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E C L A C

Economic Commission for Latin America and the Caribbean

Meeting of Regional Experts preparatory to the  
United Nations Conference for the Promotion of  
International Cooperation in the Peaceful Uses  
of Nuclear Energy.

Santiago, Chile, 15-18 April 1985



NUCLEAR ENERGY IN COLOMBIA, MEXICO, BOLIVIA AND  
ECUADOR AND PROSPECTS FOR REGIONAL COOPERATION ★/

★/ The present document was prepared by Mr Luis Galvez Cruz, ECLA consultant. The opinions expressed are the sole responsibility of the author and may not coincide with those of ECLAC.

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## FOREWORD

Preparatory to the United Nations Conference for the Promotion of International Cooperation in the Peaceful Uses of Energy to take place in 1986, ECLAC has produced the present report, resulting from the Mission that covered Colombia, Mexico and Venezuela, to be used as a background paper for a possible meeting of experts to discuss the issue of nuclear energy in Latin America.

Section A of Chapter I presents a description of the institutional structure of the nuclear sector in the country, as well as of the energetic and non-energetic uses of nuclear energy.

It analyzes the energy policy, the generation of electricity - including nuclear power production plans - and also makes some comments on uranium resources.

It describes the current status of the non-energetic uses of nuclear energy and also of the plans and programmes to be developed.

There is also an enumeration of the problems of each country vis-a-vis investments and funding, human and physical infrastructure, training of manpower, etc.

Section B of Chapter I refers to international technical cooperation and lists the different types of technical assistance from international agencies such as IAEA and IANEC as well as types of cooperation at regional and international level resulting from bilateral agreements.

The report also mentions, in Chapter II, some observations relevant

to problems common to all three countries and suggests, in Chapter III, some recommendations which, in any case, could be taken into account so that they may perhaps contribute to a possible effective sub-regional and regional cooperation as well as to a balanced international cooperation.

Annexes I, II and III include complete information on each of the countries where the mission was carried out, with the corresponding breakdowns per headings and sub-headings.

## I. SUMMARY REPORT OF THE MISSION

### Colombia

#### 1. Peaceful uses of nuclear energy

##### a) Institutional structure of the nuclear sector

This sector if formed, basically, by the following institutions:

i) Instituto de Asuntos Nucleares (IAN), a dependency of the Ministry of Mining and Energy whose aim is to prepare and develop programmes with the purpose of studying nuclear energy; promoting its use; advising the Government of Colombia on use and application of nuclear energy and promoting scientific and technological research in this field.

ii) Compañía Colombiana de Uranio, S.A. (COLURANIO, S.A.), another dependency of the Ministry of Mining and Energy whose main responsibilities are the exploration, exploitation, conversion and marketing of radioactive minerals.

iii) Other public and private institutions such as hospitals, universities and industries, that make use of nuclear energy in their respective fields.

##### b) Energetic uses of nuclear energy

In accordance with the energy policy being applied in Colombia after several studies carried out by different departments of the Federal Government (National Study on Energy, National Development Plan and National Programme for the Research and Development of Energy Resources for the years 1983-1986), all these studies coincide in concluding that there is not enough justification for nuclear power production in the near future and that it will be an

attractive alternative in the early years of the next century.

As for speculative uranium resources, these were initially explored by IAN and are at present being explored by COLURANIO S.A. However, the most important activities were carried out through joint ventures formed with foreign companies (France and Spain) between the years 1975 and 1982, which were discontinued on account of the fall in prices in the uranium market. Estimates on Colombia's speculative uranium resources have set a top limit of 200 000 metric tons of uranium, which would have to be developed by national and/or international institutions.

c) Non-energetic uses

Given the fact that Colombia envisages no nuclear power projects in the near future, it should be noted that the specific objectives of the Colombian nuclear programmes have been mainly directed to the use of radioisotopes and irradiation in several fields such as agriculture, medicine, industry, etc. as will be briefly explained below:

1) In Colombia, the largest number and variety of nuclear activities are conducted by the Instituto de Asuntos Nucleares (IAN). To this effect, the Institute has a staff of 53 professionals, 102 assistant technicians and administrative staff. Its budget in 1983 was of approximately 250 million pesos.

Since 1965 IAN has been operating an experimental reactor of 20 k W and, apart from offering radiological protection and manpower training services this institution has been engaged in the following projects, among others: small-scale production of radioisotopes, livestock fertility and vaccination,



industrial gammagraphy, hydrology, use of phosphate fertilizers, treatment of minerals, food irradiation, etc.

ii) As for the other Colombian institutions making use of nuclear energy, it may be said that there are at present 19 nuclear medicine centres, most of which form part of university hospitals, where in each of them the usual nuclear medicine procedures are applied.

d) Constraints affecting the nuclear sector

The activities of the Colombian nuclear sector have not apparently been governed by a clear, well-defined and permanent policy. This has resulted in individual and isolated efforts which do not always emerge from any explicit programme of activities.

The main problems detected, according to the above, are related to:

- i) Lack of infrastructure and of highly qualified manpower;
- ii) Lack of university training in the field of nuclear energy, and
- iii) Lack of financing, etc.

2. Regional and international cooperation

In Colombia, partly due to the absolute lack of infrastructure, the implementation and development of nuclear activities depend to a large extent on international technical assistance. For example, Colombia belongs to international agencies such as IAEA and IANEC and has signed bilateral cooperation agreements with the United States, Argentina, Brazil and Spain.

There are also prospects for cooperation with Canada, France, Italy and Chile.

It is worth noting that there is a project for cooperation with the countries of the Andean sub-region (Bolivia, Colombia, Ecuador, Peru and Venezuela) and the IAEA to launch five nuclear energy programmes of interest to all.

a) Institutions visited

- i) Departamento Nacional de Planeación, Ministry of Mining and Energy.
- ii) Instituto de Asuntos Nucleares (IAN), Ministry of Mining and Energy;
- iii) COLURANIO, S.A. Ministry of Mining and Energy;
- iv) Fondo Colombiano de Investigación Científica (COLCIENCIAS);
- v) Instituto de Investigaciones Tecnológicas and
- vi) Instituto Nacional de Cancerología

b) Documents collected by the Mission

- i) Reports on 1981 and 1982 prepared by IANEC
- ii) Report on 1982 prepared by COLURANIO, S.A.,
- iii) National Study on Energy, National Planning Department, Ministry of Mining and Energy, 1982;
- iv) National Development Plan, National Planning Department, Ministry of Mining and Energy, 1982.
- v) The IAN Reactor Project, IAN-R-2, 1983;

- vi) Lineamientos Generales para el Programa Nacional de Investigación en Recursos Energéticos, 1983-1986, COLCIENCIAS (General guidelines for the national programme for research on energy resources)
- vii) Nuclear Development Plan IAN, 1983, and
- viii) Reports on IAN Activities, 1983.

Mexico

1. Peaceful uses of nuclear energy

a) Institutional structure of the nuclear sector

This sector is formed by the following institutions:

i) Comisión Nacional de Energía Atómica (CNEA), the topmost agency responsible for the definition of policies for Uranio Mexicans (URAMEX) and for the Instituto Nacional de Investigaciones Nucleares (ININ);

ii) Uranio Mexicano (URAMEX), a decentralized agency responsible for the exploration, exploitation, application and marketing of radioactive minerals and for the execution of the different stages of the nuclear fuel cycle.

iii) Instituto Nacional de Investigaciones Nucleares (ININ), a decentralized agency responsible for research on and development of nuclear sciences and technologies and the promotion of the peaceful uses of nuclear energy in the country;

iv) Comisión Nacional de Seguridad Nuclear y Salvaguardias (NSNS) a decentralized institution dependent on the Secretaría de Energía, Minas e Industria Paraestatal, responsible for safeguarding and ensuring nuclear and radiological protection in the country, and

v) Other public and private institutions such as the Comisión Federal de Electricidad (CFE) responsible for the generation, distribution and supply of electricity, including that of nuclear sources, universities, research institutions, hospitals, private companies developing radioisotope techniques, etc.

b) Energetic uses of nuclear energy

i) The Mexican energy sector belongs by law to the State. There is a predominance of hydrocarbons, 90 per cent, with reserves equivalent to 7 200 million barrels. The reserves of coal (3 000 million tons), hydro-energy (140 TWH/year) and geothermal energy (14 TWH by the year 2000) will not be enough to cater for the energy requirements by the year 2000 (400-600 TWH), which will have to be met by hydrocarbons and/or uranium.

ii) The first nuclear energy plant is at present being built (2 BWR reactors of 650 MW), although there has been a four-year delay caused by administrative, technical and financial problems.

The first unit shows 75 per cent completion and start-up is estimated at early 1986; the second unit is only 40 per cent ready.

iii) In 1980 the Energy Programme launched a possible nuclear energy programme (20 000 MW(e) by the year 2000). SOFRATOME from France, ASEA-ATOM from Sweden and AECL from France were the companies that carried out the study. Their conclusions were that despite the large investments needed for light water (BWR or PWR) or heavy water (CANDU) reactors these were not only competitive but also involved lower investments than other conventional installations (hydraulic and thermal). However, this programme was cancelled in 1982 due to the economic problems which the country has encountered.

iv) Uranium resources have been studied and prospected since 1957, first, by CNEN, the National Nuclear Energy Commission, which in 1970 had reported finding 3 157 tons of  $U_3O_8$  in 34 locations of the States of Sonora, Chihuahua, Durango and San Luis Potosí. By 1976, ININ, the National Nuclear Research

Institute, which took over the activities carried out by CNEN, had reported 8 332.8 tons of  $U_3O_8$ . With the creation of URAMEX, Uranio Mexicano, in 1979, activities were carried out until May 1983 and reserves rose to 14 552 tons of  $U_3O_8$ . However, from May 1983 to date URAMEX has been closed due to industrial unrest.

c) Non-energetic uses

These activities are coordinated by ININ, the National Nuclear Research Institute, but are also carried out in other academic and research institutions.

ININ has a well-equipped Nuclear Centre (TRIGA MARK III nuclear reactor, laboratories, workshop, high irradiation cells and a staff of 1516). In 1983 its budget was 18 341 253 dollars.

Other research centres have detection equipment, count and irradiation laboratories and nuclear reactors, critical (UNAM) and subcritical (IPN and University of Zacatecas).

ININ has a well-equipped information and resource centre with on-line access to IAEA and other 90 data banks in other countries.

The training of nuclear science specialists in the country is carried out at professional and postgraduate levels mainly by UNAM and IPN.

The study courses include different aspects such as nuclear physics; structure of matter; nuclear and physical safety standards; environmental aspects related to nuclear plants; fuel; nuclear technology applied to agriculture, hydrology, industry, isotope production; etc.

The ININ in its capacity as government institution responsible for the

peaceful uses of nuclear energy has prepared a nuclear development plan to be covered in 10 years. Five areas of activity (Reactors and Fuels, Nuclear Technology, Human Resources Technical, and Research Services) and fifteen development lines have been incorporated aiming at maximizing the current resources of the institution and the possibilities of inter-institutional promotion. The plan will be revised every year to take into account both the results of the projects already carried out and the changes observed in the Institute's and the country's conditions.

d) Constraints affecting the Nuclear Sector

The main constraints which throughout the years have affected the nuclear sector in varying degrees and which have resulted in delays, dispersion and not altogether satisfactory results are the following:

i) Nuclear energy has not been considered a priority for the economic, scientific and social development of the country, which has produced a lack of rational investment and financing;

ii) The lack of articulation in institutional coordination in connection with nuclear matters, which has originated duplication of efforts and investment, and

iii) The under-utilization of human and material resources mainly because the training of manpower does not take place according to pre-planned programmes but responds to personal improvement reasons and also because the curricula designed by the academic institutions of the country do not correspond to the real needs of the country.

## 2. International Cooperation

To a large extent, Mexico implements the development of its nuclear activities through international technical assistance. For example, IAEA has promoted multiple projects by providing scholarships, experts, equipment and research contracts covering widely different areas (nuclear protection, fuels, instrumentation, food, hydrology, etc.)

Also, Mexico has signed bilateral agreements with the Federal Republic of Germany, Spain, the United States of America, France and Romania and has shown interest in setting up efficient cooperation links at levels both regional and inter-regional in order to combine efforts and avoid duplication.

### a) Institutions visited

- i) Comisión Nacional de Energía Atómica;
- ii) Uranio Mexicano (URAMEX);
- iii) Instituto Nacional de Investigaciones Nucleares (ININ);
- iv) Comisión Nacional de Seguridad Nuclear y Salvaguardias (CNSNS).
- v) Comisión Federal de Electricidad (CFE);
- vi) Secretaría de Energía, Minas e Industria Paraestatal;
- vii) Universidad Nacional Autónoma de México (UNAM);
- viii) Instituto Politécnico Nacional (IPN);
- ix) Consejo Nacional de Ciencias y Tecnología (CONACYT);
- x) Ingenieros Constructores Asociados (ICA);
- xi) Instituto Mexicano del Seguro Social (IMSS);
- xii) Instituto Mexicano del Petróleo (IMP), and
- xiii) Instituto de Investigaciones Eléctricas (IIE).



b) Documents collected by the Mission

- i) Law creating the Comisión Nacional de Energía Nuclear (1955);
- ii) Law creating the Instituto Nacional de Energía Nuclear (1971);
- iii) Amendment to Constitutional Article 127 (Creation of ININ URAMEX, CNSNS and CEA);
- iv) Propuesta de Lineamientos de Política Energética (a proposal of guidelines for an energy policy prepared by the Secretaría del Patrimonio Nacional, 1976, nowadays Secretaría de Energía, Minas e Industria Paraestatal);
- v) Nucleoelectricidad para Mexico, Juan Eibenshutz, CFE, 1982, (Nuclear power for Mexico).
- vi) Programa Nucleoeléctrico Nacional, CFE, 1982; (National nuclear power programme).
- vii) Factibilidad del Programa Nucleoeléctrico Nacional, CFE, 1981; (Feasibility of the national nuclear power programme).
- viii) Implantación del Programa Nucleoeléctrico, CFE, 1981; (Adoption of nuclear power programme).
- ix) Desarrollo del Mercado Eléctrico, CFE, 1978-1992 (Development of the electricity market).
- x) Annual Reports on Activities, ININ, 1979-1983.
- xi) Nuclear Development Plan, ININ, 1984-1994;
- xii) Nuclear Activities at UNAM, 1983;
- xiii) Specialization and degree studies in Nuclear Sciences CONACYT, 1978;
- xiv) Report on CNSNS Activities, 1982;
- xv) La Seguridad Nuclear en Mexico, R. Bello, 1982 (Nuclear safety in Mexico).
- xvi) Presencia de URAMEX en el Desarrollo de Mexico, URAMEX, 1980 (Presence of

URAMEX in the development of Mexico).

- xvii) Board of Trustees, Technical Cooperation, IAEA, 1983, and
- xviii) IAEA Technical Reports, 1983.

Venezuela

1. Peaceful uses of nuclear energy

a) Institutional structure of the nuclear sector

This sector is formed as follows:

i) Consejo Nacional para el Desarrollo de la Industria Nuclear (CONADIN).

The Council is a dependency of the Ministry of Energy and Mining and its main objectives are to carry out research and promote the peaceful uses of nuclear energy for the economic and social progress of the country; advise the country's executive power on such matters as participation in international agreements and covenants on nuclear energy issues; recommend standards of nuclear safety; promote teaching and research; guidelines to industry and other entities in connection with whatever programmes may be adopted, and any other activity which the national executive power may assign it.

ii) Instituto Venezolano de Investigación Científica (IVIC). It is this Institute, by means of the nuclear engineering service, that operates and is responsible for the maintenance of nuclear reactor RV-1 and its associated facilities providing also assistance to users. Apart from this activity, IVIC promotes the application of nuclear technology in different fields of science and technology. IVIC is a dependency of the State of Venezuela.

iii) Other institutions of public and private nature such as hospitals, universities and industries that use nuclear energy.

b) Energetic uses of nuclear energy

According to the information available, Venezuela has not yet launched

actions tending to the definition of a nuclear power programme, since the expansion in its power production capability has been structured mainly on the basis of the generation of thermal energy from oil (6 381.055 MWe) and hydropower (2 683.120 MWe). All this notwithstanding, in 1978 CONADIN bought the WASP Model (Wein Automatic System Planning) in order to define an optimum policy for the generation expansion of the electric system. In 1981, CONADIN ceded the model to the Venezuela electricity companies and it may well be that this model may provide the nuclear power component of the future expansion of the system.

Also, in the preparation of the 5-year national nuclear plan, CONADIN has included programmes relative to studies to be carried out and which refer to location of sites for the emplacement of nuclear plants, licensing regulations, types of commercial nuclear reactors, etc.

As for uranium resources in Venezuela, some important uraniferous areas will have to undergo prospection and evaluation to find out the real potential of the country, since at present, estimates point to uranium resources ranging between 2 000 and 42 000 tons of  $U_3O_8$  which would no doubt guarantee the launching of a plan that in the short term (2 years), medium term (5 years) and long term (10 years) will make it possible to define Venezuela's self-sufficiency vis-a-vis this resource.

c) Non-energetic uses

Activities in connection with agricultural, industrial, medical and other uses in Venezuela are carried out as follows:

- 1) The main activities within the field of non-energetic uses of nuclear

energy are conducted by CONADIN, in collaboration with other institutions, particularly the Instituto Venezolano de Investigación Científica (IVIC) and the Universities of Zulia and Simón Bolívar. Some important projects are related to mutations induced in agriculture and the application of fertilizers, the use of radioisotopes in industrial processes, radiation dosimetry services, etc.

For the purpose of technical coordination CONADIN has a reduced number of professional staff and, in general, promotes and sponsors activities channelled through the institutions listed above.

ii) Other non-energetic activities such as those related to medicine are carried out in a large number of hospitals and medical centres located in different cities of the country.

d) Constraints affecting the nuclear sector

In Venezuela, the main constraints affecting the nuclear sector arise from the fact that the State agencies have few economic resources available and that also there is a shortage of human resources with top level qualifications: despite attempts to launch a national nuclear plan it is difficult to put it into practice. It should be added that the training of staff is carried out in other countries and that, in most of the cases, this staff is not used for carrying out sector-related tasks.

2. Regional and international cooperation

Given the problems of the nuclear sector in Venezuela, most of its

activities are sponsored by the IAEA and it is CONADIN the institution responsible for technical cooperation with international agencies and for bilateral agreements with different countries.

The cooperation areas are varied and include such technical assistance as experts, scholarships, equipment, research contracts, etc.

Venezuela forms part of the Andean Sub-Regional programme promoted by IAEA. There exist at present agreements and cooperation with Argentina and Spain and prospective agreements with Italy and Brazil.

a) Institutions visited

- i) Consejo Nacional para el Desarrollo de la Industria Nuclear (CONADIN), and
- ii) Instituto Venezolano de Investigaciones Cientificas (IVIC)

b) Documents collected by the Mission

- i) CONADIN newsletter;
- ii) IVIC newsletter;
- iii) General information on CONADIN, 1982;
- iv) Reports on Projects, Studies and Programmes carried out by CONADIN, 1983;
- v) Programme of CONADIN activities for 1983.
- vi) National Plan for the Exploration of Radioactive minerals;
- vii) National Plan for the Electric Expansion of the country;
- viii) Report on the Coordination of the Andean Sub-Regional Programme, 1983;
- ix) Coordinated Projects on the Agricultural and Farming Area, CONADIN, University of Zulia.

- x) Regional Project on Non-Destructive Tests;
- xi) Report on Coordination of Radiological Protection, CONADIN;
- xii) Report on Technical Cooperation, CONADIN;
- xiii) Bilateral Agreements, CONADIN;
- xiv) Technical Assistance from IAEA, and
- xv) Equipment and nuclear activities in the Universities.

Bolivia

1. Peaceful uses of nuclear energy

a) Institutional structure of the sector

This sector is structured as follows:

i) Bolivia began its nuclear activities in 1960 through the Comisión Boliviana de Energía Nuclear (COBOEN) which after being dependent on several institutional agencies came under the jurisdiction of the Ministry of Mining and Metallurgy.

COBOEN was assigned all the activities related to research and applications of nuclear energy by means of the organization of a structure covering three departments: Radioactive Raw Materials; Nuclear Research Centre (CIN) of Viacha and Radiological Safety.

ii) In 1982, the Ministry of Mining and Metallurgy planned the restructuring of the nuclear activities of COBOEN by transferring matters related to prospection, exploration and evaluation of radioactive materials from the Department of Radioactive Raw Materials to the Bolivian Geology Service. At the same time, the Institute of Mining-Metallurgy Research was assigned responsibility for the production of uranium concentrates.

The Department of Radiological Protection and the CIN were incorporated to the Instituto Boliviano de Ciencia y Tecnología Nuclear, including also such functions as nuclear power planning and nuclear technology, control and supervision of nuclear activities in the country and signing of national and international agreements.



iii) The Nuclear Medicine Centre, which in 1982 was separated from COBOEN and became a dependency of the Ministry of Social Welfare and Public Health. This institution is responsible for the execution of all the studies on and application of nuclear energy within the field of Medicine.

iv) Amongst the other Bolivian institutions that use nuclear energy are some universities and industries.

b) Energetic uses of nuclear energy

i) The Bolivia energy sector satisfies its energy needs mainly through its oil and gas resources. It also has a hydro-power potential of 20 000 MW and has an installed power capacity of 540 MWe, 60 per cent of which is hydraulic and 40 per cent thermal.

As regards nuclear power plants, a preliminary assessment shows that given the present installed capacity and the future projection, a nuclear plant of at least 300 MWe would only be attractive in the case of networks exceeding 2 000 MWe. All this makes the possibility of generating nuclear power somewhat remote, particularly if the hydro-power reserves of the country are taken into account. However, the possibility of carrying out planning studies in the future has not been discarded, particularly in the case of small and medium power output plants used in regional interconnection systems.

ii) Bolivia has undertaken the prospection of 20 000 Km<sup>2</sup> using its own resources and of 50 000 Km<sup>2</sup> through the Italian company AGIP Uranium Ltda. (8 500 000 dollars). Only the anomalous concentration of minerals has been deemed interesting: 10.6 tons of U<sub>3</sub>O<sub>8</sub> have been assessed and another 75 tons of U<sub>3</sub>O<sub>8</sub> are estimated in Sevaruyo. AGIP did not report any commercially

attractive deposits.

IAAE through two of its experts has inferred the existence of speculative uranium reserves of nearly 100 000 tons in the Escudo Brasileiro de Bolivia (160 000 Km<sup>2</sup>). Studies on mineral concentration processes have also been carried out. Some 14 000 tons of ore have been extracted (0.07 per cent fineness) and some hundreds of tons have been processed. At present, there is stock of about 200 kg of concentrate.

c) Non-energetic uses

i) Different applications are considered in this connection: agriculture, farming, industry, medicine and research on nuclear physics and chemistry. The most important requirements have been: the implementation of manpower and material infrastructures which was developed in the period comprised between 1960 and 1970, when a large number of people were sent to other countries to get training in different areas of the nuclear field and when equipment and laboratories were acquired. Between 1974 and 1983 the Viacha Nuclear Research Centre with its three Divisions (nuclear physics, analytic methods and isotope applications) was created. This Centre started operating in the different fields of interest of COBOEN, for example, agriculture (soil fertility in rice and potato crops); radiological safety (dosimetry, register and inspection of sources); nuclear medicine (physiological and physiopathological studies, radioimmuno-analysis, etc.); analysis (fluorescence and neutronic activation) etc.

ii) The near-absence of a nuclear energy national policy in Bolivia caused the Ministry of Mining and Metallurgy to approach the Executive Board of COBOEN for the formulation of a nuclear energy policy which included non-

energetic applications. Thus the Viacha CIN and the Department of Radiological Safety were transferred to the Institute of Nuclear Research, a dependency of the Presidency of the Republic, responsible, among other functions, for the planning of nuclear and nuclear power technology, the control and supervision of nuclear activities in the country and the signing of national and international nuclear energy agreements.

d) Constraints affecting the nuclear sector

In Bolivia, nuclear activities have not reached the desired level of growth due to:

i) Little economic and financial support since the State has not assigned priority to nuclear activities;

ii) Lack of an energy policy and deficient manpower and material infrastructure, and

iii) Lack of academic training in nuclear energy matters.

2. Regional and international cooperation

The nuclear activities in Bolivia have, to a large extent, been implemented with technical assistance from IAEA, from other international agencies (INEC) and through bilateral cooperation agreements.

Bolivia has endorsed 11 cooperation agreements with national and international agencies, the most important of which are related to the use of

radioisotopes in agriculture, prospection and evaluation of uranium resources, consultancies with respect to the C/N activities, radioimmunoassay studies, radiological protection, etc.

In the past Bolivia signed regional cooperation agreements - some of which are still valid - with countries such as Argentina and Brazil, with the sub-Andean group (Colombia, Ecuador, Peru, Venezuela and the IAEA) and international agreements with Italy and France.

a) Institutions visited

- i) Comisión Boliviana de Energía Nuclear (COBOEN);
- ii) Instituto Boliviano de Ciencia y Tecnología Nuclear and
- iii) Centro de Medicina Nuclear.

b) Documents collected by the Mission

- i) Brochure describing the functions and activities of COBOEN;
- ii) Four-year-horizon plan to be developed in connection with nuclear energy issues in Bolivia (COBOEN)
- iii) Programme for the restructuring of the nuclear activities of COBOEN and
- iv) Information directly supplied by the management of the Instituto Boliviano de Ciencia y Tecnología Nuclear and of the Centro de Medicina Nuclear of La Paz.

Ecuador

1. Peaceful uses of nuclear energy

a) Institutional structure of the nuclear sector

This sector is structured as follows:

i) Comisión Ecuatoriana de Energía Atómica (CEEa), an agency assigned to the Presidency of the Republic and responsible for the execution of the nuclear policy of the country.

The organization structure of CEEa was set up in terms of a Board of Directors, a Chairman and an Executive Committee. The Board of Directors is formed by the CEEa Chairman and by representatives of seven ministries and is responsible for the formulation of general guidelines for CEEa and for endorsing the annual working plan.

It is the Chairman's job to observe and enforce the CEEa law; the legal and administrative responsibilities correspond to the Executive Committee. The functions of CEEa are: to advise the government on all matters related to nuclear energy; to carry out policies, plans and programmes for research, development and control of all the aspects of nuclear energy and also to promote national and international technical cooperation.

ii) Other institutions utilizing nuclear energy

These are academic and research institutions, hospitals and some private institutions.

It is necessary to mention that the Organización Latino Americana de Energía (OLADE) has its headquarters in the city of Quito and although

until now its activities have not covered the field of nuclear energy, in March 1984 OLADE organized a seminar on small and medium power reactors in Latin America in collaboration with the Peruvian Institute of Nuclear Energy.

b) Energetic uses of energy

Ecuador has not launched actions tending to define nuclear power programmes since being a petroleum exporting country and having vast hydraulic resources (90 000 MW) this country does not envisage possible plans in this field before the year 2010. However, the Instituto Ecuatoriano de Electrificación (INECEL) will start some planning studies for which it will use the IAEA WASP programme.

As regards uranium resources, CEEA is carrying out with IAEA assistance a programme for the prospection of uranium in all the country.

c) Non-energetic uses

The activities that Ecuador has carried out in connection with nuclear energy have got to do mainly with applications to farming, industry, hydrology, bio-physics, basic research and nuclear medicine.

The following are some examples of the work carried out, studies on stock of hydro-resources; analysis of pesticides, radioimmunoassay research, preparation of radio-vaccines, use of fertilizers marked with N-15, non-destructive tests, study on water resources of Quito, dosimetry services, radiological protection regulations, radio-therapy and radiodiagnosis.

CEEA aims at implementing a national nuclear plan based on the definition of programmes, projects and activities; determination of a calendar according

to each programme; stock-taking of resources, and promotion of natural, regional and international cooperation.

d) Constraints affecting the nuclear sector

The constraints that have affected Ecuador in the course of developing nuclear energy are the following:

- i) Ecuador has not assigned priority to nuclear energy and this has resulted in lack of financing and investment in this field;
- ii) Lack of adequate human and material infrastructures;
- iii) Lack of defined and specific programmes to respond to the country's needs, and
- iv) Lack of academic training vis-a-vis nuclear energy.

2. Regional and international cooperation

A large number of the nuclear activities in Ecuador have been carried out through international technical assistance (IAEA, UNDP, ONUDI, etc.) in fields such as nuclear energy applications to industry, agriculture, hydrology, raw materials, physics, nuclear chemistry, etc.

The cooperation instruments have been research projects and contracts, courses, grants, experts, equipment, etc. At a regional cooperation level, Ecuador has taken part in activities with the Andean Group (Bolivia, Colombia, Peru and IAEA) and also has a joint action plan with Argentina.

Ecuador is open to regional and international cooperation.

a) Institutions visited

- i) Comisión Ecuatoriana de Energía Atómica (CEEAA)
- ii) Secretaría del Consejo de Seguridad Nacional, and
- iii) Organización Latinoamericana de Energía (OLADE)

d) Documents collected by the Mission

- i) Ecuadorian Energy Commission Law;
- ii) CEEA Organic and Functional Regulations;
- iii) Radiological Protection Regulations;
- iv) Joint CEEA - Argentina Action Plan, and Information received by the  
writer from the CEEA
- v) Executive Committee.



## II OBSERVATIONS

Both in the case of Colombia and in that of Mexico and Venezuela, it is possible to say that the Mission made it possible to obtain common denominators related to, for example, activities, problems and aspects of regional and international cooperation.

### 1. Activities

Within the energy area these three countries are interested, to a larger or lesser extent, in the definition and implementation of a national nuclear energy plan and the development of the nuclear industry in the short, medium or long term.

As regards non-energetic applications, the common lines of action have to do mainly with some issues related to agriculture, food, hydrology, industry and medicine.

### 2. Problems

It is valid to assume that none of the governments of the three countries have a priority interest in connection with the peaceful uses of nuclear energy, which has slowed down both the application of nuclear energy to energetic and also to non-energetic uses. Because of this, their plans and programmes represent isolated efforts and do not always correspond to the needs of the country and the solving of the problems affecting each country.

Furthermore, the problems related to human and material infrastructure, as well as those having to do with the training of staff have been similar, to a large extent.

### 3. Cooperation

A common denominator is the technical assistance offered by IAEA to the three countries, which may be said to be the most important means to promote the peaceful use of energy in them.

Sub-regional and regional cooperation is non-existent or scarce and in most cases it has not been promoted for reasons that are not quite clear despite the fact that the development interests and the problems that affect them may have similar characteristics in all these countries.

There is good will to initiate contact, exchanges and possible cooperation with most of the countries of the Region and, in general, with the whole of Latin America. If this is promoted and put into practice, it may bring about establishing permanent and coordinated cooperation links that would no doubt benefit all the countries, since joint activity programmes could be organized, common problems tackled, isolated efforts and investments reduced and, above all, since cooperation would involve a more balanced type of cooperation and assistance scheme with the more technologically advanced countries.

It may well happen that the promotion of subregional and regional cooperation may stimulate the governments of each country to become more interested in the peaceful uses of nuclear energy as a fundamental and necessary issue.

A regional meeting of experts under the auspices of ECLA, to take place before the Conference for the Promotion of International Cooperation would be positive since it may perhaps contribute to prepare outline programmes and proposals for the nowadays practically non-existent regional and international cooperation, which would serve as possibly inspiring working material when the Conference takes place.

### III RECOMMENDATIONS

#### General Considerations

Latin America has considerable sources of energy which sooner or later will have to contribute to solve the problems of energy supply and demand. Nuclear energy will also be called on to contribute and it is therefore necessary for scientific and technological development to be achieved well ahead of time in order to ensure for the future a self-sufficient dynamic and productive structure to reduce external dependence as much as possible.

Because of this, it is advisable for the Latin American countries to initiate cooperation actions to facilitate the development of the rational and effective use of nuclear energy.

In this sense the international organizations in general and ECLA in particular could take part trying to arrive at a common formula so that, starting from the problems and requirements of the countries of the Region, the priority working areas may be defined so that, thus, some basic cooperation programmes may emerge.

a) With this aim in mind and considering the most important problems of

Latin America, the objectives of the programmes for cooperation would be the following: the regional integration of the peaceful uses of energy amongst the different countries, diversifying energy supply and technical capabilities and combining the efforts and investments made by each of the countries forming part of a Latin American cooperation system.

To reach these objectives it is possible to programme structured projects and actions as exemplified below:

i) Preparation of inventories that will make it possible to know in further detail the resources available in the Region for application in both the energetic and non-energetic areas.

ii) Concrete studies and actions in the field of peaceful uses of nuclear energy on aspects related to issues such as nuclear energy programmes and uranium resources and application of nuclear energy to farming, public health, medicine, industry, etc.

iii) Training of manpower by means of courses, seminars, meetings and symposia covering the different areas with the purpose of developing and disseminating know-how amongst the countries of the Region and, at the same time, encouraging their increased participation.

b) The programme scheme might lead to setting up a know-how infrastructure in The Region and to the definition of projects having one common denominator (funding, technological transfer, etc.)

The mechanisms to achieve all this could be the following:

i) Exchange of human, technological and financial resources amongst the countries of the Region.

ii) Backing provided by international organizations (IAEA, INEC, OPANAL, OLADE, ECLA, UNDP).

iii) Possible balanced assistance from non-Latin American countries and financial agencies.

It is easy to see that regional cooperation amongst the Latin American countries is a crucial issue since each country possesses certain types of

human, material and economic resources which, considered in isolation, might not be quite as productive as if efforts were combined along common lines of action.

c) The emerging cooperation lines of action and projects should respond to the need to solve problems identified as common to all, according to the following criteria:

i) Geographic location. Energy planning programmes (nuclear power and interconnexions at a regional level), prospection of uranium resources, applications to agriculture, etc.

ii) Technical aspects: Inventories of technologies (energetic and non-energetic), market research, technological evolution of the countries, etc.

iii) Economic feasibility. General interest projects that will make it possible to apply for national or international funding viable in terms of access and regional cooperation interest.

These criteria may provide the cornerstones for the conception and development of regional cooperation programmes.

d) The possible participation of qualified technicians from different countries, who would be involved in regional cooperation programmes, could ensure the efficient formulation and evaluation of projects and programmes and the determination of technical assistance needs to be catered for or responded to by each country. The capacity to combine the efforts of qualified staff coming from institutions operating in the different countries of the Region around the activities listed in the programmes is the core of cooperation.

## 2. Possible cooperation actions

Some of the concepts appearing in the report prepared by ECLA in connection with the preparatory regional meeting of the United Nations Conference on New and Renewable Sources of Energy (Mexico, 1981) are also applicable to the preparatory meetings that may take place on the occasion of the United Nations Conference for the Promotion of Cooperation in the Peaceful Uses of Nuclear Energy.

Thus, for example the two dimensions of the energy issue referred to in the report, i.e. a change in the world's current energy balance - highly dependent on oil - and a deep change in the economic and technological structures, are also applicable to the case of nuclear energy as an alternative source of energy.

The same concepts may serve to devise a regional action plan for the peaceful uses of energy:

- i) The potential of using nuclear energy as a factor of development, and
- ii) The effective use of nuclear energy requires an efficient support to engage in advanced research, testing and use of these technologies.

These concepts will provide the foundations of the strategies and actions to be proposed at possible meetings of regional counterparts.

- a) Strategies. Apart from the individual efforts to be made by each country, it is necessary to state and define the types of regional, inter-regional and international cooperation.

It will be necessary to determine objectives and programmes including action plans for several areas, which should be duly designed and given support by the governments of the different countries and international agencies.

The action plans should be precise, with well-defined goals and responsibilities and adequate funding mechanisms.

These plans should include the following:

i) Support to planning. Actions tending to give the countries assistance in such matters as evaluation of resources and studies of a technical, economic and social nature on the utilization of nuclear energy.

ii) Scientific research and technological development. Launching bilateral and multilateral actions to promote research and regional technological development in the field of nuclear energy.

It is also valid to apply these activities in an extra-regional way in order to achieve the adequate selection and transfer of technology.

iii) Training. Actions orientated to the training of the necessary manpower to launch the programmes for the peaceful uses of nuclear energy.

iv) Funding. Actions tending to set up financial mechanisms to support Latin American cooperation programmes.

v) Dissemination of information. Actions leading to disseminate information on the peaceful uses of nuclear energy according to the different interests of the countries of any given region.

b) From the viewpoint of international cooperation, this should contribute to bring about the institution of a fair and equitable international economic order vis-a-vis peaceful uses of nuclear energy.

International cooperation should aim at:

i) Technical and financial support in whatever evaluation and planning tasks maybe carried out in the countries of the Region, related to peaceful uses of nuclear energy;

ii) Assistance for all the activities within the field of nuclear energy that aim at the academic and practical training of staff in all the countries of the Region, and

iii) The promotion of the technological and financial flow from the more to the lesser developed countries in order to reinforce the technological capabilities of the latter and offer support to the tasks of scientific and technological research selected by the countries of the region.

In order to optimize cooperation the regional and international agencies should be given full support and made the most of since they are the instruments to achieve effective collaboration within the field of nuclear energy.

c) The objective of stating actions, projects and cooperation programmes prior to the Conference for the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy is that when the Conference takes place it may be possible to:

i) Strengthen the action capacity for peaceful uses of nuclear energy of the United Nations System with financial contributions from the industrialized



countries to develop the applications of the peaceful uses of energy via IAEA, ECLAC, UNDP, OLADE, OPANAL, etc.

ii) Urge the multilateral agencies and financial institutions to engage in bilateral cooperation actions and the regional financial institutions to promote programmes for the peaceful uses of nuclear energy.

iii) Include the discussion of international cooperation in the peaceful uses of nuclear energy in the relevant United Nations agencies to ensure the permanent orientation and statement of conditions for international cooperation.

iv) Given the conditions for the development of the peaceful uses of nuclear energy in the world, the need arises for the adoption of flexible criteria for the selection of programmes and projects to bring about actions of a regional nature.

The resulting programmes should be multidisciplinary and interinstitutional. They should define in a precise way both area and use, e.g., radioisotopes in agriculture, nuclear heat in the steel industry, etc.

The most important of the many activities to be included in an integral programme on the peaceful uses of nuclear energy are the following:

- i) Detailed studies of nuclear energy plans;
- ii) Detailed studies of uranium ore resources;
- iii) Detailed studies on the cycle of nuclear fuel (partial or total);
- iv) Detailed studies on applications to agriculture, animal husbandry, industry, medicine, etc.
- v) Economic social and environmental evaluation of the studies envisaged.

- vi) Determination of the adaptation or technological development needs implied by the studies envisaged;
  - vii) Studies on the capacity of the national and regional industry to fulfil the requirements of the programmes envisaged (nuclear energy, industrial, fuel cycle and other programmes).
  - viii) Pre-feasibility and feasibility studies of the programmes for the generation of nuclear energy and its different uses, and
  - ix) Mobilization of financial resources to determine the activities to be engaged in by the nuclear energy programmes.
- e) It stands to reason to assume that there are a large number of possibilities to design programmes orientated to the peaceful uses of energy and that, consequently, there will be a special interest in assigning priorities acting in conjunction with each of the countries of the Region and paying attention to compatibility of interests. Therefore, the following criteria should be observed when designing each programme:
- i) Priorities assigned by the different governments during the process preceding the United Nations Conference for the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy, and
  - ii) Regional programmes approved by the countries taking part in them and coordinated by the institutions appointed to such effects.

The regional programmes to be assigned priority may be the following:

- i) Supporting programmes, nuclear energy planning, information and dissemination, training;

ii) Integral programmes: nuclear energy, uranium resources, nuclear safety and protection, the production of nuclear materials, the production of components for nuclear energy plants, fuel production, storage and disposal of radioactive waste, test programmes for materials, etc., and

iii) Amongst the non-energetic programmes, the following may serve as examples: application of fertilizers, genetic studies, and plant mutations, plant nutrients, plague eradication, radioactive drugs and immunoanalysis, sterilization of surgical instruments, underground hydrology, programmes for different industries and many others.

All these programmes are to a large extent regional or international cooperation programmes and would be based on existing institutions or institutions to be created. The main function of the programmes selected would be to structure and facilitate cooperation between the national institutions in each of the areas.

f) One possible alternative is to carry out the following activities involving the different countries of the Region:

- i) Technical consultancies from one country to another;
- ii) Study, research or laboratory testing services;
- iii) Permanent exchange of technical and economic information;
- iv) Regional or extra-regional training programmes;
- v) Promotion of the participation of experts in international events;
- vi) Joint research on common interest areas;
- vii) Technological transfer within the Region;
- viii) Promotion of the creation of technological research and development centres within the Region;

- ix) Stocktaking of radioactive material resources of the Region;
- x) Pre-investment and feasibility studies;
- xi) Collaboration in getting funding for joint programmes, and
- xii) Channelling the technical assistance aspects in the Region.

It would, naturally, be advisable for the countries interested in taking part in regional programmes to coordinate their activities through institutions such as IAEA, INEC, ECLAC, OLADE, OPANAL, etc. These programmes should include execution and costing strategies.

It may safely be assumed that the regional cooperation programmes will guarantee that the countries will have total freedom to participate or abstain from participating in the different programmes to be carried out and to define the nature of their participation in and support to these programmes.

### 3. Conclusions

a) Given the results obtained by this Mission, which show similar activities, constraints and technical cooperation aspects within the context of the countries visited, which may safely and feasibly be applicable to other developing countries and particularly Latin America, the following premises may be valid for one and all in connection with the aspects of subregional, regional and international cooperation.

i) Regional, interregional and international cooperation is an efficient contribution to the development of the countries of the Region,

ii) Nuclear energy used for peaceful purposes is every country's right and has a crucial importance in their scientific, technological and social development, and

iii) The Conference for the Promotion of Cooperation in the Peaceful Uses of Nuclear Energy will be an efficient instrument to contribute to reach regional, interregional and international cooperation.

b) Because of the foregoing considerations it appears to be indispensable to achieve the following, either via the governments themselves or the existing international organizations (IAEA, INEC, UNDP, ECLAC, OLADE, OPANAL, etc):

i) Urge the different countries to promote the spirit of regional, interregional and international cooperation;

ii) Prepare and produce an inventory of needs related to the peaceful uses of nuclear energy in order to define the relevant cooperation programmes in each case, and

iii) Prepare the Latin American cooperation programmes on peaceful uses of nuclear energy at a regional, interregional and international level.

c) Regional, interregional and/or international cooperation should ensure the adequate participation of all the countries in the technical, scientific, social and economic aspects since, to date, there are no integral cooperation plans to promote these activities in Latin America, with the consequent disconnection from technological progress, financial resources, industrial development, etc.

d) The Mission recommends that a regional meeting of Latin American experts should be organized in the near future to analyze and assess all the aspects involved in achieving harmonic cooperation within the Region. All this will

result in putting forth proposals for regional, interregional and even international cooperation programmes related to nuclear energy which might be discussed at the United Nations Conference for the Promotion of International Cooperation in the Peaceful Uses of Energy in 1986.

Annex 1

STUDY OF THE OPTIONS FOR REGIONAL AND INTERNATIONAL COOPERATION IN THE  
PEACEFUL USES OF NUCLEAR ENERGY

From the report produced by the mission on nuclear energy and prospects for collaboration carried out in Bolivia, Columbia, Ecuador, Mexico and Venezuela it is possible to summarize in Tables I, II and III the aspects related to the current status of nuclear energy in each of the above-mentioned countries, their prospects of development in the field of nuclear energy and also some of the constraints affecting positive growth.

There are also some tables related to aspects of Regional and International Cooperation (Table IV) and Basic Cooperation Programmes (Table V). The most important Cooperation Instruments are also included (Table VI) and the same goes for Joint Cooperation Activities involving the countries covered by the mission (Table VII).

Finally, Tables VIII and IX show the necessary inclusions to achieve the Action Plan for a Basic Programme and some guidelines vis-a-vis International Cooperation.

The document produced as a result of this mission is intended to serve as a source of background information and possible orientation for the meetings preparatory to UNPICPUNE and the Meeting of Regional Counterparts to take place at ECLAC, Santiago de Chile, at which the possible fields for Regional and International Cooperation as well as the mechanisms and instruments contributing to harmonic cooperation will be analyzed and assessed so as to be presented at UNIPCPUNE.

TABLE I

This table presents a country-by-country breakdown of the principal fields and activities covered and also the future prospects of the energetic uses of nuclear energy.

As regards nuclear power the table includes activities such as feasibility studies, selection of locations for the emplacement of nuclear power plants, manpower training, nuclear protection, environmental studies, engineering aspects of nuclear plants and also aspects such as construction, operation and safety.

Apart from Mexico which, as can be seen, has been able to carry out activities that cover a large number of the sub-headings above, only Colombia through the Instituto de Asuntos Nucleares (IAN) has used the WASP model, foreseeing the introduction of nuclear power plant to the electricity system of Colombia.

Within the energetic applications the table includes aspects such as uranium resources and fuel cycle with activities such as manpower training, prospection and exploration, evaluation of resources, mining exploitation, concentrate production, fuel production and re-cycling and disposal of waste.

TABLE II

This table shows the current and future non-energetic uses of nuclear energy for the 5 countries included in the report, in connection with the following fields and activities:



- Basic research and technological development: activities involving physics, chemistry, biology medicine and nuclear electronics.
- Radiological protection: activities covering dosimetry, standards, regulations, environmental studies.
- Agricultural sciences: activities involving genetic studies, radioimmunoassay, assimilation of fertilizers, pesticides, etc.
- Industry and hydrology: activities involving non-destructive testing, high irradiation studies, industrial processes, surface and underground hydrological studies and sediment carriers.

#### TABLE III

This table sums up and shows the main constraints and the most important problems that in one way or another represent an obstacle for the development of the peaceful uses of energy in the 5 countries. In the first place, it is necessary to say that nuclear energy has not in fact been included among the priority plans and programmes of these countries, which has resulted in a shortage of funds and insufficient financing arrangements for the programmes which, taken as a whole, do not state defined objectives and well-determined activities in keeping with finding a solution to problems of a national nature.

The human and material infrastructure is deficient in most of the countries and in some of them there is even an underutilization of installations.

The training of manpower at both professional and post-graduate levels vis-a-vis nuclear power matters exists only in Mexico where training is restricted to short courses, seminars, conferences and symposia.

Technical assistance, with the exception of assistance offered by IAEA, is practically non-existent: there is a lack of consultancies for the definition of precise plans and goals; the supply of equipment and materials is deficient and, in many cases, the installations are not operating in an optimal way.

#### TABLE IV

In a simple way this table presents a methodology to attain an efficient regional and international cooperation in the countries of the region.

From the starting point of the requirements and problems of the Region (lack of well-defined objectives, plans and programmes) it is possible to arrive at the definition of priority working areas (nuclear power, uranium resources and fuel cycle, applications to farming, radiological and nuclear protection, industrial applications and hydrology) and the setting up of basic cooperation programmes, both of the supporting and integral types, with specific activities for each of them (planning, information, training and specific studies in each of the fields identified above).

#### TABLE V

This table presents the necessary mechanisms to establish regional cooperation programmes. In the first place and to contribute to reaching the objectives of any programme, such actions as stock-taking, concrete studies and manpower training are specified.

In the second place, projects with a common denominator are defined (financing, transfer of technology, etc.) by means of the exchange of human ,

financial and technical resources and the assistance and support of international agencies (IAEA, INEC, ECLAC, UNDP, OLADE, OPANAL).

Finally from the resulting lines of action and projects, the common problems will be tackled according to geographical location, technical aspects and economic feasibility.

TABLE VI

In terms of the fields identified, this table presents some of the instruments for regional cooperation: technical assistance between countries, consultancies between countries, regional and extra-regional training, transfer of technologies between the countries of the Region, joint research, study and research services, exchange of information, pre-investment studies, inventory of resources, participation of experts, creation of study and research centres, funding between countries.

TABLE VII

In keeping with the foregoing considerations (Tables I - VI) it is possible to present here the common fields and activities, both within the field of energetic and non-energetic applications, to be covered by the five countries by means of cooperation programmes.

TABLE VIII

This table shows the action plans for a basic cooperation programme, which should be well specified and with well-defined goals and should include the following aspects:

Action Plan

- Support to planning
- Support to scientific and technological research
- Support to theoretical and practical training
- Support to financing
- Support to dissemination and information

TABLE IX

International cooperation in the five countries should be directed, as this table shows, at the following aspects:

- Technical and financial support
- Support to academic studies and training of manpower
- Promotion of technical and financial inflows from the more developed to the developing countries.

To conclude: regional, interregional and international cooperation appears to be feasible if there is support from international agents and good will and understanding on the part of the countries involved in cooperation programmes.

TABLE I  
NUCLEAR ENERGY. ENERGETIC APPLICATIONS

ACTIVITY FIELDS	Current Status					Future prospects				
	Bolivia	Colombia	Ecuador	Mexico	Venezuela	Bolivia	Colombia	Ecuador	Mexico	Venezuela
<u>Electricity nucleus</u>										
Feasibility studies		X		X		X	X	X	X	X
Selection of locations				X					X	
Training of manpower				X		X	X	X	X	X
Nuclear safety				X			X		X	X
Environmental studies				X		X	X	X	X	X
Engineering				X					X	
Construction				X					X	
Operation										
Safety devices				X						
<u>Uranium resources and fuel cycle</u>										
Training of manpower	X	X	X	X	X	X	X	X	X	X
Prospection and exploration	X	X	X	X	X	X	X	X	X	X
Evaluation of resources	X <u>a/</u>	X <u>a/</u>		X <u>a/</u>	X <u>a/</u>	X	X	X	X	X
Mining exploitation	X <u>a/</u>			X <u>a/</u>		X <u>a/</u>	X <u>a/</u>	X <u>a/</u>	X <u>a/</u>	X <u>a/</u>
Production of concentrates	X <u>a/</u>	X <u>a/</u>		X <u>a/</u>		X <u>a/</u>	X <u>a/</u>	X <u>a/</u>	X <u>a/</u>	X <u>a/</u>
Fuel production				X <u>a/</u>					X <u>a/</u>	
Enrichment studies				X <u>a/</u>					X <u>a/</u>	
Management of fuels				X <u>a/</u>					X	
Recycling									X <u>a/</u>	
Waste disposal									X <u>a/</u>	

a/ At the level of studies

TABLE II

## NUCLEAR ENERGY. NON-ENERGETIC APPLICATIONS

ACTIVITY FIELDS	Current status					Future prospects				
	Bolivia	Colombia	Ecuador	Mexico	Venezuela	Bolivia	Colombia	Ecuador	Mexico	Venezuela
<u>Technological Research and development</u>										
Training of manpower				X		X	X	X	X	X
Nuclear physics	X	X	X	X	X	X	X	X	X	X
Nuclear chemistry	X	X		X	X	X	X	X	X	X
Biological Sciences				X	X	X	X	X	X	X
Electronics		X		X						
<u>Radiological Protection</u>										
Dosimetry	X	X	X	X	X	X	X	X	X	X
Standards and Gauges		X	X	X	X	X	X	X	X	X
Environmental aspects	X			X		X	X	X	X	X
Legislation and regulations	X	X	X	X	X	X	X	X	X	X
<u>Applications to Agriculture</u>										
Genetic and mutation studies		X		X	X	X	X	X	X	X
Studies on assimilation of fertilizers	X	X	X	X	X	X	X	X	X	X
Nutrition and reproduction studies		X	X	X	X	X	X	X	X	X
Plague erradication studies		X	X	X	X	X	X	X	X	X
RIA studies	X	X	X	X		X	X	X	X	X

(continued)

TABLE II (Concluded)

ACTIVITY FIELDS	Current Status					Future prospects				
	Bolivia	Colombia	Ecuador	Mexico	Venezuela	Bolivia	Colombia	Ecuador	Mexico	Venezuela
<u>Industry and hydrology</u>										
Non-destructive tests	X	X	X	X		X	X	X	X	X
Studies on industrial processes			X	X			X		X	X
Hydrology and oceanography	X	X	X	X		X	X	X	X	X
<u>Nuclear Medicine</u>										
Radiotherapy and radio- diagnosis	X	X	X	X	X	X	X	X	X	X
Physiology and pathology studies	X	X		X		X			X	
Radioimmunoanalysis	X	X		X		X			X	
Radio-drugs Studies	X	X		X		X	X	X	X	X

TABLE III

CONSTRAINTS AFFECTING THE USE OF NUCLEAR ENERGY

Constraints and Problems	Bolivia	Colombia	Ecuador	Mexico	Venezuela
Undefined programmes	X	X	X	X	X
Lack of funds	X	X	X	X	X
Lack of manpower	X	X	X		X
Lack of installations	X		X		X
Lack of equipment supplies	X		X		X
Lack of materials supplies	X		X		X
Lack of consultancies	X	X	X	X	X
Lack of technical assistance	X		X		
Absence of manpower training	X	X	X	X	X
Deficient training	X		X		



TABLE IV

REGIONAL AND INTERNATIONAL COOPERATION METHODOLOGY

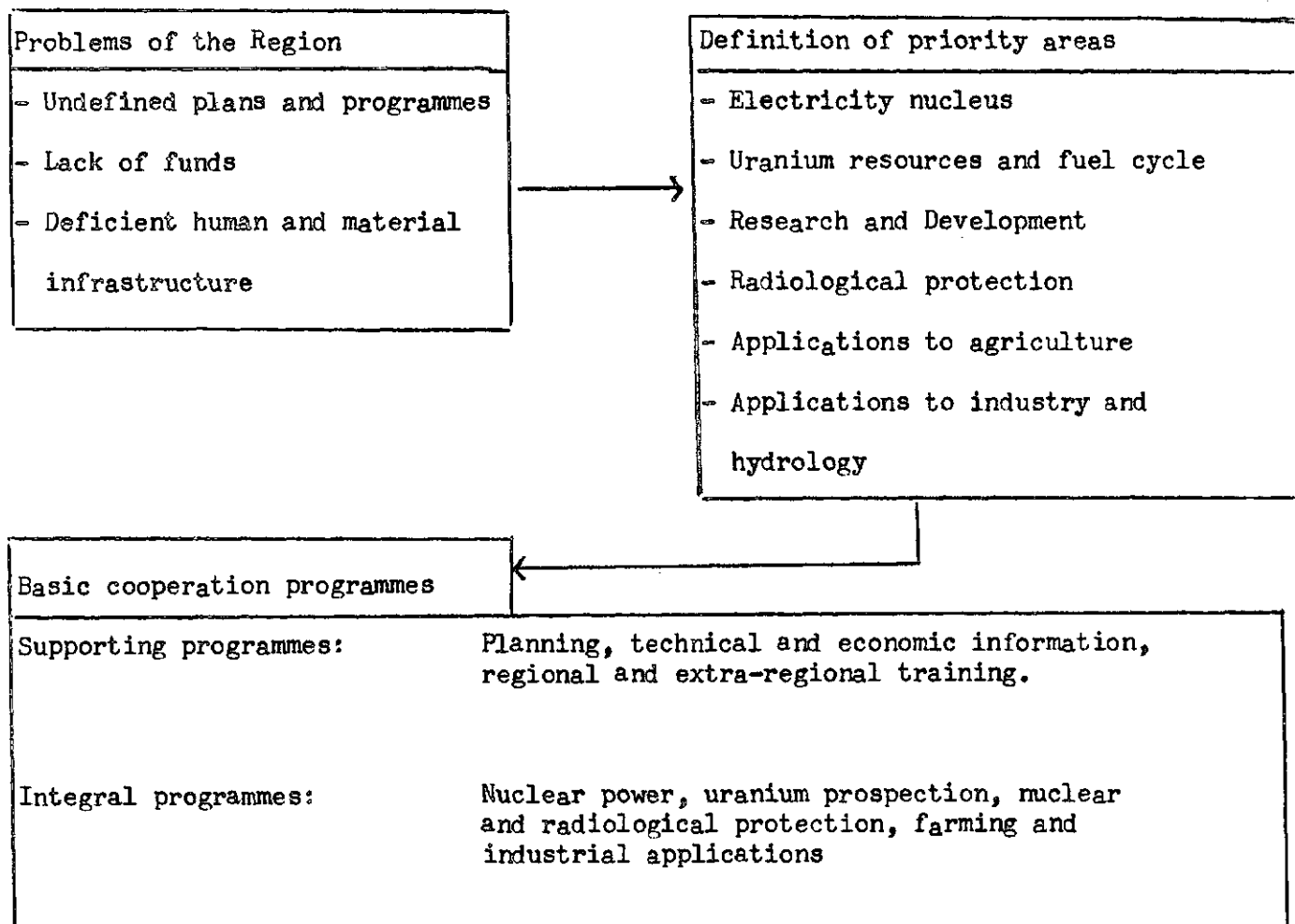


TABLE V

COOPERATION PROGRAMMES. MECHANISMS TO SET THEM UP

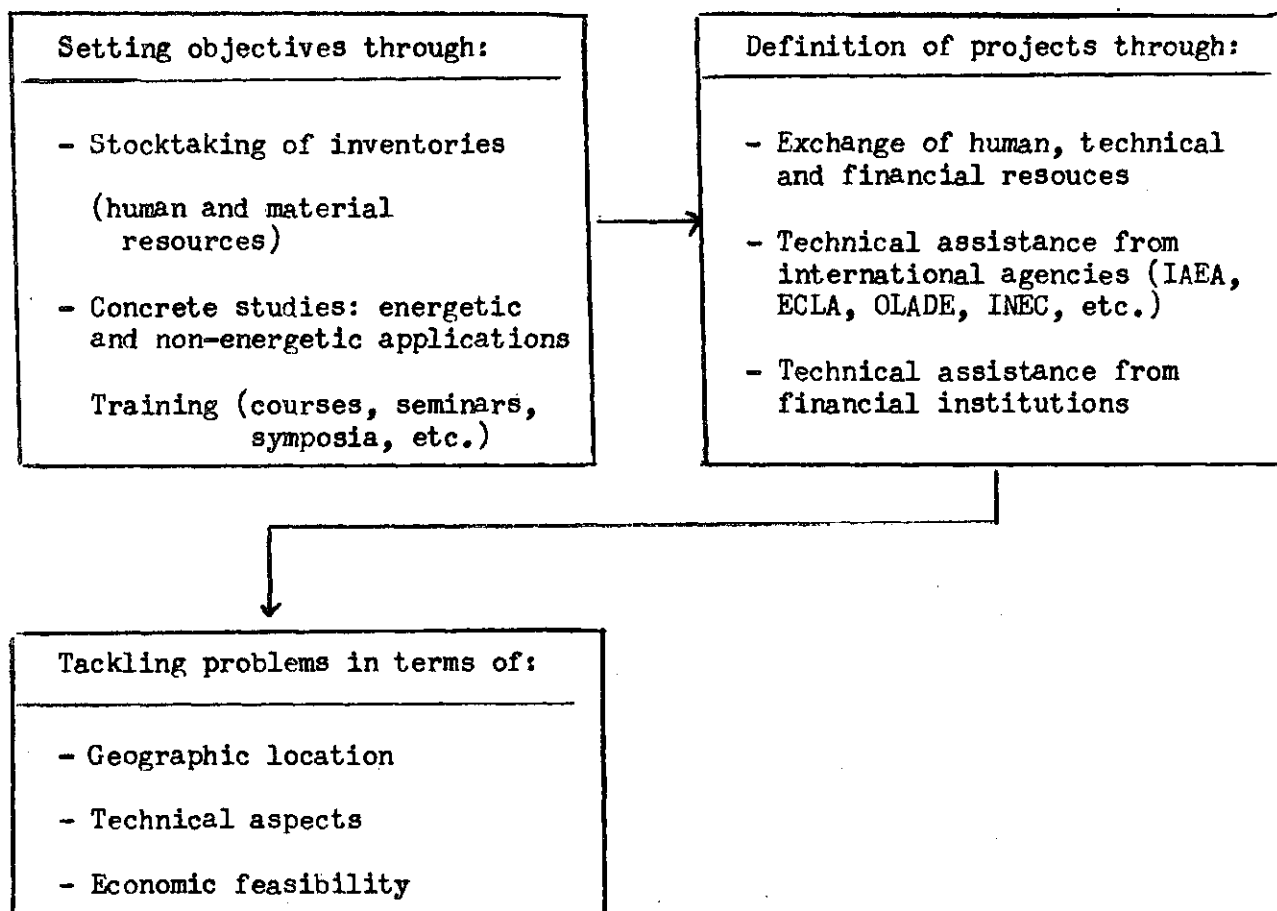


TABLE VI

	Nuclear power	Uranium resources and fuel cycle	Farming	Radiological Protection	Industry and Hydrology	Medicine
Technical Assistance		X	X	X	X	
Consultancies	X		X	X	X	
Training	X	X	X	X	X	X
Technological transfer	X					
Joint research		X	X	X	X	X
Research services			X	X	X	X
Information	X	X	X	X	X	X
Pre-investment studies	X	X				
Inventory of resources						
Experts	X	X	X	X	X	X
Study centres	X	X	X	X	X	X
Financing arrangements	X	X	X	X	X	X

TABLE VII

COOPERATION PROGRAMMES JOINT ACTIVITIES

Fields and activities	Bolivia	Colombia	Ecuador	Mexico	Venezuela
<u>Electricity nucleus</u>					
Feasibility studies and nuclear energy programmes	X	X	X	X	X
<u>Raw materials</u>					
Detailed studies on uranium resources	X	X	X	X	X
<u>Applications to agriculture</u>					
Genetic studies	X	X	X	X	X
Studies on fertilizers	X	X	X	X	X
Plague eradication	X	X	X	X	X
<u>Applications to animal husbandry</u>					
Fertility studies	X	X	X	X	X
Vaccine studies	X	X	X	X	X
Nutrition studies	X	X	X	X	X
Radioimmunoassay	X	X	X	X	X
<u>Industrial applications</u>					
Non-destructive tests	X	X	X	X	X
High irradiation studies	X	X	X	X	X
Studies on industrial processes	X	X	X	X	X
<u>Applications to hydrology</u>					
Underground hydrological studies	X	X	X	X	X
Surface hydrological studies	X	X	X	X	X
Sediment carriers	X	X	X	X	X
<u>Radiological protection</u>					
Desimetry studies	X	X	X	X	X
Establishing standards, legislation and regulations	X	X	X	X	X
Environmental studies	X	X	X	X	X
<u>Basic research</u>					
Medicine, physics, chemistry, etc.	X	X	X	X	X

TABLE VIII

ACTION PLAN. BASIC PROGRAMME

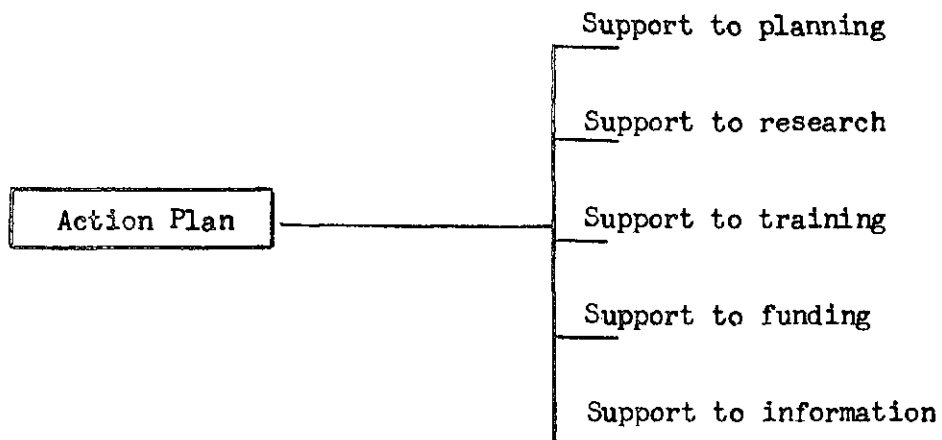


TABLE IX  
LINES OF INTERNATIONAL COOPERATION

