods transport, and airborne navigation in all flight stages. Applications are to be found in a wide-ranging area which includes agriculture (precision farming) and geological prospecting. In addition to the systems already in operation, such as GPS (USA) and GLONASS (Russia), there are plans for the development of other complementary systems, such as GNSS (Global Navigation Satellite System) and EGNOS (European Geostationary Navigation Overlay System), as well as the future European system, ENSS (European Navigation Satellite System), an autonomous system for purely civilian applications.

2. SATELLITES AND PAYLOADS

The purpose of the Satellite and Payloads Program is to equip the country with an autonomous capacity for the conception, design, development, construction and use of satellites and specific satellite subsystems.

The major objectives for the 1998-2007 period are:

a) To develop satellites and payloads with increasing complexity and technological modernity, with a view to fulfilling the country's needs, either by autonomous projects or in cooperation with other countries.

b) Make feasible Brazil's participation in the International Space Station (ISS), via the supply of equipment and installations.

c) Consolidate the industrial know-how necessary for building space subsystems in Brazil.

2.1 Data Collection Satellites

The Data Collection Satellite (DCS) subprogram is aimed at providing the country with data retransmission satellites and the capacity to build them. The purpose of these satellites is the reception and re-transmission, to one or more ground stations, of meteorological and environmental data, including information on rainfall and water level, collected by data collection platforms (DCPs) installed on land or on ocean buoys.

The MECB program initially included the specification, design, development, integration and operation of two data collection satellites - SCD-1 and SCD-2. Two more satellites of the same series, SCD-2A and SCD-3 were subsequently approved.

The SCD-1 satellite, launched on February 9, 1993, continues to operate successfully well beyond its nominal 1 year design lifetime, and will be substituted by the SCD-2 satellite, which should enter into operation during the first semester of 1998[17]. In this way it is intended to avoid any discontinuity in the operation of the DCP network being installed[18].

[17] Translator's Note: The SCD-2 satellite was launched successfully on October 22, 1998.

[18] The total number of DCPs in operation in various parts of the country should reach approximately 400 in 1998. Of these, a large number constitute a part of the National Department of Waters and Electrical Energy (DNAEE) network, belonging to the Ministry of Mines and Energy, which already makes routine use of the system for pluviometric and fluviometric monitoring in the various Brazilian

As for the SCD-1, the SCD-2 will be the object of a foreign commercial launch. The SCD-2A was lost during the first qualification test of the national satellite launch vehicle, the VLS-1.

The SCD-3 satellite, designed for a circular equatorial orbit at a height of 1,110 km, will make possible, from the data collection point of view, a coverage complementary to that of the other SCDs and the CBERS satellites, apart from providing for increased data reception and transmission capacity. It should also serve as a platform for experiments in voice and data communications via low equatorial orbit satellites. The SCD-3 satellite will use the *multi-mission platform*, conceived for repeated use in some of the future satellites.

It should be mentioned here that the CBERS project satellites, which are being developed in cooperation with the People's Republic of China, include a data collection repeater as a secondary payload (see item 2.2).

This group of initiatives guarantees the consolidation of the national system of environmental data collection.

2.2 Earth Observation Satellites

The Earth Observation Satellite subprogram is aimed at the conception, specification, design, and construction, either autonomously or in international cooperation, of satellites equipped with cameras and sensors designed to generate images of the Earth, which can provide, either as a complement to, or in substitution of international systems, the data required by applications in the national interest. Included in this subprogram, as Earth observation satellites, are satellites which not only obtain images of the Earth's landmasses and oceans, but also obtain atmospheric data.

Small-Scale Remote Sensing Satellites

In addition to the SCD satellites, the MECB program established amongst its objectives two national remote sensing satellites (RSSs).

The RSSs will have nominal mass of 280 kg, three-axis attitude control, orbital control by hydrazine thrusters, and should operate in a circular equatorial orbit at an altitude of 900 km. Using the same *multi-mission platform* as the SCD-3, the main payload of these satellites will be a wide-angle CCD (*charge coupled device*) camera, operating in two bands in the visible region (blue and red), and two in the infrared (near and mid-IR). They will allow global coverage of a belt situated between 5° N and 15° S, with a passage every 105 minutes, with spatial resolution of 100 to 200 meters in the visible and 300 to 400 meters in the infrared. They will have on-board data compression capability, making possible direct real-time reception of 500 km by 500 km images by local end users equipped with small, low cost, ground stations. These characteristics make the RSS satellites very useful for missions such as the permanent monitoring of the Amazon region, allowing the real-time monitoring of biomass burning and similar phenomena. The high rate at which repeated images are obtained, for the same region, will help solve the problem of imaging regions where there is persistent cloud cover at the fixed times of coverage by conventional satellites.

The first satellite of the series is programmed for the year 2000; the second, incorporating technological improvements, for the year 2003. Also under study is a second series of satellites using radar imaging technology.

Under study, within the same program, is the development of a remote sensing satellite in cooperation with Argentina. This satellite, called SABIA, would be aimed at applications in water resources, agriculture and the environment.

---

hydrographic basins, improving hydrological alerts and the operation of hydroelectric reservoirs. Also planned is the installation of 200 DCPs for the SIVAM project.

The China-Brazil Project (CBERS)

The China-Brazil Earth Resources Satellite project (CBERS), the result of an agreement signed with the People's Republic of China in 1988, is aimed at the joint development of two medium-scale remote sensing satellites (1450 kg). The two satellites will have performance characteristics similar to those of LANDSAT or SPOT: life expectancy of two years, 778 km sun-synchronous orbit, global coverage in 26 days, and imaging in 9 spectral bands, with maximum spatial resolution of 20 meters.

In accordance with the initial agreement, Brazil took responsibility for 30% of the total project costs, including launch. Brazil also accepted responsibility for various subsystems, including the mechanical structure, energy supply, wide-angle camera, and S-band service telecommunications. Other subsystem equipment, such as the on-board computers, although originally the responsibility of the Chinese, are being developed in Brazil under subcontract. In addition, Brazil is sharing the work of management, engineering, integration and tests. The final integration of the first satellite will be done in China, and that of the second in Brazil, at the Integration and Tests Laboratory (LIT).

The launch of the first CBERS satellite is set for 1998[19], and the second should be launched in the year 2000. Brazil will have access to orbital tracking and control of the satellites in proportion to its participation in the project.

In accord with a memorandum of understanding signed at the end of 1995, studies are under way with the intention of including two new satellites in the series (CBERS-3 and CBERS-4). This undertaking will involve a significant improvement in the resolution of the satellites, together with an increase in the Brazilian participation from 30 to 50%.

2.3. Scientific and Demonstration Satellites

This subprogram is aimed at developing small, low-cost satellites for short-duration missions. It is intended to offer the academic community a chance to carry out scientific experiments of recognized merit in orbit and, in addition, allow the involvement of new university groups in Brazilian space activities. It is also aimed at stimulating international cooperation in an environment of scientific and technological interchange, and providing the means for testing new concepts and technological solutions under conditions of limited risk.

The first satellite in this scientific applications subprogram, called SACI (Scientific Applications Satellite), financed by the Financing Agency for Studies and Projects (FINEP), is in the final stages of integration and tests. It will carry four scientific experiments selected, with the assistance of the Brazilian Academy of Sciences, amongst proposals from the Brazilian scientific community and their foreign associates. With a design mass of 60 kg and a useful lifetime of 2 years, SACI will be given a piggy-back launch with the first China-Brazil satellite, CBERS-1. The use of copies of this satellite with different payloads, could constitute a convenient option for future qualification flights of the VLS-1 launch vehicle (prototypes 2 to 4: see item 3.2).

Also under study is the development of a France-Brazil scientific micro-satellite (SFB), under an agreement signed in May, 1996, between the Brazilian Space Agency and the Centre National d'Etudes Spatiales (CNES).

2.4. Telecommunications Satellites

This subprogram is aimed at developing national competence in communications satellite technology, both low-orbit and geostationary, with the intent of reaching, in the long term, a reasonable degree of autonomy. This autonomy should make it possible to conceive and design systems which exploit alternatives of specific interest to Brazil, as well as qualifying national firms for a greater participation in the telecommunications satellite subsystems market.

Low Orbit Satellites

In recent years the concept of telecommunications via a network of small low orbit satellites has gained wide acceptance, and the first global commercial systems are now being installed. As a result of the fortuitous fact that a large part of Brazil is located close to the equator, it is possible to use a type of equatorial orbit satellite system, of low cost, specific to equatorial locations.

---

[19] Translator's Note: Now scheduled for 1999.

This circumstance led to the proposal for the Low Equatorial Orbit Communications Satellite System (ECO-8), originally conceived by INPE. After feasibility studies carried out under the auspices of COBAE, and coordinated by the Ministry of Communications, the project was recommended to the President of the Republic in July, 1994, via an Inter-ministerial Memorandum[20], and was duly approved.

The studies which followed the implementation of the project were based on the concept of an international consortium with a major participation by TELEBRÁS[21]. Within the framework of these studies the Ministry of Communications duly notified the International Telecommunications Union (UIT), informing it of the ECO-8 project in April 1994, and again in 1996, communicating alterations in the project resulting from interaction with potential members[22] of the consortium.

During the first semester of 1997, changes in the telecommunications scenario, at both the national and international level, led to a decision by TELEBRÁS, not to continue with the project. As a result of this decision, the Brazilian Space Agency initiated further studies, expected to lead to a new strategy for the continuation of the project, hereafter known as ECO.

It should be noted that the SCD-3 satellite (see item 2.1) will also involve a low equatorial orbit telecommunications experiment.

Geostationary Satellites

Since 1982, the domestic demand for telecommunications services has led EMBRATEL[23] to acquire five dedicated geostationary satellites. These satellites, purchased from foreign companies, represent an investment of about 400 million dollars for the satellites themselves, and 250 million in launch services. With the large number of new applications appearing on the telecommunications scene today, and the government's policy of opening up this sector to private enterprise, a growth in domestic demand for such systems can be foreseen. This fact justifies an effort to increase Brazilian competence in the area, qualifying national firms to participate in this market. At the appropriate time, an in-depth study should be made to evaluate the feasibility of a complete Brazilian system, perhaps including a meteorological mission, following the Indian example.

2.5. Payloads and Complementary Initiatives

Experiments within Cooperative Missions with Foreign Space Agencies.

A number of scientific and technological missions, planned within the framework of cooperative agreements with NASA, will be launched either by the Space Shuttle or on board NASA satellites. The first experiment (project CIMEX) will test an infrared CCD camera on two flights, starting in 1999. A second project (HSB) involves the development of a humidity sensor, which will be part of the payload of the EOS-PM1 satellite, expected to be launched in the year 2000. Both payloads are in the development phase.

During the period covered by this program, it is expected that new experiments will arise from opportunities for cooperation being discussed with agencies from other countries.

Sub-Orbital Stabilized Platforms

The aim of this project it to develop a prototype stabilized platform, to be known as the PSO, to be launched by sounding rockets, and to meet the needs of a range of scientific and technological experiments of interest to the scientific community and to industry. Stabilization broadens the scope for applications of such a platform, and standardization will enable it to be "mass-produced", in such a

---

[20] E. M. No. 02528/COBAE, dated July 29, 1994, signed by the following ministers: Foreign Relations; Aeronautics; Communications; Science and Technology; Joint Chiefs of Staff; and by the Secretary for Strategic Studies of the Presidency of the Republic.

[21] Translator's Note: Until its recent break-up and denationalization, TELEBRÁS was the holding company responsible for coordinating the entire public telecommunication system in Brazil.

[22] The system incorporating these modifications became known as ECCO (Equatorial Constellation Communications Organization).

[23] Translator's Note: Until its recent privatization, EMBRATEL was the public company responsible for most of Brazil's inter-regional and international telecommunications.

way as to reduce costs and allow a larger number of experiments to be carried out. The launch of the first prototype of the PSO is programmed for 1998[24].

2.6. The International Space Station

Brazil's participation in the International Space Station (ISS) is awaiting funding, estimated at 120 million dollars up to the year 2002. The inclusion of Brazil in the consortium responsible for the construction of the Space Station was negotiated with NASA, and approved by the AEB's Superior Council.

The ISS, originally an American concept, probably represents the greatest exercise in international technological cooperation of all time. At the present time, work on its construction is divided between 15 countries (the USA, Russia, Japan, Canada and 11 European countries), and Brazil should become the only developing country to participate in this consortium. The estimated total cost of the construction of the Space Station is US$ 37 billion, including monies already spent since the project's inception in 1984. The estimated operational cost over the Space Station's intended 10-year lifetime is US$ 13 billion.

The original project underwent successive modifications before reaching its present form in 1994, with the inclusion of Russia in the project. In its final configuration the ISS will have a span of 108 meters, a length of 88 meters, mass of 470 metric tons, and a pressurized volume of 1,300 cubic meters, equivalent to that of two Jumbo jets. It will be located at an average height of 355 km, in an orbit inclined at 51.6° to the equator. In the operational phase, set to start in the year 2002[25] and last at least 10 years, the Space Station will have a permanent crew of 6.

The ISS will provide a micro-gravity environment for basic, applied and commercial research into physical, chemical and biological processes. It will also be important for engineering tests and will serve as an exceptional platform for Earth observation. The scientific applications plan for the ISS includes, for example, experiments in biotechnology (specially in the area of pharmaceuticals); physiology (lung and heart metabolism, bone growth and maintenance); combustion (improvements in the efficiency of surface-based power generators) and materials science (mainly the development of new semiconductors, glasses, alloys and ceramics).

Seeking to extend the internationalization of the project, and to divide its costs, NASA, its general coordinator, has identified new potential partners, amongst which is Brazil. The invitation for Brazil to participate led to the negotiation mentioned in the first paragraph of this section.

In general terms, Brazil's investment in the ISS will, as a co-proprietor of specific installations, guarantee the country a utilization quota for the Space Station, an annual free transport quota, to and from the station, and the right to propose the inclusion of Brazilian astronauts in its crew.

The participation of Brazilian industry in the supply of systems and equipment for the ISS will lead to the benefits of improvements in its qualification, specially in the area of manned space flight, and in its ability to compete in the international high technology market, as well as the direct creation of specialized jobs in Brazil.

One should also emphasize the great expectations, of the international scientific and technological communities, with respect to the results which can be foreseen from experiments conducted under the unique conditions offered by the ISS. It is reasonable to expect that experiments conducted on board the International Space Station should produce results and products of direct utility to Brazilian society.

Given the future availability of the ISS, one can foresee the prior development, in Brazil, of an experimental program in Earth Observations, biotechnology, materials science and other fields, which explore not only micro-gravity (see item 5.4), but also the other special conditions to be provided by the Space Station.

[24] Translator's Note: Now scheduled for 1999.
[25] Translator's Note: Recently rescheduled for 2004.

3. LAUNCH VEHICLES

The Launch Vehicle Program is aimed at qualifying the country to design, develop and construct launch vehicles for both sub-orbital payloads and satellites. Vehicles designed for sub-orbital missions are generally referred to as sounding rockets, and those intended for orbital missions are known as satellite launchers. One of the objectives of this program is to stimulate the development of an industrial competence in this area, contributing to increased qualification of Brazilian industry, and its competitive entry into the international market.

This program, to be executed either autonomously or in international partnership, will have the following main objectives:

a) Design, develop and construct launch vehicles capable of meeting the needs of the other programs established in this National Space Activities Program (PNAE).

b) Provide Brazil with an independent capability to launch the low orbit satellites foreseen in PNAE, and ensure its capacity to compete in this segment of the international market.

c) Provide the country with a family of sounding rockets, competitive in the international market.

d) Equip Brazilian industry for the design and fabrication of space transport systems, especially sounding rockets, from the component to the complete systems level.

e) Seek cost reductions in the launch operations and in the systems involved, with a view to encouraging the wide-spread use of these vehicles by groups from universities and research centers for both sub-orbital and orbital experiments.

f) Equip the country in the area of liquid fuel propulsion, initially for the precision orbital injection stages of satellite launchers, and subsequently for auxiliary propulsion systems, and finally leading to large rocket engines, with the objective of expanding the capability of launch vehicles to compete in the international market for space transport.

g) Equip the country for the production of large solid fuel boosters, used today in all launch vehicles under development in the western world.

This program includes three subprograms.

3.1. Sounding Rockets

This subprogram is aimed at the production of already operational rockets and the development of new vehicles.

Brazil already has operational sounding rockets which provide for a major part of its present needs. The SONDA II and SONDA III vehicles, which continue to be operational, have a long and successful history of scientific and technological payload launches. The policy of seeking a growing participation of universities and research centers in the space program should lead to a growing demand for these vehicles, thus justifying their continued production, estimated at a minimum of two rockets per year, and aiming at a target of five per year.

The VS-40 rocket was originally developed for flight testing the fouth stage motor for the satellite launch vehicle under development in Brazil. The results already obtained with this vehicle, however, indicate that it should constitute a new sounding rocket of high performance. The qualification of the VS-40 will be completed with the launch of two more prototypes.

Within this subprogram it is intended to further develop the SONDA III and VS-40 rockets, with a view to meeting national needs and also competing in the international market.

The further development of SONDA III was started in 1996, with the aim of improving its payload capacity without increasing its production costs. Further development of the VS-40, aimed at equipping the vehicle with a control system and, eventually, increased payload capacity, will be started after qualification of the present model.

In continuation of the rocket development program, feasibility studies will be conducted for the VS-43 vehicle, with and without control, with the expectation of achieving better performance than that of the larger capacity rockets operational or in development abroad.

3.2. Launch Vehicles for Small and Micro-Satellites

This subprogram is aimed at completing the qualification of the Satellite Launch Vehicle (VLS), initiated within the MECB program, and subsequently known as VLS-1, as well as developing new vehicles of the same class.

The VLS-1 can be classified as a small satellite launch vehicle. Included within its mission is the launch of data collection satellites compatible with the SCD-1 series, as well as remote sensing satellites in the same class as the SSR series. The qualification of this vehicle started with the first launch attempt of a prototype on November 2, 1997, and will continue with three more prototype launches by the year 2003.

The miniaturization of on-board systems has enabled considerable reductions in the weight and volume of satellites, opening up possibilities for launch vehicles smaller than the VLS-1. To attend the needs of micro-satellites up to 100 kg, a simpler vehicle, the VLM, will be developed. It will also be possible to use the VLM for launching sub-orbital experiments, heavier than those possible with the present line of sounding rockets. The configuration of this vehicle will be a derivative of the central part of the VLS-1, to which will be added a new fourth stage motor. Since nearly all the VLM subsystems will be derived from the VLS-1, the number of new items to be developed will be a minimum. Additionally, apart from a few small adaptations, the launch infrastructure and test installations will be the same, with consequent reductions in costs and the time required for the vehicle's qualification. The necessary studies and the development phase of the VLM started soon after the first launch attempt of the VLS-1 prototype.

3.3. Launch Vehicles for Medium Sized Satellites

This program is aimed at the development of medium capacity vehicles which, in the first phase, would be designed for satellite injection into low Earth orbit. Further development would aim at injection into medium and geostationary transfer orbits, with the intention of attending the needs of this National Space Activities Program. The first vehicle to be developed, the VLS-2, will be aimed at injecting medium capacity satellites into low Earth orbit, and will be able to attend the needs of the ECO project, and other similar programs, both national and foreign. The VLS-2 will be designed to take advantage of the privileged location of the Alcântara Launch Center, with a wide range of orbital inclinations.

In order to guarantee its ability to compete, the vehicle should be designed to satisfy a number of basic requisites, including:

- the flexibility required to carry out different missions;
- low development, production and operational costs;
- short period of development;
- high reliability;
- launch safety over the whole range of orbital inclinations;
- preference for non-toxic propellants;
- possibility of further development into a higher capacity vehicle.

In principle, the development of the VLS-2 should be carried out in cooperation with foreign organizations, with the aim of achieving easier access to new technology, especially that of liquid fuel propulsion. In this way it is hoped to reduce the development time for the vehicle, making it operational as soon as possible, and increasing its chances of becoming commercially competitive at an opportune moment. In a subsequent stage, this subprogram contemplates technical and economic feasibility studies for the development of a vehicle capable of placing medium sized satellites into geostationary transfer orbit.

4. SPACE-RELATED INFRASTRUCTURE

This program includes the expansion, modernizing and maintenance of the centers and laboratories which constitute the support infrastructure for space activities, in addition to the setting up of new facilities where necessary. These centers are not only operational, but also support the research and development activities involved in the National Space Activities Program.

The principle objectives of the Program are:

a) Equip the country with a fully operational launch center which, taking advantage of its equatorial location, should be able to provide a wide range of services commercially competitive in the international market.

b) Provide up-to-date laboratories and production facilities for Brazilian space activities, with the capacity to provide for the basic and strategic needs of the national program.

c) Guarantee the operational status and modernization of the centers which launch sub-orbital scientific and technological payloads.

d) Consolidate the infrastructure required for satellite assembly, integration and tests.

e) Promote the intensive use of Brazilian infrastructure for space activities; including, in view of the high investment costs and generally rapid obsolescence of the installations involved, its use in other areas.

f) Make possible the access to and dissemination of services of an international standard, in the supply of information, images and data in general, which allow the effective use by Brazilian society of the results generated by the space sector.

The Program is divided into four subprograms corresponding to the infrastructure facilities involved.

4.1. Support Infrastructure for Satellite Development

Integration and Tests Laboratory

The Integration and Tests Laboratory (LIT), the only one of its type in the whole of Latin America, was set up to provide facilities for the assembly, integration and functional testing and qualification of satellites and other orbital systems, as well as qualification and fault analysis of components for use in space.

In addition to meeting the needs of Brazilian space projects, LIT has the secondary objective of consolidating technology transfer in the space sector, via the conducting and analysis of tests at all levels (from components to integrated space systems), fomenting the participation of Brazilian industry in space activities, and serving as a Brazilian counterpart in development programs in cooperation with other countries, intensifying technological interchange.

It is intended to maintain LIT's operational conditions within the highest international standards, and to perfect its installations, making them suitable for the projects included in the National Space Activities Program.

In this process priority will be given to:

- modernization and expansion of the measurement and data acquisition systems;
- expansion of the laboratory's installations so as to enable integration and testing of medium sized remote sensing satellites;
- additions to the tests system for communications satellites;
- additions to the component qualification laboratory;
- installation of an acoustic chamber;
- installation of equipment for measuring mass properties of medium sized satellites;
- increase in the frequency and power ranges available in the electromagnetic compatibility and interference, electrical standards, and antenna laboratories.

Satellite Tracking and Control Center

The Satellite Tracking and Control Center (CRC) is designed to provide for tracking and control of the PNAE satellites, as well as support services for foreign satellites.

The CRC is constituted by the Satellite Control Center in São José dos Campos (state of São Paulo) together with the Cuibá (state of Mato Grosso) and Alcântara (state of Maranhão) ground stations, interconnected by a dedicated data network. The mission-critical nature of tracking and control activities imposes special conditions on the CRC, with respect to high reliability and uninterrupted operation.

Upgrading the CRC, with the aim of equipping it for the needs of the PNAE projects, involves the addition of the following installations:

- a tracking and control ground station at the Southern Regional Space Research Center in Santa Maria, in the state of Rio Grande do Sul (see item 4.3);
- a transportable ground station in Cruzeiro do Sul, in the state of Acre;
- a dedicated control system for satellite constellations.

In addition, periodic updates of the Center's computational infrastructure will be necessary.

Satellite Propulsion Laboratory

The Satellite Propulsion Laboratory, located in Cachoeira Paulista (SP), is intended to provide the means for, and give support to, research and development in the area of satellite propulsion.

The principal improvements foreseen for this laboratory during the PNAE period are:

- *implantation of the installations necessary for qualifying mono and bipropellant satellite motors;*
- implantation of installations for the laboratory scale production of liquid propellants;
- modernization of installations for quality control of liquid propellants;
- modernization of installations for the production of catalysts for hydrazine motors.

4.2. Support Infrastructure for the Development and Launching of Space Vehicles

4.2.1. Facilities in Operation or Implantation

Alcântara Launch Center

The CLA has the purpose of providing launch services in the equatorial region for both orbital and sub-orbital missions.

The Center is already operational for sounding rocket launches, and is equipped to launch the VLS-1 vehicle. In the future the installations will be extended to allow for later projects. The main facilities to be installed and modifications to be made during the next decade are:

- the Dangerous Operations Building, to allow for flight preparation of vehicles and satellites;
- a meteorological monitoring and forecasting system;
- a satellite communications station;
- the adaptation of the VLS-1 launch platform to allow the integration, transport, and launch of the VLM vehicle,;
- the construction of the launch platform and ground systems, including the launch control system, for the VLS-2;
- storage and/or production facilities for liquid fuels.

It is also intended to expand support facilities so as to allow the Center to adequately house both Brazilian and foreign teams during launch operations.

Maintaining the reliability and the competitive status of the Center will also require the maintenance of equipment to international standards. It will also be essential to continuously upgrade the installations and the satellite and launch vehicle operational facilities.

In view of the commercial possibilities of the Center, INFRAERO[26] has been made responsible for the administration of those areas of CLA where facilities for the launch of foreign vehicles are to be set up. The same organization will be responsible for modernization of the Center in other areas[27].

Barreira de Inferno Launch Center

With respect to satellite launches, especially equatorial, the CLBI will play an important role as a support station, providing tracking and safety services for satellite launch vehicles launched from Alcântara. This service is already being provided by the CLBI in support of foreign organizations, constituting an important factor for the implantation of the Launch Vehicle Tracking and Control Network.

The present capacity of the CLBI should be preserved by the maintenance required for it to operate with VS-40 class rockets. With respect to the Tracking and Control Network, the necessary equipment will be installed to interconnect it in real time with the other network links, perhaps by satellite.

Complementing these measures, CLBI equipment should be modernized. The following technical installations should be given priority:

- preparation and launch sectors;
- operational safety systems and devices;
- data processing and transmission, including a satellite communications station.

Support installations should also be modernized and extended so as provide adequate conditions for both national and foreign launch teams.

Propellants Utility

The Col. Abner Propellants Utility, for the production of solid composite propellants, was designed to provide for the needs of the MECB vehicle motors, with possibilities for expansion to meet the needs of larger diameter motors, or higher production rates.

To attend to the needs of PNAE it will be necessary to extend the production capacity, including control, tests and storage facilities, already almost saturated by the sounding rocket and VLS-1 programs. The VLS-2 will probably use solid fuel boosters of the same or larger diameter than that of the VLS-1 first stage, thus reinforcing the need for enlarging the present facilities.

4.2.2. Future Facilities

Satellite Launch Vehicle Tracking and Control Network

Satellite launch vehicle operations require the existence of a network of tracking and control stations, capable of tracking the vehicle from its take-off to the point where the satellite is injected into orbit. This network must also have the capability to send tele-destruction commands when necessary. As well as meeting the needs of launches from Alcântara, a network of this sort could also be used commercially to support other launch centers.

The network will consist of a group of remote stations, interconnected at various levels according to the tracking needs, capable of being used for simple telemetry data acquisition by one of the stations, or having the overall responsibility for controlling a mission from a given point in the launch operation. Whenever the remote stations are used, there will be a need for intercommunication between them and the CLA in real time. To allow such links to be established, there will also be a need for satellite communication stations at the tracking sites.

In the initial stage (equatorial VLS-1 launches) stations situated on Brazilian soil will be sufficient. With the further development of the Program (or in improved support of service launches from Alcântara) it will be necessary either to set up stations outside of Brazilian territory, or to establish agreements to permit the use of existing foreign stations.

As an initial step in the setting up of the network, a link between the Barreira do Inferno and Alcântara launch centers should be established, with a view to providing support for the launch of medium and

[26] Translator's Note: INFRAERO is the organization responsible for Brazilian airports.
[27] Term of Agreement No. 001/DPED-MAer / No. 001/96/0001-INFRAERO, dated 1/11/96.

large rockets. Operational tests of the system would be implemented via the launch of VLS-1, VLM and VS-40 type vehicles.

Rocket Motor Propulsion Laboratory

The Rocket Motor Propulsion Laboratory will provide support for the development of a national capability for the design, construction and operation of liquid fuelled propulsion systems launch vehicles and sounding rockets, as well as the electro-hydraulic servo actuators used for rocket nozzle steering. In the assembly stage this laboratory will provide for the assembly and testing of the hydro-pneumatic systems used in these vehicles.

The Laboratory will make the development of high thrust liquid fuelled motors possible. It will include, in the form of an annex, a test bench for liquid fuelled motors of up to 100 kN thrust. To meet the needs of the liquid fuel propulsion program, larger test benches will be installed, not only for the testing of subsystems, such as motors and turbopumps, but also for the qualification of complete rocket stages. The capacity of these test benches will be decided after the configuration of the VLS-2 has been finalized. Installations for test firings under simulated high altitude conditions will also be included.

Acoustic Tests Laboratory

This laboratory will be set up with the aim of carrying out tests on launch vehicle systems and modules, to simulate the severe acoustic environment to which they are subjected during lift off and flight.

The Acoustic Tests Laboratory will consist basically of a large reverberant chamber, capable of housing complete modules and vehicles. The acoustic environment will be generated by air-driven acoustic horns. The dimensions of this chamber will determined according to the dimensions of the test pieces involved. The Laboratory will also include a number of annexes, housing the compressed air feed systems for the acoustic horns, the control and data acquisition rooms and operational support facilities.

Carbon-Carbon Research and Production Facility

This facility will allow the production of strategic materials used in numerous parts of space vehicles (thrust nozzles, thermal shields, nosecones) in the quantities required for the Launch Vehicle Program. It will consist of a rod manufacturing unit for billet pre-form fabrication, a vacuum chamber for impregnation of the carbon matrix, thermal chamber for graphitization, and an auxiliary equipment unit.

Transonic Wind Tunnel

The implantation of a transonic wind tunnel, together with a computational fluid mechanics laboratory, will provide the country with the capacity to determine test profiles for space vehicles and aircraft under simulated flight conditions. At the moment, tests in the transonic regime have to be made abroad. Access to the necessary facilities in other countries is not always possible, because they depend on the interest of the host country in a given project. Apart from this, the use of foreign facilities makes it difficult to maintain the secrecy required in the case of potentially competitive projects.

The implantation will be carried out in two phases. In the first phase the tunnel will be open, allowing tests at velocities up to Mach 1.1. In the second state the tunnel will be closed and pressurized, allowing an increase of the operating velocity up to Mach 1.3.

The computational fluid mechanics modeling laboratory, dedicated to numerical simulations of interest to the space program, will be set up as an additional step in this part of the program.

4.3. Support Infrastructure for Research in Space and Atmospheric Sciences

4.3.1. Facilities in Operation or Implantation

Itapetinga Radio Observatory

The Itapetinga Radio Observatory (ROI)[28] *is aimed at providing the means for observing radio emissions from astrophysical sources. The data obtained from the observatory are used mainly in the study of solar physics, the interstellar medium, ionospheric radio propagation and quasars. The laboratory also provides for the development of the advanced instrumentation used in these studies.*

At the present time the Observatory is undergoing extensive remodeling, including an overhaul of the radio-telescope.

São Luís Equatorial Space Observatory[29]

The purpose of this laboratory is to provide a set of ground-based instruments for acquiring data to be used in space and atmospheric sciences research in the Brazilian equatorial region.

It is intended that the laboratory should become a center for carrying out research campaigns in the equatorial region. To this end the following stages are planned:

- finalization of the installation of a coherent scatter radar, and the start of its operation;
- construction of a second, more modern transportable radar, with the aim of making simultaneous measurements of the atmosphere-ionosphere system;
- construction of a building to house the radar, together with other instruments such as a digisonde and a magnetometer.

Balloon Launch Unit

The Balloon Launch Unit (SLB) is housed at INPE's São José dos Campos and Cachoeira Paulista[30] *installations. The basic purpose of the unit is to provide support for researchers and projects from Brazilian institutions, in the planning and launch of stratospheric balloons, including telemetry, tracking and payload recovery. In addition, the SLB develops balloon payloads and control and safety systems with the aim of increasing flight reliability.*

Improvements to be made include an increase in payload weight and higher telemetry data rates. Also foreseen are improvements in systems and procedures, in areas such as radio beacons, aimed at more efficient payload recovery.

Southern Regional Space Research Center

The Southern Regional Space Research Center (CRSPE/INPE), located in Santa Maria[31]*, is aimed at providing the conditions needed for INPE's activities in the southern region of Brazil. It will consist of two units: The Southern Space Observatory, and the Satellite Tracking and Control Ground Station, which will also be used for satellite data reception. The center will allow for an expansion in cooperative space research with the Southern Cone countries, and will house activities in the research, applications and operations areas, especially in aeronomy, space geophysics and radio-astronomy.*

The implementation of the center is being carried out in two stages. In the first phase the Southern Space Observatory will be built, and in the second will be included the construction of the CRSPE and the Satellite Tracking and Control Ground Station buildings.

---

[28] Translator's Note: The Itapetinga Observatory is located near to the city of Atibaia, in the state of São Paulo.
[29] Translator's Note: The São Luís Observatory is located near the city of São Luís, in the state of Maranhão.
[30] Translator's Note: Both São José dos Campos and Cachoeira Paulista are located in the state of São Paulo.
[31] Translators Note: Santa Maria is located in the state of Rio Grande do Sul.

4.4. Support Infrastructure for Space Applications

4.4.1. Units in Operation or Implantation

Satellite Data Reception, Processing and Distribution System

The Satellite Data Reception, Processing and Distribution System is aimed at providing the services necessary to guarantee, to the end-user, access to data and data-products[32] derived from the operation of payloads on both Brazilian and foreign satellites. To this end, a number of tasks must be carried out by installations in different locations, with well-defined characteristics, according to the specific mission in hand.

The present remote sensing missions (using the Landsat, Spot, and ERS satellites) make use of a reception station in Cuiabá[33], and processing and distribution installations in Cachoeira Paulista.

For the meteorological satellite missions, both the reception and processing stations are located in Cachoeira Paulista, allowing prompt distribution of data products. The present facilities allow reception from the Meteosat and GOES geostationary satellites, in addition to the polar orbit NOAA series.

The data collection mission has its Mission Center located in Cachoeira Paulista. The data transmitted by the satellites are received in Cuiabá, and retransmitted to Cachoeira Paulista via the Satellite Tracking and Control Center in São José dos Campos.

In view of the increase in the number of missions to be served (CBERS, SSR Series, Radarsat etc.) and the obsolescence of a large part of the present installations, a series of improvements will be necessary. With respect to remote sensing, a new reception system will be installed in Cuiabá, designed for the simultaneous reception of two satellites, with a programming capacity which takes into account reception priorities and the predicted satellite pass times. A new processing system will be installed in Cachoeira Paulista. In addition, a ground station to be installed in Santa Maria, as part of the Southern Regional Space Research Center (see item 4.3), will also be equipped for image reception. With respect to meteorological data, the capacity for receiving and processing data from geostationary satellites will be updated. Finally, in the case of the data collection platforms, the receiving capacity will be expanded by the Santa Maria station, and a new mission center will be installed, based on work-stations using recently developed software.

Weather Forecasting and Climate Studies Center

The Weather Forecasting and Climate Studies Center (CPTEC) is aimed at producing and disseminating numerical weather and climate forecasts for Brazil, with lead-times and reliability similar to those achieved by the best foreign centers.

The forecasts produced by CPTEC are based on numerical models, running on a supercomputer, which depend on input data over a rectangular grid covering the whole of Brazil. To obtain this input data it is essential to have not only satellites and data collection platforms, covering the whole of Brazil and neighboring territories, but also the techniques for extracting data from meteorological satellite images (especially in the case of areas where direct measurements are unavailable).

The end-users of CPTEC's products are public and private institutions such as the National Institute of Meteorology (INMET), the National Department of Waters and Electrical Energy (DNAEE), the departments in charge of air and maritime transport, the power generation and distribution companies, agricultural co-operatives, and the press.

As well as providing reliable weather forecasts for several days ahead, CPTEC makes draught and flood forecasts, facilitating the decision taking process in areas such as civil defense, electrical power generation, and water resources management. The forecasts should also make a significant impact in the areas of farming, transport, supply, tourism and leisure activities.

---

[32] Processed data in the form of digital images, photographs, computer-compatible tapes, compressed and reduced resolution images for distribution via the Internet, as well as in other feasible forms according to need.

[33] Translator's Note: Cuiabá is located in the state of Mato Grosso.

CPTEC's physical installations will be completed, and its computational infrastructure will be kept up-to-date.

4.4.2. Future Units

Integrated Space Data Center (CIDE)

This Center will be aimed at the installation and operation of a data bank system which will unite information on, and means of access to, all space data archives, with the following basic functions:

- To provide both hardware and software support for the computerization of relevant data bases which lack resources or infrastructure at their original locations;
- To provide for remote access to the available information by the user community, with modern technology;
- To advertise and promote the use of available information at both national and international levels;
- To provide support for the interchange of information with similar organizations and with international scientific institutions.

5. RESEARCH AND DEVELOPMENT

The Research and Development Program is aimed, in the widest sense, at fostering, coordinating and supporting, projects and activities directed at both basic and applied research in space science and technology and related fields. It also includes investigations and experiments involving the use of the space environment, or space techniques.

The specific objectives are:

a) To foster research in Space and Atmospheric Sciences, especially in the areas of Aeronomy, Astrophysics, Geophysics, Space Plasma Physics and Solar Physics.

b) To establish, in Brazil, a competence in research in the fields of meteorology and hydrology, based on the use of space technology.

c) To consolidate lines of research on processes and phenomena of global impact, defined as being of particular interest to Brazil.

d) To foster scientific and technological research which makes use of the space environment, especially micro-gravity.

e) To develop technologies of strategic importance to space systems in the national interest.

f) To develop research projects in areas related to space, such as physics of materials, plasma, applied and computational mathematics, which can directly contribute to the advancement of space science and technology.

The program is divided into six subprograms as follows.

5.1. Space and Atmospheric Sciences

The aim of the Space and Atmospheric Sciences subprogram is to carry out both basic and applied research into phenomena which occur in the Earth's atmosphere and outer space.

Research in this area is principally concerned with the areas of Aeronomy, Astrophysics and Space Geophysics. Support activities for research in these areas will also be carried out, including the development, construction, qualification and launch of scientific payloads aboard sounding rockets and stratospheric balloons, the development of specialized instrumentation, and the establishment and maintenance of laboratories, observatories and other support installations.

Research in aeronomy is aimed at studying the behavior of the upper atmosphere and ionosphere, including their dynamics, electro-dynamics, neutral and ion chemistry, together with their coupling with other regions and processes. In astrophysics the aim is to carry out basic research with emphasis on the sub-areas of high energy astrophysics (X- and gamma-rays), optical astrophysics, the interplanetary medium, molecular radio-physics, cosmology and gravitation. Finally, in Space Geophysics, the aim is to carry out basic research in the fields of geomagnetism, magnetosphere, chemistry of the lower and middle atmosphere, and atmospheric electricity.

5.2. Meteorological Sciences

The purpose of the Meteorological Sciences subprogram is to promote research into meteorology in general, especially in theoretical studies and observations of weather, climate, and hydrological resources. Priority is given to research in the areas of dynamical climatology, micro-meteorology, meteorological instrumentation, hydrological instrumentation, hydro-geochemistry, and the environmental impact of human activities.

5.3. Global Change

This subprogram is aimed at supporting, on a national scale, research projects related to global change[34], especially those based on the use of space-related means, techniques, or products, and which are coherent with the priorities[35] established by the Inter-American Institute for Global Change Research (IAI), whose headquarters are located in Brazil.

5.4. Microgravity

This subprogram is aimed at fostering and coordinating, in Brazil, research and development projects, scientific, technological or commercial, based on experiments conducted under conditions of microgravity.

The use of the microgravity environment is thought to be promising in a number of areas, such as biotechnology and materials science. The subprogram contemplates the use of various different ways of achieving microgravity conditions, such as sub-orbital rocket launches, manned flights and, in particular, the International Space Station.

5.5. Space Technology

This subprogram has the purpose of supporting projects and activities in space-related areas which, in the medium and long term, will be necessary for space systems of national importance, specially in the area of satellites and launch vehicles. It is aimed not only at achieving mastery of techniques considered strategic, but also at providing conditions for the consolidation and modernizing of specialized teams working in both public and private institutions.

5.6. Related Areas

This subprogram includes research activities in fields of knowledge associated with space activities, such as materials physics, mathematical modeling, scientific computation, and plasma physics – areas which have traditionally contributed to the solution of scientific and technological problems which arise in space activities.

---

[34] The term “global change” refers to changes in the Earth environment, either natural or man-made, with long-term effects on natural cycles, chemical, physical and biological processes.

[35] The IAI’s scientific agenda consists, today, of the following themes: tropical ecosystems and biochemical cycles; the impact of climate change on biodiversity; the El Niño southern oscillation and inter-annual climate variability; Earth-ocean-atmosphere interactions; comparative studies of coastal, estuarine, and ocean processes in the temperate zone; comparative studies of temperate latitude ecosystems; high latitude processes.

6. ESTABLISHMENT AND FURTHER TRAINING OF HUMAN RESOURCES

The purpose of this program is to coordinate initiatives directed towards establishing, in the relevant fields of activity, the trained human resources necessary for carrying out PNAE's aims and objectives.

On a ten-year time scale this program has the following objectives:

a) To promote the consolidation, in teaching and research establishments, of specialized centers in the principle areas of interest to Brazilian space activities.

b) To promote the formation of MS and Ph. D. graduates, both within Brazil and abroad, in cooperation with government organizations which support this kind of activity.

c) To support and encourage the formation of human resources, in space activity-related areas, in technical schools and institutes of higher education.

d) To promote the training of Brazilian professionals, taking advantage of opportunities for international scientific and technical cooperation and interchange.

e) To disseminate the accumulated knowledge about space activities, with the aim of creating new vocations and attracting new talents to the area.

In the short and medium term, as well as reinforcing, coordinating and articulating actions and initiatives of a general nature in the area of space activities, relevant to the last four themes outlined above, the *Uniespaço* project is being initiated, with the specific aim of achieving objective a).

The *Uniespaço* project, coordinated and financed by the AEB, is aimed at creating, making operational, and perfecting, a basis of research and development constituted by specialized centers in universities and similar institutions, capable of carrying out research and development relevant to space activities. These centers should be able to compensate lacunas amongst the specialist groups traditionally concentrated in the SINDAE sectorial organizations, in areas such as, for example, structural mechanics, telecommunications, orbital and attitude control, thermal control, on-board computation, and propulsion.

It is the intention of *Uniespaço* that, by the year 2001, there should exist a group of centers, capable of carrying out tasks of magnitude and complexity such as that of developing complete subsystems needed by PNAE projects. The intended work would naturally continue with activities aimed at maintaining and improving the centers, as well as the setting up of new centers where necessary.

It should be noted that *Uniespaço* activities will also contribute to the R & D in space technology subprogram (see item 5.5)

It should also be pointed out that the recent intensification of cooperation between the USA and Brazil, in the field of space research, has made it possible to start discussions aimed at establishing, in the near future, a technico-scientific interchange program supported by NASA, the Brazilian Ministry of Science and Technology, and the Brazilian Space Agency. This program will make possible interchange visits of personnel at research and development institutions in the two countries.

7. DEVELOPMENT OF NATIONAL INDUSTRIAL CAPABILITY

The aim of this program is to develop a growing industrial competence in Brazil, making it possible for Brazilian companies to participate in the supply of space related products and services, both within the country and abroad.

Efforts have been made in this direction for some time, in the context of sectorial organizations carrying out Brazilian space projects. These efforts need to be coordinated and directed so as to increase their effectiveness. Over the first few years of the period covered by this document, a number of basic actions needed can be defined by the following objectives:

a) The establishment and maintenance of a national register of companies with capability in the space sector.

b) The establishment of national legislation and norms, consistent with international standards.

c) The creation of mechanisms for certifying companies and products qualified for the space program, in conformity with national and international norms.

d) The fostering of technology transfer to the certified companies.

e) The proposal of legal mechanisms which stimulate the preservation of an equitable competitive environment for companies with operations in the space sector.

Structured activities in three general lines of action are foreseen within the context of the AEB. The first is directed at technical management support, covering the aspects of business and production. The second is aimed at stimulating the establishment of technical standards, product certification, and quality control, to ensure that adequate standards of design, production and operation are recognized in the space sector. The third is directed at establishing channels for disseminating information about the products and services offered by Brazilian companies.

Part 3
IMPLEMENTATION

1. GUIDELINES

The National Space Activities Program will be implemented in a decentralized manner by the organizations and entities participating in the National System for the Development of Space Activities (SINDAE).

The execution of the central core of PNAE's projects and activities falls naturally to the National Space Research Institute (INPE) and the Research and Development Department (DEPED) of the Ministry of Aeronautics (MAer), as sectorial organs of the system dedicated to Brazil's space program for more than thirty years. On the time scale of ten years, concentrated on in this document, the cast of participants in the System should be extended substantially by the inclusion of university centers and Brazilian industrial organizations. The identification of these elements will be made, taking into account their legal competence, historical involvement, and their technical and administrative preparedness for carrying out the tasks involved.

DEPED will be the coordinator and principal executive organization for the Launch Vehicle Program. This includes the implantation, operation and maintenance of the associated Infrastructure, and the development, integration, tests, and launching of such vehicles. It will also coordinate and carry out research and development activities relevant to space transport and similar systems.

INPE will act as the principal coordinator and executive organization for the Satellite and Payload Program, and for the implantation, maintenance, and operation of the Infrastructure associated with the development, integration, tests, tracking and control of satellites, and the reception, processing and dissemination of satellite data. It will also coordinate and conduct research and development activities in the fields of space science and applications, as well as in satellite and payload technology, and similar fields.

SINDAE's two sectorial organizations are also expected to make a significant contribution to the Establishment and Further Training of Human Resources and the Development of Capability in the Brazilian Industrial Sector programs.

It is expected that the Brazilian universities will not only play a fundamental role in specialized education for the space sector, but will also come to play an increasingly important role in the execution of PNAE projects, complementing the activities of the sectorial research and development establishments.

In consonance with PNAE, the AEB, as the central agency, together with the sectorial organizations, should always strive to involve Brazilian companies in the execution of the program, in order to achieve the maximum possible benefit from the mastery of space technology and the use of its associated techniques.

Finally, it should be emphasized that the sectorial organizations subordinate to the various ministries and secretariats in the different spheres of government, should participate not only as users of space systems and technology, but also in the implementation and financing of PNAE activities. In particular, the public sector, wherever it acquires space systems or services, although they might be for purely commercial or service purposes, should always explore the possibilities for contractual counterparts which help to develop Brazilian space activities.

2. BUDGETARY CONSIDERATIONS

Brazilian space activities are presently financed mainly by government resources allocated via the Brazilian Space Agency, the Ministry of Science and Technology, and the Ministry of Aeronautics, principally via budget allocations to INPE and DEPED. Complementary resources are research grants and scholarships from both national and international organizations which support research, receipts from the sale of services and products by the executive agencies and, potentially, overseas loans. In addition, the Ministry of Science and Technology and the Ministry of Aeronautics pay the Infrastructure and personnel cost of the their subordinate agencies.

The present budgetary situation is shown in Table 3.1, which shows, by source of funding, the resources allocated to each program for the years 1996-98 (values actually spent in 1996, budget allocation for 1997 and budget planned for 1998). The data presented in Table 3.1 refers to resources destined directly for projects and end-activities, together with the costs of support Infrastructure and personnel.

Table 3.2 shows a partial break-down of the three programs which are responsible for a major part of the resources applied by PNAE, namely, the Satellite and Payload Program, the Launch Vehicle Program, and the Space Infrastructure Program.

Table 3.1

PNAE Budget Break-down for 1996-1998

R$ 1000 (current value)

PROGRAMS	MCT[4]	AEB	MAer	Others	Total
	1996 (Actual Values)				
Space Applications	1,926	465	0	0	2,391
Satellites and Payloads[1] [2]	13,196	7,713	0	1,710	22,619
Launch Vehicles	0	10,409	4,473	151	15,033
Space Infrastructure	14,983	8,300	5,510	976	29,769
Research and Development	2,217	913	718	298	4,146
Human Resources and Training[3]	419	320	0	2,000	2,739
Industrial Development	0	0	0	0	0
Subtotal	**32,741**	**28,120**	**10,701**	**5,135**	**76,697**
Maintenance of Infrastructure	10,576	1,407	8,400		20,383
Personnel	33,590	1,461	20,219		55,270
TOTAL	**76,907**	**30,988**	**39,320**	**5,135**	**152,350**
	1997 (Confirmed Budget)				
Space Applications	2,530	0	0	0	2,530
Satellites and Payloads[1] [2]	14,050	18,320	0	2,147	34,517
Launch Vehicles	0	9,243	9,660	0	18,903
Space Infrastructure	17,500	3,237	2,000	0	22,737
Research and Development	3,060	0	0	0	3,060
Human Resources and Training[3]	745	500	0	2,000	3,245
Industrial Development	0	0	0	0	0
SUBTOTAL	**37,885**	**31,300**	**11,660**	**4,147**	**84,992**
Maintenance of Infrastructure	14,655	1,236	8,545		24,436
Personnel	38,000	1,380	23,001		62,381
TOTAL	**90,540**	**33,916**	**43,206**	**4,147**	**171,809**
	1998 (Proposed Budget)				
Space Applications	3,850	0	0	0	3,850
Satellites and Payloads[1] [2]	19,920	21,000	0	3,694	44,614
Launch Vehicles	0	10,500	6,600	0	17,160
Space Infrastructure	25,370	6,500	2,000	0	33,870
Research and Development	4,450	400	0	0	4,850
Human Resources and Training[3]	730	1,200	0	2,000	3,930
Industrial Development	0	400	0	0	400
SUBTOTAL	**54,320**	**40,000**	**8,660**	**5,694**	**108,674**
Maintenance of Infrastructure	10,370	998	12,436		23,804
Personnel	31,700	1,342	31,735		64,777
TOTAL	**96,390**	**42,340**	**52,831**	**5,694**	**197,255**

Notes:

(1) Includes satellites, SCD-2 launch campaign (1996 and 1997), experiments in cooperation with NASA (CIMEX and HSB) and participation in the ISS (1997 and 1998).

(2) The value quoted in the “Others” column refers to the financing, by FINEP, of the SACI and SFB micro-satellite projects.

(3) The value quoted in the “Others” column is an estimate referring to post-graduate scholarships.

(4) Refers to decentralized budget resources for INPE. The MCT also contributed via FINEP and the CNPq (scholarships).

Table 3.2
Partial Break-down for Major Programs

R$ 1,000 (current value)

Programs	1996 Actual Values	1997 Confirmed Budget	1998 Proposed Budget
Satellites and Payloads	**22,619**	**34,517**	**44,614**
CBERS	12,462	13,700	18,320
Other Satillites	5,928	6,949	13,694
Launch Services (SCD-2)	2,400	13,518	
Experiments with NASA and Others	1,829	250	8,600
International Space Station - ISS		100	4,000
Launch Vehicles	**15,033**	**18,903**	**17,160**
Satellite Launch Vehicles	14,355	18,680	14,660
Sounding Rockets	678	223	2,500
Space Infrastructure	**29,769**	**22,737**	**33,870**
Satellite Development Support	7,331	6,500	8,620
Support for Development and Launch of Space Vehicles	11,367	4,900	8,500
Support for Space and Atmospheric Sciences	161	2,837	4,950
Support for Space Applications	10,910	8,500	11,800
TOTAL	**67,421**	**76,157**	**95,644**

Note: Personnel and maintenance of support Infrastructure not included

Although the available financial resources for Brazilian space activities have been growing in recent years, they are still sufficient only to maintain present activities. The implementation of the new proposals - specially the more substantial of them, such as participation in the International Space Station, the development of new satellites and a new launch vehicle – will certainly mandate the existence of additional resources, implying a virtual doubling of the present level of funding over the next few years.

The data shown in Table 3.3 and Figures 3.1 through 3.5 show the present relative distribution of resources per program, and according to source. These distributions may be used as a baseline for analysis, but it must be borne in mind that there will be a tendency for them to suffer major modifications with the inclusion of the resources necessary to implement the major proposals referred to in the previous paragraph.

Table 3.3
Average Distribution of Resources per Program and Source
(Percentage)

Programs	Sources				
	MCT	AEB	MAer	Others	Total
Space Applications	3.1	0.2			3.3
Satellites and Payloads	17.4	17.4		2.7	37.5
Launch Vehicles		11.2	7.7	0.1	19.0
Space Infrastructure	21.4	6.7	3.5	0.4	32.0
Research and Development	3.6	0.5	0.3	0.1	4.5
Human Resources and Training	0.7	0.7		2.2	3.6
Industrial Development		0.1			0.1
TOTAL	46.2	36.8	11.5	5.5	100.0

Notes:
Average for the years 1996, 97 and 98
Personnel and maintenance of support infrastructure not included

Fig. 3.1

Average Distribution of Resources by Source

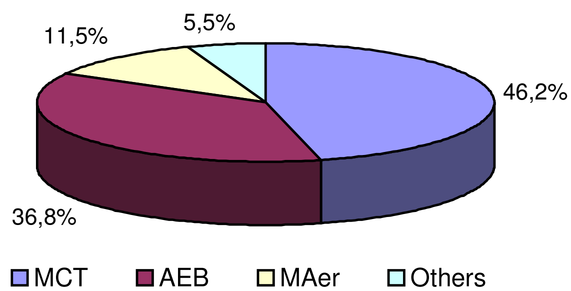


Fig. 3.2

Average Distribution of Total Resources by Program

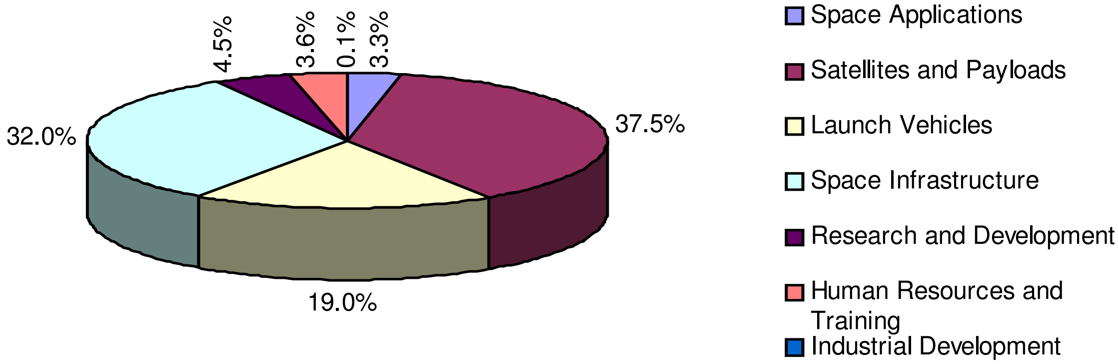


Fig. 3.3

Average Distribution of AEB Resources by Program

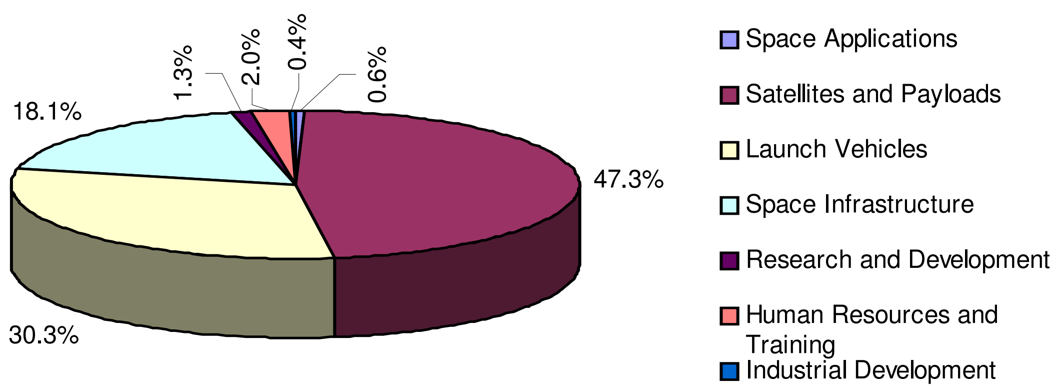


Fig. 3.4

Average Distribution of MCT Resources by Program

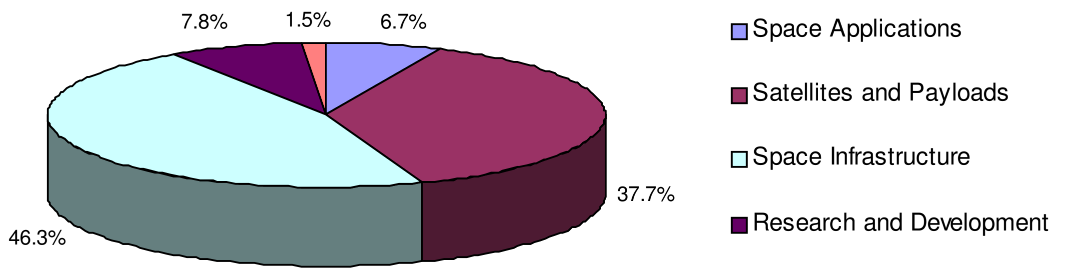
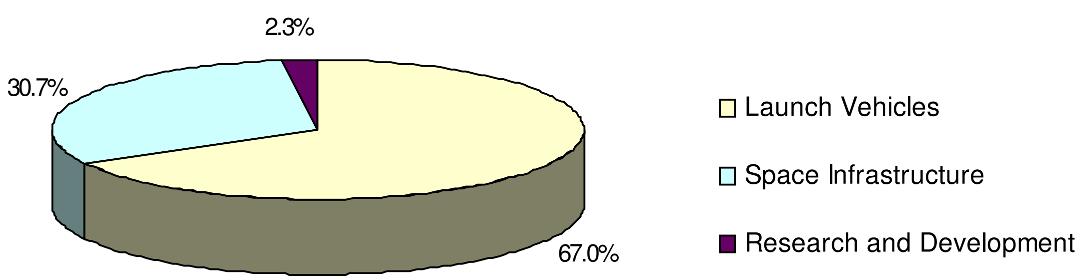


Fig. 3.5

Average Distribution of MAer Resources by Program



4. Appendix

LAW NO. 8,854 OF FEBRUARY 10, 1994.

Creates the Brazilian Space Agency (AEB) as a civilian organization, and addresses related matters

THE PRESIDENT OF THE REPUBLIC
I make it known that the National Congress decrees, and I sanction the following law:

Art. 1 The Brazilian Space Agency – AEB is created as an autonomous civilian organization, associated to the Presidency of the Republic, with the purpose of developing space activities of national interest.

§ 1. The AEB answers directly to the President of the Republic.

Art. 2 The AEB, granted administrative and financial autonomy, with its own patrimony and staff, is physically and legally located in the Federal District.

Art. 3 The functions of the AEB are:

I. Carry out, and cause to be carried out, the National Policy for the Development of Space Activities – PNDAE, in addition to proposing guidelines and implementing the consequent actions;

II. Propose the revision of the National Policy for the Development of Space Activities, and the actions to be taken for its implementation;

III. Elaborate and revise the National Space Activities Programs – PNAE, and the respective budget proposals;

IV. Promote relations with similar institutions both within the country and abroad;

V. Analyze proposals and sign international agreements and conventions, together with the Ministry of Foreign Relations and the Ministry of Science and Technology, with the aim of cooperation in the field of space activities, and accompany the execution of such;

VI. Provide assessments of questions related to space activities under discussion in the international forum and, in coordination with the Ministry of Foreign Relations and the Ministry of Science and Technology, act as representative in such forums;

VII. Stimulate the participation of universities and other institutions of teaching, research and development in space-related activities;

VIII. Stimulate the participation of the private sector in space activities;

IX. Foment scientific research and technological development in activities of interest to the area of space;

X. Stimulate the access of national bodies to knowledge obtained by the development of space activities, aiming at their technological advancement;

XI. Articulate the joint use of space-related technical installations, with a view to the integration of available means and the rationalization of resources;

XII. Identify commercial possibilities for the use of space applications and technology, with a view to stimulating entrepreneurial initiatives in supplying services and products;

XIII. Establish norms and emit licenses and authorizations relative to space activities;

XIV. Apply standards of quality and productivity in space activities.

§ 1. In the execution of its activities, the AEB has the right to act, directly or indirectly, via contracts, conventions and agreements, both in the country and abroad, without prejudice to the content of item V of this article, and to the competence of the Office of the Solicitor-General of the Treasury[TN].

Art. 4 Brazilian space activities will be organized in a systematic way, established by the Executive.

§ 1. Within the system which is the subject of this article the AEB will hold the central position.

Art. 5 The AEB has the following basic structure:

I. - President;

II. - Superior Council;

III. - Director-General;

IV. - Department of Administration;

V. - Department of Planning and Coordination;

VI. - Department of Space Programs;

VII. - Department of Technical and Scientific Development;

VIII. - Department of Space Cooperation.

Art. 6 The Superior Council, of a deliberative nature, has the following composition:

I. - The president of the AEB and the Director-General, as permanent members;

II. - Representatives of the Ministries and Secretariats of the Presidency of the Republic with activities related to the space area;

III. - One representative from the scientific community, and one from the industrial sector involved in the space area, with two year mandates.

§ 1. The members of the Superior Council referred to in item II, not less than ten, and not more than 18, in number, are designated by the President of the Republic.

§ 2. The Superior Council will be presided over by the president of the AEB or, in the absence of the latter, by the director-general.

§ 3. The president of the AEB will, after hearing the Ministries and Secretariats referred to in item II, submit the names of the indicated representatives to the President of the Republic for his approval and designation.

§ 4. The Superior Council will approve the instrument which describes its competence and procedures.

Art. 7 The AEB will be administered by a president, a director-general, and five heads of department, nominated by the President of the Republic, and chosen from Brazilians of irrefutable moral standing and known technical and administrative competence.

Art. 8 The Executive is authorized to redistribute or transfer to the Brazilian Space Agency, the balance of the Armed Forces budget provisions destined for the Brazilian Commission on Space Activities – COBAE, maintaining the same sub-projects, sub-activities and budgetary groupings defined in Law No. 8,652, of April 29, 1993.

Art. 9 Also constituting AEB sources of income are:

I. - Financial designations included in the National Budget;

II. - Income of any nature resulting from its holdings or activities;

III. - Special credits designated by law;

IV. - Other resources obtained or designated.

[TN] Translator's Note: In the original "Procuradoria-Geral da Fazenda Nacional"

Art. 10 The patrimony of the AEB shall be constituted by the properties it acquires, including donations and inheritances from individuals or legal entities.

§ 1. The Executive is hereby authorized to cede to the AEB, for its use, such properties of the Union as should be necessary for the exercise of its activities.

Art. 11 The AEB will succeed COBAE in its rights and obligations with respect to national and international agreements and instruments of cooperation.

§ 1. The Office of the Solicitor General of the Treasury will adopt the measures necessary to celebrate terms of addition, with a view to formalizing the determination of this article.

Art. 12 This law creates, within the permanent staff of the AEB, the civilian post of President of the Agency, and the commissioned posts and patronage positions, foreseen in Annex 1 of this law, and in conformity with the budget provisions made for this purpose.

§ 1. The occupants of special or commissioned positions, as defined in Annex 1, will be freely chosen by the administration, and in conformity with the legislation in force.

Art. 13 This law creates, within the AEB, the civil service posts defined in Annex II of the law.

§ 1. Appointments to the positions referred to by this article require prior approval in public examination, in the terms of the legislation in force.

§ 2. The Executive will determine the regulations pertaining to the positions created by this article.

Art. 14 The values corresponding to the remuneration of the AEB posts are those shown in Annex II of Law No. 8.622, of January 19, 1993, with their subsequent alterations, including legal adjustments.

Art. 15 To the federal public servants placed at the disposition of the AEB, are guaranteed the remuneration and rights of the permanent position or post, including promotions.

§ 1. The public servant under the conditions defined in this article, will continue to contribute to the pension fund to which he is affiliated, without interruption, for the purposes of calculating his years of service in the organization or entity to which he belongs, for all purposes pertaining to the legislation relevant to labor and social security, including special laws and internal norms.

§ 2. The period during which the public servant remains in the service of the AEB shall be considered for all effects of the public service, as being time served in the position or post occupied in his organization or entity of origin.

Art. 16 Until a minimum of sixty percent of the total number of the AEB's permanent posts should be filled, any public servant occupying a permanent post or position may be designated to occupy a commissioned post.

Art. 17 The employees of the AEB shall receive the "activity gratification" defined under the law "Lei Delegada" No. 13, of August 27, 1992, at the level of 160 percent.

Art. 18 Within a period of 180 days from the date of publishing of this law, the Executive will make appropriate dispositions concerning the structure of the AEB.

Art. 19 The President of the Republic will decree the extinction of COBAE, as soon as the AEB has been set up and has entered into operation.

§ 1. Until the extinction of COBAE foreseen in this article, the directors and employees of COBAE will continue to exercise their present functions.

Art. 20 This law enters into effect on the date of its publication.

Brasília, February 10, 1994, in the 173rd year of Independence, and the 106th year of the Republic.

ITAMAR FRANCO
Celso Luiz Nunes de Amorim
Lélio Viana Lobo
José Israel Vargas
Arnaldo Leite Pereira

DECREE NO. 1,332, OF DECEMBER 8, 1994

Approves the revision of the National Policy for the Development of Space Activities – PNDAE

The **PRESIDENT OF THE REPUBLIC**, by the power invested in him by Article 84, Items IV and VI of the Constitution, and in view of the dispositions of Item II of Article 3 of the Law No. 8,854, of February 10, 1994,

DECREES:

Art. 1 That the revision of the National Policy for the Development of Space Activities – PNDAE described in Annex I of this Decree is approved.

Art. 2 This decree enters into effect on the date of its publication.

Brasília, December 8, 1994; in the 173rd year of independence and the 106th year of the Republic.

ITAMAR FRANCO

Mauro Motta Durante

NATIONAL POLICY FOR THE DEVELOPMENT OF SPACE ACTIVITIES

I. INTRODUCTION

The current update of the National Policy for the Development of Space Activities (PNDAE), prepared by the Brazilian Space Agency, in fulfillment of Item II, Article 3, of Law No. 8,854 of February 10, 1994, and approved by the President of the Republic, establishes the objectives and guidelines which shall guide the actions of the Brazilian Government aimed at the development of space activities in the national interest.

II. DEFINITIONS

1. The term *space systems* is used to indicate systems, either designed to operate in space or to make feasible the operation in space of equipment designed to provide access to information or services. In this manner *space systems* will signify, generically, space stations, satellites, space platforms (or busses), payloads, represented by measuring, observing or telecommunications equipment, and rockets and space transport vehicles.
2. *Space infrastructure* is to be taken as the set of ground facilities, systems or equipment, together with the associated services, which provide the necessary support for the effective operation and utilization of *space systems*. Included in this category are launch centers for sounding rockets, satellite launch vehicles and stratospheric balloons, specialized laboratories for fabrication, integration and tests, stations and centers for tracking and control, and for the reception, processing and distribution of satellite data etc.
3. *Space Activities* are to be understood as the systematic effort to develop and operate *space systems,* as well as the essential corresponding *infrastructure,* with a view to allowing man to expand his knowledge of the universe, especially the planet Earth and its atmosphere, and to exploit, with utilitarian motives, the availability of these new devices.
4. A country's space activities are usually organized into programs, composed by subprograms, projects and activities of a continuous nature. It is customary to refer to the conjunction of these programs as the *Space Program* of the country. In analogous form, the National Space Activities Program (PNAE) is to represent the conjunction of initiatives put forward by the Brazilian Space Agency, and approved by the President of the Republic.

III. GENERAL CONSIDERATIONS

The principal considerations forming the basis for this policy are summarized as follows:

- Space Activities typically require large scale investments in long-term projects, but with substantial expected returns. Over the last four decades of the recent world history of space activities, many direct and indirect economic and social benefits can be clearly recognized. These benefits stem directly from the application of artificial satellites to the solution of everyday problems, specially in the fields of telecommunications, weather and climate forecasting, inventory and monitoring of natural resources, navigation and science. The indirect benefits come mainly from the use of the resulting scientific and technological knowledge in innumerable areas of human activity, from medicine to the production of a wide range of goods and services, amongst which micro-electronics, computational technology and materials are outstanding examples.
- Brazilian investments in the field of space, over the past 30 years, have allowed the country to form competent teams of specialists, consolidate research and development institutions, set up important infrastructure installations, and initiate the formation of a Brazilian space industry. They have also made it possible to disseminate the techniques of satellite communications, navigation, remote sensing and meteorology, of great potential in the solution of innumerable problems confronting the nation.
- The Complete Brazilian Space Mission (MECB), started in 1979, represented the first major national program in the ambit of space, and the adoption of the universally accepted model of development via the taking on of projects which are both long-term and highly ambitious. MECB has been successful, and amongst its results should be emphasized the highly successful launch of the first satellite developed in Brazil, the SCD-1, the setting-up of the basic infrastructure for future Brazilian space missions, including the Integration and Tests Laboratory (LIT) and the

Satellite Tracking and Control Center (CRC), both located at the National Space Research Institute of the Ministry of Science and Technology. Equally noteworthy are the setting-up of the Alcântara Launch Center (CLA) and the completion of the principal steps in the development of the Satellite Launch Vehicle, the VLS, both by the Research and Development Department of the Ministry of Aeronautics.

- As a result of Brazil's geo-economical characteristics, space technology offers major potential for the solution of a wide range of national needs. Amongst these characteristics can be included the country's massive territorial extent, the concentration of its population in the coastal zone, its vast regions of tropical forest, large areas of difficult access and low population density, extensive borders and sea-coast, and the significant volume of natural resources as yet inadequately mapped.
- Brazil's location on the terrestrial globe makes it possible to conceive of specific space systems, economically advantageous for the solution of a number of problems of national importance, and which could be of interest to other neighboring or appropriately located countries.
- Geo-political changes in the international scenario have provoked changes in space programs all over the world, creating expanded opportunities for international cooperation, and greater importance for smaller, less costly programs, aiming at results with shorter lead-times.
- As a result of international tendencies, the technologies of small satellites and associated launch vehicles have come to be of greater importance, with a corresponding increase in the value of the experience gained with MECB, and in the opportunities for future initiatives.
- Space transport vehicles deserve special attention by virtue of the nature of the technology involved, the difficulties of international cooperation, and their strategic importance, guaranteeing autonomy to the country in the launch of satellites, platforms and payloads of national interest.
- Brazil's advances in the space sector need to be consolidated and extended. This requires the completion, maintenance and modernization of the existing infrastructure, the extension and updating of the human resources dedicated to space activities, increased institutional participation in space programs, and the creation of opportunities for the commercialization of space-related products and services. The institutional participation referred to here includes not only the government, but also the private sector and, especially, Brazilian industry.

IV OBJECTIVES

The general objective of the National Policy for the Development of Space Activities (PNDAE) is to advance the capacity of the country, according to appropriate criteria, to utilize space techniques and resources in the solution of national problems and in benefit to Brazilian society.

For the achievement of this general aim, the following specific objectives may be identified:

1. *The establishment, in the country, of a technico-scientific competence in the area of space, permitting a genuine autonomy of action in:*
    - The selection of alternative technologies for the solution of Brazilian problems;
    - The development of in-house solutions for problems specific to our territory or society, wherever more economical alternatives are either unavailable or cannot be guaranteed;
    - The effective use of information of interest to Brazilian society, provided by space techniques;
    - International negotiations, accords and treaties, involving material pertinent to space activities, or capable of benefiting from knowledge based on such activities.
2. *Advancement of the development of space systems, together with the corresponding means, techniques and ground-based infrastructure, making necessary or desirable services and information available to Brazil.*
3. *Qualification of the Brazilian industrial sector to participate and become competitive in the supply of products and services related to space.*

V. GUIDELINES

In the planning and execution of the programs consequent upon the objectives specified above, the following guidelines should be observed:

1. Priority for the Solution of National Problems

The resources available for the development of Brazilian space activities should be concentrated in initiatives aimed at seeking solutions to national problems, or problems of national interest, through the use of space techniques and the knowledge obtained from them.

2. Concentration of Efforts in High-Profile Projects

International experience has shown that progress in the space sector is most significant, and most appreciated by public opinion, when spearheaded by major high-profile programs, which concentrate efforts in clear objectives, of merit and consequence, which impose major scientific and technological challenges to the organizations and companies entrusted with their execution.

The Brazilian Space Agency, and the other organizations which form part of the National System of Space Activities, should permanently strive to conceive new initiatives, and to organize the activities under way in programs with the characteristics emphasized above.

3. Scope Defined by the Final Results

Government initiatives in the space area should be organized via programs conceived in such a way that the desired results will provide concrete benefits to Brazilian society.

As a consequence of this, the applications programs should take into account all the segments necessary to guarantee the end-user access to the products and services made possible by the program. They should also take into account the availability of means for the full utilization of the new information available. In general, this directive implies the application of significant efforts in the processing and analysis of data, and in the development of technology for that purpose. It also involves the establishment and operation of suitable base structures, and a significant effort in technology transfer.

4. Critical Investment Analysis

Government investments in research and development in the space area should explicitly seek to achieve the objectives expressed in this policy. Additionally, it should be required that programs and projects to receive government financing should be clearly characterized by their efficiency, and should:

- Prioritize initiatives involving a balanced temporal distribution of results, with guaranteed returns in the short and medium terms, diminishing the project's global risk, and facilitating decision taking with respect to investments and continuity;
- Submit program investment proposals to cost-benefit analysis, taking into account the results to be achieved.

5. International Cooperation of Consequence

Today, in view of the fact that such projects are extremely expensive, international cooperation is a natural choice for making space projects feasible. Nevertheless, it must be borne in mind that, in the technical area, international cooperation is not usually characterized by a free interchange of valuable information. Information sharing is limited to that strictly necessary to achieve the common objective. In this context, the following guide-lines should be followed:

- Proposals for international cooperation should state clearly and pragmatically the benefits to be accrued for the parties involved, and the basic interests on the Brazilian side should be within the ambit of this policy;
- Cooperative scientific projects should be encouraged, seeking to establish favorable conditions for the interchange of personnel, equipment and data, as well as assuring beneficial participation for Brazil in the major international scientific programs;
- Opportunities for cooperation in space engineering, technology and systems, and the corresponding infrastructure, should be taken advantage of whenever within the interests of the country;

- Cooperative initiatives with countries which share problems and difficulties similar to those of Brazil should merit special attention;
- The establishment and adoption of international standards should be supported, so as to ease the interchange of information, and assure a growing compatibility in space systems between cooperating organizations the world around.

6. Incentives for Industrial Participation

Participation by Brazilian industry in the development of space systems and technology is an essential condition for the effective absorption of the know-how resulting from these programs by the productive sector. This participation should be foreseen explicitly in proposals for new programs, which should:

- Promote the qualification of national industry, not only as suppliers of equipment and parts but, also in the development and manufacture of complete systems and subsystems;
- Seek the integration of institutional research and development teams and their industrial counterparts, by the joint execution of technological development projects which include industry right from the start;
- Seek to establish long-term plans which allow Brazilian firms to decide on their participation in the national space program with reduced uncertainty.

7. Optimized Use of Resources

It should be recognized that human resources and infrastructure are scarce in Brazil and, consequently, their exceptional value should be recognized, preserved and used in the best way possible. In this context the following points should be kept in mind:

- The analysis of new proposals should take into account their needs for personnel and infrastructure, seeking at the same time to avoid not only duplication of efforts but, also, the overload and/or breaking-up of existing teams;
- Laboratory installations set up in government research and development institutes, to attend the needs of the National Space Activities Program, should be shared with universities and Brazilian industry, without prejudicing their primary functions.

8. Development of Capability in Strategic Technologies

Projects aimed at developing competence in new technologies should give priority to dominating techniques considered strategic for the country, following criteria which include:

- Their importance for space systems or services of major interest to the country;
- Difficulties existing with respect to imports;
- The potential commercial value of the technologies involved for Brazilian companies;
- The competence and facilities available within the country, in the context of possible innovative contributions to the state of the art.

9. Pragmatism in the Conception of New Space Systems

In conceiving new projects for the development of space systems, efforts should be directed, preferentially, to the solution of problems peculiar to Brazilian society or territory, and which are also of interest to the international community. The solutions sought after should preferentially be characterized by an attractive cost/benefit ratio, by the exploitation of comparative advantages inherent to Brazilian conditions, and by their potential for commercial exploitation.

10. Importance of Scientific Activities

The activities of scientific investigation or basic research in the area of space should be given due value, not only because they contribute to universal knowledge but, principally, because they contribute to national development.

11. Emphasis on Space Applications

The application of space technology to the solution of problems typical of a country with the geo-political characteristics of Brazil, constitute the principal justification for government investments in the area. The planning of Brazilian space activities should consider the application of space technology to the solution of problems such as communications in remote regions, environmental monitoring, surveillance of the Amazon region, border and coastal patrol, monitoring and inventory of natural resources, planning and monitoring of land use, crop forecasting, environmental data collection, climate and weather prediction, vehicle and accident location, and the development of industrial processes in the micro-gravity environment, as well as national defense and security. Government institutions involved in space activities should work to develop systems, products, processes and methods which make possible space applications and, wherever possible, should transfer to private firms the supply of services or products derived from these applications.

12. Coherence Between Autonomous Programs

The National Space Activities Program (PNAE) , which should plan actions to realize the objectives established in this Policy, should consist of scientific, technological development and applications programs, as well as programs aimed at the implantation, maintenance and expansion of, not only the operational infrastructure, but also that applicable to basic research and development. A coherent relationship must be maintained between these programs in both the short and long terms.

In this way, scientific or applications missions under way should be based on technology and facilities either already available, or in the acquisition or implantation phase. In counterpoint, the foreseeable long-term needs of scientific or applications programs should guide technological development programs.

In this manner, missions planned for the future will define parameters for satellite and payload technology development programs. These missions, and the needs of the satellites involved, will set the constraints for proposals for the development of space transport vehicle technology. Finally, proposals for expanding infrastructure, both for operational support and for research and development, should be based on the future needs of the other programs.

13. Conciliating Technological Objectives with Scientific Aims and Applications Goals

The conciliation of the objectives of technological development of space systems with those of science and applications should be taken as fundamental in programming the development of space activities.

It must be recognized that, in many cases, technological development leads to the possibility of applications. On the other hand, the need for solutions to problems of national importance produces technological challenges. The direction to be taken by the space program should lie in the conjunction of these two aspects. In general, the purely technological goals are set by extrapolating the existing technological capacity linearly in time, always with the aim of perfecting existing technologies and incorporating new ones. One might say that the ultimate technological objective is to dominate the technology, not only for its own sake, but also as a national possession, as an investment for future needs not foreseen in the present program.

The scientific and applications objectives, respectively, should be directed towards:

- The advancement of universal knowledge, which can both benefit and be benefited by the development of space activities, in the first case;
- The solution of problems of national scope, or of interest to the country, in the case of applications.

In this context, it is irrelevant whether the technology used was developed in the country, or acquired abroad, so long as the practical result is achieved.

14. Dual Use Technologies

A significant fraction of the technology developed for space applications can be classified as dual use technology[TN]. PNAE should take account of government policy and legislation on export controls on dual use material and related services, seeking, where appropriate, to coordinate the activities of the Agency with those of other federal organizations in respect of these goods and services.

15. Other Guidelines

In addition to programs, projects and activities related to scientific research and development, applications and specific technological development, the National Space Activities Program (PNAE) should also contemplate more general programs and activities, based on the following guide-lines:

- *Promote the creation and further training of highly qualified human resources,* together with the consolidation and strengthening of specialized research and development teams in national institutions, in all fields of space activities of national interest;
- *Promote international cooperation at all levels*, as a way of accelerating the acquisition of scientific and technological knowledge, guaranteeing access to data and making economically feasible the development of space systems of interest to the country;
- *Promote greater integration between universities and Brazilian industry*, via various mechanisms, such as industrial contracts for the supply of parts, equipment, subsystems and services, in the context of national space systems development programs, or fomenting the creation of specialized space technology centers in Brazilian teaching and research establishments. These measures will make it possible to extend the supporting base and human resources development in space activities, in addition to seeking a gradual and selective autonomy in the country in certain technological areas considered to be of high priority;
- *Promote, with priority, the development of space systems* which associate clearly defined objectives of technological and industrial development with essential scientific or utilitarian objectives;
- *Promote the development and dissemination of space applications,* in strict consonance with the government policies for the sectors to be directly benefited;
- *Promote and encourage commercial participation in the financing of space systems aimed at providing commercial services;*
- *Encourage the commercial exploitation of services and products resulting from or associated with space activities, giving priority to the private sector;*
- *Complete, maintain and make adequate the necessary infrastructure for space missions of national importance, including development, integration and tests and space systems laboratories, tracking and control centers and launch centers;*
- *Promote the dissemination and effective use of space-related technico-scientific information, with emphasis on that of normative nature.*

[TN] Translator's Note: "Dual use technology", in this context, refers to technology with both military and non-military applications.

DECREE NO. 1,953 OF JULY 10, 1996

Creates the National System for the Development of Space Activities - SINDAE and other matters.

The **PRESIDENT OF THE REPUBLIC**, by the powers invested in him by Article 84, Item IV, of the Constitution, and in view of the dispositions of Article 4 of Law No. 8,854 of February 10, 1994,

DECREES:

Art. 1. The National System for the Development of Space Activities – SINDAE is created with the purpose of organizing and carrying out space activities aimed at space development of national interest.

Art. 2. SINDAE is constituted by a central body, responsible for its general coordination, by sectorial organizations, responsible for sectorial coordination and the execution of activities defined in the National Space Activities Program – PNAE, and other participating organizations, responsible for the execution of activities specific to PNAE.

Art. 3. Constituting SINDAE are:

I. - As the central organization, the Brazilian Space Agency - AEB;

II. - As sectorial organizations:

a) The Department of Research and Development of the Ministry of Aeronautics – DEPED;

b) The National Institute for Space Research of the Ministry of Science and Technology – INPE;

III. - As participating organizations and bodies:

a) The ministries and secretariats of the Presidency of the Republic, when involved in the subject, by their representatives indicated by the competent authority;

b) The states and federal district and municipalities, where there exists interest, by their representatives indicated by the respective executive principal;

c) The private sector, as indicated by its legal representative.

§ 1 In any of the cases defined in Item III, participation in SINDAE will depend on the prior approval of the AEB's Superior Council.

§ 2 The participation in SINDAE by the organizations and bodies defined in Item III will be formalized by the signing of an agreement of participation.

§ 3 The agreements of participation should clearly establish the courses of action to be followed by the signatories, including those of a budgetary or financial nature, in such a way as to make possible the complete execution of PNAE, with the obtainment of greater benefit from the available resources.

Art. 4. The functioning of SINDAE shall be regulated by normative resolution, approved by the AEB's Superior Council.

Art. 5. This decree enters into effect on the date of its publication.

Brasília, July 10, 1996; in the 175th year of independence and the 108th year of the Republic.

FERNANDO HENRIQUE CARDOSO

Clóvis de Barros Carvalho

ABBREVIATIONS USED

ABC – *Academia Brasileira de Ciências:* Brazilian Academy of Sciences

AEB – *Agência Espacial Brasileira:* Brazilian Space Agency

AIAB – *Associação das Indústrias Aeroespaciais do Brasil:* Brazilian Aerospace Industries Association

CBERS –China-Brazil Earth Resources Satellite

CCD – Charge-Coupled Device

CIDE – *Centro Integrado de Dados Espaciais:* Integrated Space Data Center

CIMEX – CCD Imaging Instrument Experiment

CLA – *Centro de Lançamento de Alcântara:* Alcântara Launch Center

CLBI – *Centro de Lançamento da Barreira do Inferno*: Barreira de Inferno Launch Center
CNAE – *Comissão Nacional de Atividades Espaciais*: National Commission on Space Activities
CNES – *Centre National d'Etudes Spatiales:* National Center for Space Studies

CNPq – *Conselho Nacional de Desenvolvimento Científico e Tecnológico:* National Council for the Development of Science and Technology

COBAE – *Comissão Brasileira de Atividades Espaciais:* Brazilian Space Activities Commission

CPTEC – *Centro de Previsão do Tempo e Estudos Climáticos:* Weather Forecasting and Climate Studies Center

CRC – *Centro de Rastreio e Controle:* Tracking and Control Center

CRSPE – *Centro Regional Sul de Pesquisas Espaciais:* Southern Regional Space Research Center

CTA – *Centro Técnico Aeroespacial:* Aerospace Technical Center

DAE – *Divisão de Assuntos Especiais:* Special Affairs Division

DEPED – *Departamento de Pesquisa e Desenvolvimento:* Department of Research and Development

DNAEE - *Departamento Nacional de Águas e Energia Elétrica:* National Department of Waters and Electrical Energy

ECCO – Equatorial Constellation Communications Organization

EGNOS – European Geostationary Navigation Overlay System

EMFA – *Estado-Maior das Forças Armadas:* Joint Chiefs of Staff of the Armed Forces

ENSS – European Navigation Satellite System

EOS – Earth Observation System

ESA – European Space Agency

FINEP - *Financiadora de Estudos e Projetos:* Financing Agency for Studies and Projects

GETEPE – *Grupo Executivo e de Trabalhos e Estudos de Projetos Espaciais:* Executive Group for Space Project Activities and Studies

GNSS – Global Navigation Satellite System

GOCNAE - *Grupo de Organização da Comissão Nacional de Atividades Espaciais:* Organizing Group of the National Commission for Space Activities

HSB – Humidity Sensor – Brazil

IAE – *Instituto de Aeronáutica e Espaço:* Institute of Aeronautics and Space

IAI – Inter-American Institute for Global Change

INFRAERO – *Empresa Brasileira de Infra-Estrutura Aeroportuária:* Brazilian Company for Airport Infrastructure

INMET – *Instituto Nacional de Meteorologia:* National Meteorology Institute

INPE – *Instituto Nacional de Pesquisas Espaciais:* National Institute for Space Research

IPD – *Instituto de Pesquisas e Desenvolvimento:* Research and Development Institute

ISS – International Space Station

LIT – *Laboratório de Integração e Testes:* Integration and Tests Laboratory

MAer – *Ministério da Aeronáutica:* Ministry of Aeronautics

MCT – *Ministério da Ciência e Tecnologia:* Ministry of Science and Technology

MECB – *Missão Espacial Completa Brasileira:* Complete Brazilian Space Mission

MTCR – Missile Technology Control Regime

NASA – National Aeronautics and Space Administration

PCD – *Plataforma de Coleta de Dados:* Data Collection Platform

PNAE – *Programa Nacional de Atividades Espaciais:* National Space Activities Program

PNDAE – *Política Nacional de Desenvolvimento das Atividades Espaciais:* National Policy for the Development of Space Activities

ROI – *Rádio Observatório de Itapetinga:* Itapetinga Radio Observatory

SACI – *Satélite de Aplicações Científicas:* Scientific Applications Satellite

SCD – *Satélite de Coleta de Dados:* Data Collection Satellite

SFB – *Satélite Franco-Brasileiro:* Franco-Brazilian Satellite

SIG – *Sistemas de Informações Geográficas:* Geographic Information Systems

SINDAE – *Sistema Nacional de Desenvolvimento das Atividades Espaciais:* National System for the Development of Space Activities

SIVAM – *Sistema de Vigilância da Amazônia:* Amazon Surveillance System

SLB – *Setor de Lançamento de Balões:* Balloon Launch Sector

SSR – *Satélite de Sensoriamento Remoto:* Remote Sensing Satellite

UCA – *Usina de Propelentes Coronel Abner:* Colonel Abner Propellants Facility

UIT – *União Internacional de Telecomunicações:* International Telecommunications Union

VLM – *Veículo Lançador de Microssatélites:* Microsatellite Launch Vehicle

VLS – *Veículo Lançador de Satélites:* Satellite Launch Vehicle