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A-1143 UNCLASSIFIED

SUBJECT

Department of State

INFO : Amembassies BUENOS AIRES, MEXICO
AmCons BELÉM, BELO HORIZONTE, BRASÍLIA, CURITIBA, PÔRTO ALEGRE, RECIFE, SALVADOR, SÃO PAULO



AmEmbassy RIO DE JANEIRO June 23, 1967

Atomic Energy XII: Nuclear Power Problem in Brazil, by physicist Pedro Bento de Camargo
Embassy A-1141; A-1142

1. This is the third in a series of three airgrams bearing the same date, designed to make available to the Department and to the USAEC materials drawn together by the country team on the burning topic of atomic energy in Brazil today. The two prior numbers are concerned with the status of Nuclear Energy Development in Brazil and Hemispheric Nuclear Cooperation, respectively.

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2. Pedro Bento de Camargo is Chief, Nuclear Engineering Division of the Atomic Energy Institute (IEA), São Paulo. He is a good friend of ours. Some two years ago arrangements were made for him to do three months special work at Oak Ridge National Laboratory (ORNL). He has maintained close contact since his return with the friends he made there and has been placed in charge of one phase of the CNEN nuclear power reactor study. The text was originally published in Portuguese in the Brazilian magazine "Digesto Econômico" earlier this year.

3. This is one of the most straight-forward presentations of the problem and its complexities, and what one Brazilian expert thinks national policy should be, that has appeared recently.

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Attachment: The Nuclear Power Problem in Brazil

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# THE NUCLEAR POWER PROBLEM IN BRAZIL*

Pedro Bento de Carmargo

## 1. Fuels as an energy source

In the gross national product (GNP) the direct contribution of energy generation is relatively small; nevertheless, inadequate generation of energy and periodical brown-outs are responsible for substantial delays in the economic growth of the nation.

Obviously, electricity is the most versatile and convenient form of energy. The cheaper and more abundant sources of electricity are, nowadays, hydraulic potentials and fossil fuels (coal, oil, natural gas, etc.) Now being considered are the nuclear fuels, which will become prevalent in the near future.

The history of fuels in one of successive displacements of some fuels by new ones. The use of the new ones become gradually prevalent, depending on the abundance of its occurrence relative to the old one, the shipping cost and the versatility of the power machinery. These factors, depend on economic parameters and strategic situations.

A new fuel rarely eliminates an old one but economic and strategic reasons lead to a new sectoral distribution, where each one performs its role in the economy and security of the nation.

Besides its use for nuclear weapons, nuclear fuels already have a definite place for submarine propulsion. Being a highly concentrated fuel which does not need oxygen, it increases the submarine's range, not load and useful room.

Another sector where nuclear fuels begin to show promise is in the field of electricity generation. In this case the high energy density helps to reduce the fuel shipping cost and, therefore, the cost of electricity will not increase appreciably if the power plants are built far from the deposits of nuclear minerals. Besides, for reasons peculiar to reactor design principles, the unit cost ($/KW) of the nuclear boilers decreases as their size increases, even more than happens with conventional boilers. Consequently, the cost of energy generation ($/KW) decreases this same way. These two factors favour the "nuclear decision" in the following situations.

- first, when the load center to be supplied is far from natural resources such that the shipping cost of fuel or the investment on transmission lines increases substantially the cost of electricity;

*Published in Portugese in the Brazilian magazine "Digesto Econômico" nº 193, February 1967.

- second, when the capacity of the power system is such that is allows the addition of new large units.

However, the complete utilization of the energy stored in nuclear fuels is very difficult, and on proved reactors the degree of utilization is very low. The best utilization of this potential depends on the success of technological research from which there should result improved materials and reactors of advanced concepts. The forecasters expect that around the year 1985 the problem of the maximum utilization of the energy concentrated in nuclear fuels will be solved.

By that time, nuclear materials will become the most important world resources of energy to be used by mankind.

Besides their role as energy source, fuels participate in the development of other sectors of industry. Fuel oil, which is only one of the products of oil refineries (perhaps the least important one), serves as raw material in the petro-chemical industry; in the future it may be transferred completely to this industry. Nuclear fuels require a modernization of industry, for it makes necessary the introduction of new techniques in chemistry, metallurgy and electronics. Besides, radioisotopes contribute to development of new research and control methods which are applied successfully in biology, medicine, industry and agriculture.

Thus, employment of nuclear fuel in the generation of electricity will advance the modernization and growth of some secondary sectors of the industry and will create new productivity factors. The result will be the development of a more sophisticated technological level, development of new research and control methods, where radioisotopes perform a fundamental role.

2. About the supply of electricity

Fuels perform a complementary role in the supply of electricity when hydraulic potentials are abundant, and a basic role when they are rare or un-economic. The abundance of hydro resources for a certain region is always relative and temporary because the growth of the population and the increasing consumption of electricity per capita may exhaust even abundant hydraulic potentials, in which case the increasing demand of energy must be met by other sources. In this way, fuels will pass from the role of a complementary to a basic source of electricity sooner in some regions and later in others, depending on the size of the hydro resources, on the rate of population growth and on their social and economic stage.

The decision for using fuels as a complementary or as a basic source of electricity depends on studies on the efficient utilization of hydro-resources, on the characteristics of the market, on the operation of the interconnected hydro-thermal power generating system and on minimization of black-out risks in the supply of electricity to large industrial centers.

Once it has been decided to construct a thermal power generating plant, and the capacity and a date for operation have been determined, the decision must be made as to the kind of fuel which should be used. The choices are restricted to fossil (coal, oil, natural gas, etc.) and nuclear fuels. At this point, the nuclear energy experts are responsible for the feasibility studies of nuclear fuels and reactors in order to provide information to the planning offices on the best nuclear system to be selected considering the present status of their technology, their future development, and their relationship to national security and economic growth.

3. Nuclear Fuels

In the same way as coal and oil are called fossil fuels, properly made mixtures of fissionable and fertile materials are called nuclear fuels. Fertile materials produce new fissionable materials, a part of which immediately contributes to heat generation, and the rest of which may be used later to make new fuels or nuclear weapons.

Nuclear fuels always have two aims: one it to generate heat and the other is to produce new fissionable materials.

Fissionable materials may be used to make fuels or to make nuclear weapons; in the first case they are always mixed up with fertile materials, and in the second case they should be used as pure as possible.

Fissionable Materials - There are four fissile isotopes which are important as energy sources:

U-235, U-233, Pu-239 and Pu-241

U-235 is the only natural fissionable material and appears associated with U-238, in the ratio of 1:139. In plants for Isotopic Separation, (the most important ones using the Gaseous Diffusion process) mixtures are obtained containing more U-235 than in natural uranium.

The other fissile isotopes, U-233 and fissile plutonium are produced from the fertile ones, Th-232 and U-238 respectively, in the same reactors that are used for energy generation or in reactors designed and operated specifically for their production.

Fertile Materials - Though only fissile materials can generate heat, fertile materials are equally important in nuclear fuels technology. Fertile material Th-232, U-238, when deployed in the reactor with fissionable materials, produce U-233, Pu-239 and Pu-241, respectively, which are fissile and for this reason may generate heat.

The importance of nuclear fuels - The importance of nuclear fuels, to the national economy and security is due to two main facts:

1) The great energy concentration in fissionable materials;

2) The abundant and widespread occurrence of fertile materials in the world.

From the great energy concentration in fissionable materials, it follows:

a) its importance as explosives for nuclear weapons;

b) its importance as a source of thermal power.

From the abundance and widespread occurrence of fertile materials in the world it follows:

a) the possibility of nuclear weapons proliferation;

b) the possibility of producing thermal power by almost all nations from their own natural resources.

At the request of the parties concerned, the proliferation of nuclear weapons may be inhibited by the application of International Atomic Energy Agency Safeguards System on contracts or other arrangements which refer to nuclear material and to the equipment for their production.

The generation of electricity from their own natural resources is very important to the growth of underdeveloped nations, especially those that find difficulty in promoting their development because of the absence of fossil fuels.

4. About Nuclear Policy

A Nuclear Policy should attend the needs for the nation's development and security in the broad sense; that is, it should recognize that the economic growth is a factor of national security and that security is necessary to support the development of the nation.

There are two main reasons that may drive a nation to adopt a National Policy to guide the development of nuclear technology:

1) the production of nuclear explosives for weapons;

2) the generation of thermal power for civilian purposes.

Nuclear technology will supplement the growth and modernization of the industry and develop radioisotopes production and their applications. These secondary sectors will concern a Nuclear Program even more than

these principles of a Nuclear Policy.

The orientation of Nuclear Policy may lead to one or the other of these particular purposes or to an association of both; in the later case the result will depend on the emphasis given to each component.

The two technologies are basicaly the same. The technical knowledge necessary for the development of a nuclear industry for civilian purposes is the same as the one necessary for nuclear explosives for weapons. They differ mostly in the design optimization and operation of the reactor. In the first case, one tries to generate thermal power on an economical basis and the fissionable material produced, as a by-product, is rich in non-fissionable isotopes. In the other case, one tries to get fissionable material as pure as possible, that is, free from non-fissile isotopes (there is then a possibility to generate electricity as a by-product).

In short, any nation with a nuclear technology and a incustry developed for civilian purposes is potentially prepared to make explosives for nuclear weapons.

A prominent Canadian political figure, Mr. Eric Kieran,* remarked in a recent speech that Canada is rich enough to build an atomic bomb and sensible enough to refuse to do so. Mr. Kierans meant by rich enough, that Canada has raw material, technology and is financially capable to build, in a short period of time, the necessary industries to make an atomic bomb. By the word sensible, he meant that the Canadian Nuclear policy is dedicated to the proposition that nuclear energy must serve mankind and must not be used to produce bombs.

A Nuclear Policy oriented to the production of power on an economical basis will contribute to the development and the security of the nation, in the following ways:

a) by generating, now or in the near future, thermal power with its own natural resources;

b) by introducing modern technology in some sections of industry, by creating new industrial control and research methods and by increasing the productivity in almost all national production sectors.

c) by elevating the technological level and consequently, improving the national human skill;

d) by endowing the nation with the potential capacity of producing nuclear weapons, which may be realized in a short period of time by converting civilian industry.

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* International Edition of Financial Times of Canada - September 1966.

A Policy oriented towards the direct production of nuclear weapons may bring the following problems to the nation:

a) it may contradict the nation's foreign policy;

b) the production of nuclear weapons must be developed outside the IAEA's Safeguards System and this will reduce international trade possibilities and exchange of know-how for nuclear purposes;

c) the thermal power generated by reactors optimized for the production of fissionable materials for nuclear weapons is much more expensive than the one produced by reactors specially made for energy purposes.

Therefore, the generation of nuclear power will contribute to the nation's progress and security, creating wealth, participating in the national effort to improve the human skill and endowing the nation with the potential capacity to produce modern defense weapons, with no additional cost to the nation's economy.

On the other side, the direct production of nuclear weapons will delay the development of the nation, increasing the cost of power and introducing difficulties in nuclear trade and exchange of information with other countries well developed in the field of nuclear technology. This situation will not bring any specific advantage to the nation.

5. About Brazilian Nuclear Policy

Everything related to the establishment of a National Nuclear Policy for the introduction of nuclear power in Brazil is the direct responsability of the President.

This policy was not established by the government before the Revolution of March 1964, except for the points mentioned in the law 4118/62, and the revolutionary government has not yet established new principles for a Nuclear Policy consistent with the Revolution.

It is urgent for the government to assume a revolutionary position regarding the national problems of nuclear power. First, by eliminating the marks left by a policy which disagrees with the revolutionary ideals, and next by establishing its own policy. This will not be a very difficult task, for the realizations of the last government in the nuclear power field were not so important as those in some other administrative sections. However, it left behind a xenophobic environment and the reminiscences of a fanciful promotion of the merits of nuclear power as compared with hydropower and fossil fuels in electricity generation.

This environment and the monopolizing of nuclear power generation by

the Comissão Nacional de Energia Nuclear contributed to the lack of interest in nuclear power in Brazil by the planning offices responsible for the energy policy and the generation of electricity.

The law 4118/62, by giving exclusively to CNEN the privilege to study, design, build and operate nuclear power plants, created a monopoly of the generation of electricity by nuclear fuels. This is a strange privilege because nuclear fuels, as an energy source, should be used by utility companies the same way as coal and oil. It would be equally strange if there was a law giving Petrobrás the privilege to generate electricity by oil-fuelled machines. Not even the purpose of production of fissile materials for weapons would justify the monopoly given to CNEN, because nuclear power plants optimized to generate electricity do not produce fissile materials pure enough to be used in weapons. Furthermore, the government will always implement national safeguards on the production and use of the fissile materials through CNEN inspections.

Development and national security should always work together, supported by all national forces and there is no reason to exclude utility companies by maintaining CNEN's privilege concerning electricity generation by nuclear fuels.

Nuclear Power promotion was made by the exageration of the merits and sometimes by mentioning fancy figures about nuclear power in Brazil. In this way, the authors praised their own personality and tried to lead the nation to a precipitous decision about the first nuclear power units.

Before the Revolution, one would easily find in the newspapers statements such as:

"...around 1970 Brazil will have 1.200.000 KW from nuclear sources in the south central region"(O Estado de São Paulo, March 10, 1964).

"...the efficiency of the Nuclear Power plants is already beyond that of conventional electric plants that use oil or coal". (Fôlha da Manhã, February 21, 1964).

"...an authority on the matter spoke widely about nuclear power plants. We have plenty of raw material and 80% of the components may be produced in this country". (A Gazeta, February 29, 1963).

Xenophobia, sometimes appearing as nationalism, did not approve the adoption of Safeguards System (IAEA), on the false purpose of preserving national security by the production of nuclear weapons. Truly, the main purpose was to maintain Brazil distant from some friendly countries, but what it really achieved was the delay of our economic growth, upon which the real national security should be established.

About Safeguards, the general opinion before the March Revolution is briefly explained in the following text:

"...Once sure of the inconvenience of importing enriched uranium as a consequence of the Safeguards which would be imposed by the supplying nation, the first Brazilian power reactor will be built using natural uranium, which is being prospected in its soil, or using imported natural uranium (which is not controlled by safeguards)" (Manchete August 24, 1963).

The inconvenience of importing enriched uranium is mentioned mostly because of the requirement by the supplier that the uranium not be used for military purpose, and because inspection would be made through the IAEA Safeguards System. The statement that imported natural uranium may be obtained without Safeguards is not always true; for instance, if natural uranium was bought from Canada, it should not be used for any military purpose.

In reality, the fundamental problem is not whether to accept or not the Safeguards but it is to decide what is the best way to use nuclear materials in pursuit of national security and economic growth; 1) to accept the charges of a nuclear program with a component directed to weapons production or, 2) to receive the benefits of a nuclear program oriented exclusively to civilian purposes.

If, in the opinion of the leaders of Brazilian administration, the national interests were better attended by the civilian program, the acceptance of Safeguards to imported nuclear materials, instead of being a stone in the road, will be like a catalytic agent helping the construction of a nuclear industry inside the country.

6. <u>The Fundamental Problem</u>

Today, the fundamental problem of Nuclear Power in Brazil is more a political problem than a technical one. To solve this problem the Government must erase the marks of an old-fashioned policy, left by the previous government and establish its own Nuclear Power Policy.

The establishment of this Policy should be consistent with the ideals of the March Revolution, should have a national sense and should be supported by realistic facts and true hopes about nuclear technology.

1) to be consistent with the ideals of the Revolution it should be:

a) integrated in the National Security Policy;

bb) consistent with the country's Foreign Policy and with the Defense and Economic Development Policy;

c) planned together with the National Energy Program and with the plans for Industrial Development.

2) to have a national sense, it should:

a) gather together all the country's motivating forces around a true nationalism and the economical integration of the national territory, eliminating:

- the marks of xenophobia and of a foggy technology, so that the nuclear problems in Brazil and the proposals for their solution might be presented to the nation and to other countries with their real possibilities and true hopes;

- privileges of any kind, so that the utility companies may have the opportunity to study, design build and operate their own nuclear plants, integrated in a national plan. Thus they would participate, by their own decision, in the effort to build a nuclear industry in Brazil;

b) in negotiations with foreign countries, accept without fear, the IAEA's Safeguards System, and strongly propose conditions that will favour the development of a national nuclear industry;

3) to be based on realistic facts, it should recognize the following:

a) that, sooner or later, Brazil will use nuclear or fossil fuels as a basic element, instead of a complementary one, in order to attend the increasing demand for electricity;

b) that nuclear fuels may provide thermal power to Brazil on an economical basis:

- now, in certain geo-economic regions;

- in the near future, in all the territory and with Brazilian natural resources.

c) that an integrated nuclear industry, using Brazilian natural resources will produce energy and will supplement the country with:

- potential capacity to produce nuclear weapons, with no additional cost;

- new ways to increase the productivity and modernization of industry of industry improving the country's economy.

It is only by proper orientation of the National Policy, within the Brazilian scene, that the goals "Nuclear Energy" should attain in the fight for economic development can be brought into focus. Only then, the technician's work will be efficient and the nuclear budget will be productive.