

ACTIVITIES OF THE INSTITUTE FOR ENERGETIC
AND NUCLEAR RESEARCHES

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1 - HISTORIC INFORMATIONS

In 1956 was created, in Brazil, the first institute for Nuclear Research, called, at that time, Atomic Energy Institute. It has been built around a 5MW Swimming Pool Reactor, bought from USA, and mainly designed for University utilization.

The Institute, under Brazilian Nuclear Energy Commission, and São Paulo State University began its researches in the areas of Nuclear Physics, Reactor Physics and Radio-Chemistry.

Later, during the years 1960-1970 many other laboratories has been created and some studies in Chemical Engineering, Nuclear Metallurgy, and Radio-Isotopes production began to be developed. At the same time many courses have been established for the formation and specialization of personnel to work at the different departments. With the increase of activities, a larger area was necessary, and several buildings has been constructed, many equipments has been bought, mainly imported from other Countries and the number of persons working grew steadily.

To follow the developments in many fields of research, an infra-structure was necessary, and many facilities has been put in service.

A very good and specialized library was created at 1956. It occupies now about 2000 sq. m., and it is considered the best specialized library on the nuclear field, in Brazil.

It, contains 15000 volumes of books and subscribes 1660 titles of periodicals. Besides this it has a collection of about 300.000 micro-cards.

The automation system adopted is ILS (Integrated Library System) that permits, by integration with the electronic computer, an easier and faster approach to the subjects stored.

This year the Institute has been transformed, and had its name changed to Institute for Energetic and Nuclear Researches, under the Secretary for the Industry, Commerce, Science and Technology. Its main scope is to develop the technological research in both areas, nuclear, and of new sources of energy. This last group of researches has been developed because of the petrol crisis that keeps all the world in a state of tension and, at Brazil has had a large effect due to the large quantities of petrol that must be imported, about 85% of the total needs. These researches cover the development of new and modern techniques for the use of coal by gaseification, or fluidized bed, and new types of electrical batteries.

Beside the researches named above, a great attention is given to the formation and perfectioning of technical personnel, that will operate the future nuclear installations of the uranium cycle, now under construction, or will work at other research centers, or Universities.

2 - LOCATION

IPEN is built at São Paulo State University Campus, about 15 Km (10 miles) from down-town São Paulo. It can be reached by cars, buses, and suburban trains.

Its proximity to different Faculties and Research Centers of the SP University allows good any easy relations among these organs, and many researches and studies are developed in a joint programme, by the exchange of professors and specialized Technicians, and common

use of laboratories, equipments, and so on.

The Institute is constructed inside a total area of 500.000 sq. m., the buildings covering approximately 80.000 sq. m., spread in the area, covered mainly by gardens, small woods, and green areas.

Many of the constructions have a modern and agreeable architecture, being functional and comfortable.

3 - ORGANIZATION AND STRUCTURE

IPEN structure includes one Direction, with the general administrative and Technical attributions and three technical Executive Directorates: the first is charged with basic and applied research that develops its studies on Nuclear Physics, Radio-Chemistry Production of Radio-Isotopes, Radio-Biology and Medicine, and Industrial Uses of Radio-Isotopes, using a 5MW Babcock-Wilcox swimming pool reactor.

The second Executive Directorate is responsible for the development of technological researches, mainly in Nuclear Chemical Engineering, Nuclear Metallurgy, and Nuclear Engineering.

The third Directorate congregates the sectors that work for the Institute as a whole, on Radiological Protection, Dosimetry, Waste Disposal, Electronics and Instrumentation, Electronic Computation, and Human Resources Formation.

Besides these there is a large Administrative Directorate, that covers the Administrative and Financial Areas, and is responsible for all the operation, maintenance, and running of the Institute.

There are working at IPEN some 950 persons, being 300 superior level technicians, 250 of medium level technicians and 400 administrative and auxiliary personnel. Most of the superior level technicians have Ph.D. or M.S. degrees.

4 - SOME TECHNICAL ACTIVITIES

The activities of the Institute are executed by the specialized Departments, each one responsible for one or more areas of research. Some of these are slightly described below.

a - At the Nuclear Chemical Engineering Department a complete line of equipments, at pilot plant scale, produces all the materials for the conversion of uranium, from the yellow-cake to the Uranium hexafluoride. The pilot-plant for purification of uranium and production of uranium diuranate uses sieve-plate pulse columns for the solvent extraction with T.B.P.

b - At the Nuclear Metallurgy Department many studies are performed on the production of nuclear fuel elements, from the fabrication of uranium dioxide powder, to the metallic uranium. Many researches, have been made in the line of production of pellets, micro-spheres, and plate type elements. Some of Research Centers in Brazil have been supplied, for their reactors or sub-critical assemblies, with fuel elements produced at IPEN.

c - At the Radiological Protection and Dosimetry Department some research is being developed in the field of new types of dosimeters, with production of mono-crystals, and fabrication of thermo-luminescent materials.

d - At the Radio-Isotope Production Service, radioactive isotopes are produced for use in hospitals, medical research centers, biological centers, industries and so on. The production of these materials is limited by the flux of the reactor, not sufficient for the irradiation of medium and long half-life nuclides, in acceptable conditions.

e - At the Nuclear Physics Area many experiments and studies are on development. The Nuclear Measurement Laboratory is equipped with two 4π , $\beta - \gamma$ coincidence systems which are used in calibration work and for comparisons with international standards of radio-nuclides. Research in the field of neutron physics and nuclear reactions are also performed in the laboratory.

Using thermal neutrons inelastic-scattering techniques the properties of matter are investigated.

To determine crystal and magnetic structures under mechanical treatment, IPEN uses the neutron-diffraction technique. For the study of interaction of quadrupoles in compounds and alloys, perturbed angular correlation techniques are being used.

f) The activities in the field of Radio-Chemistry include studies on Chemical reactions and processes, and development of radio-analytical methods, mainly by neutron activation and isotopic dilution.

g - The main objectives in the Area of Nuclear Electronics are:

- 1 - to develop a national technology
- 2 - to design and manufacture electronic equipments for use in research, control and plant safety;
- 3 - to provide assistance to other organizations;
- 4 - training of personnel;
- 5 - maintenance of the Institute's electronic equipments.

In this area, among other projects, the Institute has developed electronic systems for thyroid monitoring, measurement of thermo-luminescence, automatic measurement of low currents in ionization chambers and measurement of environmental radiation.

h - Besides being a advanced scientific center, IPEN is, also, concerned with industrial and engineering problems. In this way it accomplishes jobs and researches in areas such as: environmental pollution, hidrological processes, mineral analysis, etc. In the field of industry many studies on weldings, corrosion, mixing, and flow measurements have been carried out, solving problems for local industries or other entities, governmental or private ones. A linear accelerator is working at industrial application of radiations.

i - Many other types of research were developed. A Radio-Biology and Nuclear Medicine Department began its work on experiments "in vitro", and later, "in vivo". In order to get more data for researches some agreements have been signed with hospitals and bio-medical research institutions, to allow the application of radio-tracers techniques to people needing a diagnosis or submitting to treatment.

At the same time biological research was developed in many areas and today the researches contribute with new informations in this field. Also important biological studies on proteins, growth of algae, and so on, have been accomplished.

j - In the field of Nuclear Engineering many studies started on certain types of nuclear reactors. Research has been made, for many years, on the High Temperature, and Gas-Graphite Reactors. An Helium Loop was mounted, and it is in use to get informations on thermodynamic characteristics of gas cycles. Some studies on concrete pressure vessels are in course. A water loop under construction will be operating in few months.

k - On the field of Solid State Physics many researches are in development, on analytical studies, microscopic structures, action of radiations on materials, and so on.

l - In order to control the operation of the pilot-plants, has been developed an Analytical Chemistry Laboratory, where many methods and techniques for the analysis of all the raw materials, intermediate products and final control of specification are used, allowing to accompany all the phases of the work, and check the conditions of those experiments.

At two solvent extraction pilot-plants many studies are in development for Uranium purification, and Thorium separation.

The first plant receives the yellow cake produced at other instalations outside the Institute, and establishes the conditions for the purification, according to the composition of each one of the materials, from different sources. Thorium plant is used mainly for studies on products (Th, Rare, Earths, U) received from a Monazite Processing Plant, owned by Nuclebrás.

5 - HUMAN RESOURCES

One of the important activities of IPEN is the formation of specialized people in the nuclear area.

This program is performed at Nuclear Energy Training Center, one of the Departments under Executive Directory III.

The instructors of this center are almost all of them members, of the Technical Staff of the Institute, the majority with the degrees Ph.D. or M.S. obtained in Brazil or abroad .

In some special cases, professors from the Brazilian Universities, or other Countries are invited to present some disciplines or cooperate at Seminars or Congresses.

Many courses on specialization, pos-graduation, and perfectioning of technicians from different levels are usually presented. Among them we can cite:

1 - University degrees

The Engineers, Physicists and other specialists, working at IPEN can attend regular courses on Master or Ph.D. level at São Paulo University, the programas for these Courses being proposed and approved by the Pos-Graduation Council of the University. In addition to the disciplines taken during 12 months, the students must choose a theme for this final thesis. This last one is, usually, related to the job that they do executive, at the Institute, being prepared under the supervision of an adviser.

After finishing their work, the students go to the final examination, by a Commission of three professors, designated by the University, that after the discussion of the document, gives the approval. Only then, they receive the title of Master of Sciences or Ph.D.

Usually these thesis takes some 18-24 months to prepare, and during all this time they continue the researches at IPEN.

2 Participation at University Courses

Due to the great specialization of the different sectors of research, the M. S. and Ph. D. working at the Institute collaborate with the University, presenting some of the disciplines offered at regular graduation level courses, at the different Faculties. Many of these disciplines are presented at the Institute, site for the students of São Paulo and others Universities, under the terms of agreements signed between these organisms and IPEN. In this case the students attend the courses, and prepare their thesis at the laboratories of IPEN, under the supervision of one professor. Sometimes, in the case of Universities from others regions of Brazil, the students work at their Universities, making periodic contacts with their advisers, and eventually this one go to their University, for final examination.

3 Medium level technicians formation on special jobs

These technicians come to IPEN, with an initial formation, at technical schools. They attend specific courses for the job in which they go to work. Only after finishing the courses are they allowed to enter the group, assisted by engineers or other technicians already experienced, and with a long period of practice.

4 - Specialization Courses

By request of many industries and research centers in Medicine, Pharmacy, etc, some special courses are prepared, at specific subjects. They are presented periodically, on some of the areas listed below.

Some of these courses are:

a- Radiological Protection

Presented to technicians that use radio-isotopes or radiation sources. By the Brazilian laws only the technicians that have attended this course can be approved as Radiological Inspector of those installations; the Brazilian Nuclear Energy Commission, recognizes these courses and periodically makes inspections at the site, to verify the radiation protection measures taken under the responsibility of these technicians.

b - Industrial Applications of Radio-Isotopes or Radiations.

These are specific courses for people working on hidrology, sedimentology, environmental control, and so on.

c - Nuclear techniques courses

These courses are intended for technicians that work in plants, laboratories and research centers. They give to the students the knowledge on the techniques used for analytical, nuclear chemistry or metallurgy, solvent extraction, radio-isotopes preparation and manipulation, medical uses of radio-isotopes, ceramics, etc.

d - Courses in Nuclear Specialization

Within the governmental program for Formation and Specialization of Technicians in the Nuclear Field- PRONUCLEAR -the Institute provides some special disciplines to complement the "curricula" of normal courses in the pos-graduation level.

These courses are presented for students received from the Universities, sent by the Brazilian Nuclear Energy Commission. These students after finish the course are contracted by CNEN or NUCLEBRÁS (governmental Company responsible for the Execution of Brazilian Nuclear Program). Some of them are sent to Germany, within the terms of the agreement Brasil - KFA, to work at plants or laboratories related to the Technology Transfer Program.

Under the PRONUCLEAR, the Institute has also received, regularly, many professors from Germany that present courses on special techniques, like reprocessing, waste treatment, fuel elements fabrication, enrichment, etc.. The courses are ministered in periods from 3 to 6 weeks, each, and are attended by the superior level technicians of IPEN, CNEN and NUCLEBRÁS.

e - Courses and Stages for foreign people from Latin-America Countries.

IPEN receives for stages, many persons coming from other countries; they work together with the Brazilians, and many times, after finishing their allocated time they begin to work under contract at IPEN, for some time, before to go back.

6 - MAIN EQUIPMENTS

At IPEN many research equipments and sophisticated instruments are in operation:

a - Nuclear Reactor

IPEN's research reactor, is a 5 MW swimming-pool type, designed by Babcock-Wilcox. It reached criticality on September, 1957. This was the first controlled chain reaction in Latin America. Since then it has been in continuous operation with a perfect safety record.

Low power operation is used for maintenance and training purposes. For production of radioisotopes and research, the reactor operates at 2 MW. To allow continuous operation up to 10 MW its cooling system was expanded and modern control instruments were installed.

Automatic equipment has been developed for production of industrial radioisotope sources for in gammagraphy.

b - Electronic Computer: Data Processing Center has an IBM/370-155 computer with a 2 Megabyte memory, and teleprocessing system with IBM 3270 and Tektronix 4010-1 terminals. It operates with OS/US2 system and it is used by almost all of the Technical Departments, as an aid for their researches, and also for administrative jobs.

One of the most important uses of the computer comes from the integration with the Technical Library of the Institute making easy, for the technical staff, the access to all the literature stored at the Data Bank.

c - Helium loop: this equipment with a total installed capacity of 2250 KVA is used for engineering studies on heat transfer, thermodynamics, and to get data on gas flows in nuclear reactors, under different simulated conditions. It allows experiments up to 800 °C; 20,7 atm; and gas flow of 2 Kg/seg.

d - Linear Electron Accelerator

Our linear accelerator was built by Radiation Dynamics Inc, USA and uses a high frequency rectifier, for DC high voltage. It generates a beam of mono-energetic electrons up to 1,5 MeV and a current density up to 25 mA.

It can be used for industrial uses as cross-linking and hardening of plastic materials, sterilization of materials and sewage muds, and so on.

e - Variable Energy Cyclotron

It is an Isochrone Cyclotron made by Cyclotron Corporation. It can produce charged particles beams (p, d, He-3, He-4) with variable energy, up to 36 MeV. Three tubes can be used, for external and internal beams: the sample is located and ejected pneumatically. It is in final phase of assembling, and will be used mainly for radio-isotopes production, studies on radiation damage and Nuclear Physics researches.

f - Other equipments

Many other equipments are in operation at all laboratories, mainly at the technological fields. The instruments for tests, chemical analysis and control are very sophisticated, and can perform different functions allowing to the researches to have the the informations necessary to their work.