

The Argentine Nucleoelectric Program

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ABSTRACT

The Argentine National Atomic Energy Commission [Comisión Nacional de Energía Atómica (CNEA)] is the institution responsible for planning the country's electric generating plants; it was established in 1951 and at present it has approximately 5000 agents and an annual budget of about \$200 million. Its activities range from basic research to operation of the Atucha Nuclear Power Station [Central Nuclear en Atucha (CNA)] and construction of the Embalse Nuclear Power Station [Central Nuclear en Embalse (CNE)]. Exploration and exploitation of the Argentine uranium resources are also within the scope of its activities.

Since the date the CNA began commercial operation, the CNEA joined the group of electricity generating companies that supplies the national market, and has participated in the study group of the Secretary of Energy. The Secretary of Energy has defined the electric plant expansion up to 1986; a program that will cover the period from 1986 onward is being studied and the conclusions are likely to be known during the second half of this year. Apart from the CNA, which has been in commercial operation since mid-1974, and the CNE, which is scheduled for commercial operation in 1981, the approved generating plant installation program anticipates a third nuclear power station (CNA II) for 1986/1987.

Because of the priority that has been given to exploitation of the hydroelectrical resources, it is anticipated that the nucleoelectric plant additions from 1986 to 1994 will be insignificant, except for the possible addition of a fourth nuclear power plant in 1989/1990 and a fifth plant in 1993/1994.

After that date, the economically available hydroelectric resources will be exhausted, and all further system expansions will be made on the basis of nuclear power stations.

The present report reviews the three nuclear power stations mentioned before:

319-MW(e) Atucha Nuclear Power Station (operating)
600-MW(e) Embalse Nuclear Power Station (under construction)

≈600-MW(e) Atucha Nuclear Power Station II (in project).

ATUCHA NUCLEAR POWER STATION

About 100 km northwest from Buenos Aires, in the vicinity of the town of Lima, Argentina's first nuclear power station is in operation. The 319.3-MW(e) Atucha Nuclear Power Station is equipped with a heavy-water-moderated and -cooled natural uranium reactor, of the

pressure vessel type. On March 20, 1974 it was synchronized for the first time to the "Gran Buenos Aires-Litoral" electric system network, having generated a net 7,728,177 MW up to March 1, 1978. Our experiences at each stage of the project are described.

Nuclear Power Station Planning

Since its creation, the CNEA has carried out actions that provided it with the necessary scientific and technical capability to undertake a project with the significance of a nuclear power station.

In January 1965, the Executive Power instructed CNEA to carry out a feasibility study on a nuclear power station for the supply of electricity to the "Gran Buenos Aires-Litoral" area, which, after having been completed in 1966, reached favorable conclusions as to the technical feasibility, economic convenience, and financial viability of the project. In 1967, a complementary study was carried out jointly between the State Secretary of Energy and Mining and the CNEA, with emphasis on operation and exploitation of a nuclear versus a conventional power station of the same capacity.

After analyzing the conclusions of both studies, in the Autumn of 1967 the Executive Power approved the nuclear power station erection and instructed CNEA to proceed with the corresponding call for bids.

This first stage, for CNEA, meant a transition from its former activities, which had been almost totally circumscribed to basic and applied research, to a wider action closely related to the sectors engaged in the energy business.

Request, Reception, and Evaluation of Proposals—Contract Award

As a result of the invitations sent in May 1967, 17 proposals were received on July 31, 1967. Owing to the fact that CNEA had emphasized the importance it assigned to the amount of local industrial participation contemplated by each bidder, this requirement was generally adequately covered. After CNEA's evaluation of the proposals, the Executive Power decided in February 1968 to award the contract in accordance with CNEA's recommendation. Although the emphasis of the evaluating groups was put on the technical, economic, and financial aspects, recognition of the role this plant would play as a fundamental step in a nuclear policy had priority on the final decision. Looking at the natural uranium alternative from that perspective, the CNEA, which had considered it inconvenient to make an *a priori* choice, but had decided to compare concrete offers of both types, finally recommended the natural uranium line as the most adequate for the country, even having evaluated the risks particularly involved in accepting an offer by a company that had no prior experience with a plant of the same type and capacity, either in operation or under construction.

In the period between the above-mentioned decision and the moment the contract was signed on May 31, 1968, CNEA successfully completed the financial and contractual negotiations, thus obtaining a contract that later experience qualified as excellent. The final cost of the nuclear power station, including construction, erection, and delivery as a complete finished plant operating in guaranteed exploitation, as well as the financing expenses up to commissioning and the higher costs resulting from application of the respective price readjustment formulas, came to approximately DM 360,000,000, totally financed over 20 years with a grace period equal to the construction period and an annual 6% rate of interest. This amount does not include the heavy-water inventory (300 tons plus 27 tons as reserve), nor the first core loading of 253 fuel elements totaling 38.6 tons of uranium, nor the cost of auxiliary constructions amounting to an approximate \$10,000,000 (U.S.) which were directly performed by CNEA.

Plant Construction, Startup, and Take Over

The CNEA took over full responsibility for nuclear plant construction, while definitions of responsibilities of the Agency that was to undertake its operation were postponed. Although the CNA was contracted as a turnkey project, CNEA imposed certain conditions to assure participation of national industry in different areas of supply, as well as to guarantee participation of its scientific and technical staff in the various stages of the project. The results are described.

Participation of National Industry: From the moment the project was conceived, one of the basic objectives set by CNEA was to obtain maximum participation of national industry in the projects. This objective exposed two important areas that needed natural development:

1. preparation of a nuclear components industry
2. improvement of the technological level of national industry.

The work carried out by CNEA aimed at:

1. effectively manufacturing in the country those items that, during the evaluation stage and in the following contract, had been considered feasible for local industry, particularly those involving a greater technological advance
2. enlarging the contractual list with new items that could be included as a consequence of advancement of local capabilities, thus developing additional tasks
3. advising national industry on how to best achieve these objectives.

To achieve these objectives, it was necessary to establish a legal frame that would place the local suppliers in the best possible situation, without excessively taxing CNEA's economic actions or affecting the rhythm of the project which had a very exacting time schedule. The contracts for electromechanical supplies were awarded keeping in mind the aim of assuring the highest technological advance.

The response of Argentine firms was such that it became possible to considerably expand the anticipated list. In short, national participation reached 38% of the total cost of the project. National contribution in electromechanical supplies was 12% of the total.

But even more important than the percentages of national participation in this first nuclear power station

was the fact that local industry successfully faced the requirements imposed by strict and severe quality control standards. The Atucha Nuclear Power Station was the first big public work in which, with the aim of obtaining the greatest possible national participation, a study was performed to analyze the technology involved to ascertain how it could be apportioned among the different firms potentially suited for the task.

Participation of CNEA's Technical and Scientific Personnel: Contrary to what happened with industry, the participation of national engineering firms was minimum, due primarily to lack of previous experience in this area. This circumstance was understood during development of the project and was overcome for the second nuclear power station, as will be seen.

On the other hand, CNEA clearly understood the importance of taking advantage of this stage to integrate the training of its technical and scientific personnel. In addition to future plant operating staff, CNEA sent those members of its staff having the greatest experience in the disciplines related to the project to the offices of the main contractor. These personnel acquired enough experience and training to cooperate in development of the project and also to provide technical and scientific support in the stages of commissioning and later operation.

Nuclear Power Station Operating Personnel: As a consequence of practically no participation by conventional electrical utilities in the project of the progress in construction, and postponement of the decision as to the constitution of the Agency that would be in charge of operating the power station, CNEA had to assume responsibility for integrating the operating crew. This was accomplished on the basis of personnel having previous experience in conventional power plants and, to a lesser proportion, CNEA personnel with experience in research reactors. These personnel were commissioned abroad for periods of 12 to 18 months to complete their training.

The project delay during the commissioning period, the delays in completing construction of facilities for lodging personnel in the vicinity of the plant, their heterogeneous extraction and, in certain cases, their lack of identification with the aims of CNEA, the absence of a clear labor legislation contemplating the operational peculiarities of a nuclear power plant, and finally, the beginning of a period of responsibility after the training period led to the defection of a high percentage of the crew during the final stages of the plant's commissioning. Anticipating this possibility, by the middle of 1973 CNEA had started intensive and accelerated training of additional operating personnel to be employed in future projects and to cover situations such as this. This training, which was done in the country at much less expense, was given to professionals who had been affiliated with CNEA practically from the beginning of their professional careers. This enabled CNEA to have available, at the moment of receiving the power station, the necessary personnel to face the responsibility of its operation.

By the middle of 1977, and after a general overhaul of the CNA, which will be described below, its most experienced professionals and technicians were assigned to the CNE and the CNA II, while operation of CNA was entrusted practically to personnel trained in accordance with the above-mentioned schemes. After an initial period of adaptation to their responsibilities, these personnel are performing their duties with total efficiency.

Development of the Project: Plant construction started on June 15, 1968 with a contractually anticipated delivery on June 15, 1972, while its effective reception date by CNEA was June 24, 1974. This meant an extension of the original delivery term of slightly more than two years.

This delay was due to the following main reasons:

- a. difficulties during the fabrication of the pressure vessel, which resulted in a 15½-month delay in its delivery
- b. a problem detected in the original design of the fuel elements which interrupted the power plant's commissioning for a period of almost 9 months starting in February 1973.

These two events were an adequate opportunity for CNEA to appraise the importance of having technical and scientific capability enabling it to actively participate in evaluation of the problem and in weighing the solutions chosen for both events.

Total supervision by CNEA was a task that exceeded its human resources, but the effects were lessened by the responsibility shown by the supplier in carrying out the project.

Commissioning and Takeover: The commissioning stage proved to be the most valuable from the viewpoint of CNEA's staff integration.

Although the defection of some operating personnel reduced its benefits, it was, however, a relevant experience.

CNEA's double role as operator and licensing authority constantly required *ad hoc* solutions.

During this stage, CNEA's limitations in human resources, which prevented covering these two functions in a completely independent manner, became more evident. It was thus necessary to use the available personnel for both functions, a situation that could have led to difficulties not only among CNEA's personnel but with the supplier as well. Fortunately, this was not the case because of the clear mutual understanding between the parties and particularly because of implementation at the site of an *ad hoc* commissioning team of representatives from the three parties who, following the general regulations established by CNEA's licensing committee, made a permanent evaluation of progress in commissioning and made pertinent decisions with the celerity required.

This close participation in the plant's commissioning, not only regarding performance of the tasks but also evaluation of the results, permitted CNEA's personnel to acquire adequate knowledge of the power plant, which in turn facilitated rapid performance of the tasks associated with the contractual takeover and with classification and compensation of the discrepancies encountered.

Plant Operation

Shortly before the nuclear power plant's commissioning, CNEA had to decide on the constitution of the Agency which, according to the decree authorizing construction of the plant, should be in charge of its operation. Sources outside CNEA were of the opinion that CNEA's functions had culminated, and that the plant should be transferred to an electric utility. Against such arguments, CNEA maintained that another priority of the Atucha Nuclear Power Station was that of contributing to the development of an Argentine nuclear policy, at least for as long as it would be the country's only

nuclear power station; and that, from this point of view, its role should still be as significant as the electric power utilities. This thesis was accepted, and now, 45 months after takeover date, the plant is still under CNEA's responsibility.

The Atucha Nuclear Power Station has operated successfully during 1974, 1975, and 1976.

During 1974, and after being synchronized to the network on March 20, the plant contributed 947,000 MWh to the system. On November 16, 1974 it reached its design capacity, after scheduled performance tests were completed and the fuel elements had reached the required burnup.

On December 16, 1974 the plant was run at 108% of its design capacity to verify the possibility of steady operation at that new power level. This test showed that only a few minor modifications would be necessary, which, as explained below, were introduced during the first months of 1977.

During 1975, the first complete calendar year of full power operation, net power generation was 2,357,925 MWh and gross generation amounted to 2,517,000 MWh, with an 85.6% load factor and an availability of 89.4%.

In 1976 it generated a net 2,408,674 MWh and a gross 2,571,654 MWh, with an 87.23% load factor and 88.9% availability.

In January 1977, after 30 months operation, it was decided to proceed with a general plant overhaul. Until that time, due to the national network demand, it had been possible to stop the plant for only very short periods, which did not allow making a detailed evaluation of the plant's condition. It was also decided to simultaneously carry out the necessary modifications, as dictated by the December 16, 1974 tests, to allow routine operation at 108% of the plant's original design capacity.

Programming this general overhaul, preparing tests to verify the facility's condition, and introducing the required modifications to increase the plant's capacity, signified a major engineering task. This was planned and scheduled in cooperation with the nuclear power plant's supplier and a consortium of five local engineering firms to participate in the process.

The plant was reconnected to the network on April 28, 1977 and, after the various performance tests were completed, on May 6, 1977 the plant reached 367 MW(e) gross, corresponding to 1179 MW(th); i.e., 8.16% higher than the design capacity.

During the remaining eight months of 1977 the plant generated 1,537,028 MWh, corresponding to a load factor of 80.9% during the period.

The power increase thus achieved contributed on the order of an additional 27 MW(e) to the system, which, calculated at the current installation costs and deducting the lost generation during modifications, as well as the costs incurred, resulted in a benefit on the order of \$17 million (U.S.).

During the first two months of 1978 the plant has generated 476,948 MWh, which translates into a 107.72% load factor and a plant availability of 100%.

Until January 1, 1978, 1172 fuel elements had been replaced. The average burnup for the first loading reached 5255 MWd/MT, and for the total fuel elements removed to that date, the average was 5650 MWd/MT. The maximum burnup for a single fuel element was 6750 MWd/MT.

At the end of December 1976, CNEA completed fabrication of its first two fuel elements, which, to date, have reached burnups of 4500 and 1200 MWd/MT, respectively. Another 11 fuel elements that were locally made during 1977 are about to be loaded into the reactor.

Heavy water losses since initial loading the end of December 1973 until March 1, 1978 totaled 6106.82 kg, or about 50% of the originally estimated amount.

The plant's present generating costs represent 17.37 mill/kWh, of which 7.7 mill correspond to the fuel cycle.

EMBALSE NUCLEAR POWER STATION

Argentina's second nuclear power station is now under construction in the vicinity of Embalse, Río III, about 700 km from Buenos Aires. The 600-MW(e) Embalse Nuclear Power Station will be equipped with a CANDU-type, heavy-water-moderated and -cooled natural uranium reactor. The contract was signed on December 20, 1973 and the plant was scheduled to begin commercial operation in 1981. Experience with this project, to date, follows.

Nuclear Power Station Planning

On the initiative of the "Provincial Energy Utility of Córdoba" [Empresa Provincial de Energía de Córdoba (EPEC)], CNEA undertook a feasibility study in 1967 to install a nuclear power plant in that province. The CNEA had to delve into areas that were not strictly its concern, so it was considered to be convenient, in this case, that the aspects related to predictions of the electrical market demand should remain the responsibility of EPEC, who, due to lack of definition, decided to analyze the province's market without taking into account any interconnections with the rest of the country's network. As a result, the feasibility study established that the maximum plant size should be 150 MW, which, all factors considered, would be economically competitive. As a result, analysis of the convenience of elaborating a plan of national interconnection was intensified. This led to revision of the respective chapters of the feasibility study, which, in turn, resulted in determination of the technical-economic feasibility of a 600-MW nuclear power plant. The proposed nuclear power plant site was moved about 40 km and, although the new site was further from the province's load center, it was closer to the interconnection line. On the other hand, the proposed new site on the shore of the Embalse of the Río III lake made it easier for transportation of heavy components and the plant's cooling water intake.

The Río III lake, the largest in the province, presented advantages over the lake of "Dique Los Molinos," which had been foreseen as the site for the 150-MW plant. In particular, a careful study of the area's hydraulic characteristics was made and a compromise solution on utilization of the lake for irrigation and hydroelectric power generation and the nuclear power plant's cooling water requirements was made.

After the conclusions of such studies were analyzed, CNEA was authorized in May 1971 to proceed with a call for bids on a 600-MW nuclear power station, with no specifications as to a particular fuel type. Unlike the case of the CNA, in which CNEA acted without the assistance of conventional utilities, the National Executive Power decided that on this occasion, taking into account the role EPEC had played in the project from the beginning, the Province of Córdoba should be officially represented in the CNEA branches responsible for project coordination.

A special team composed of about 100 CNEA and EPEC professionals was in charge of preparing the tender's specifications, which were made available to the potentially interested firms early in December 1971.

As a step ahead of the Atucha project, in which emphasis was given to participation of national industry, the Embalse Nuclear Power Station, from the beginning, was conceived as an opportunity for participation of national engineering.

Request, Reception, and Evaluation of Proposals—Contract Award

On May 2, 1972, as a result of the invitations made, eight proposals were received from six firms representing five different countries (Canada, Italy, U.S., the German Federal Republic, and Japan). CNEA was in charge of their evaluation, which was finished at the end of November 1972.

As a result of this evaluation, CNEA recommended the proposal submitted by the AECL/IT Consortium, consisting of a CANDU-type 600-MW net nuclear power station. A decisive factor for this selection was the "Technology Transfer Agreement" that AECL offered together with its proposal.

The selected proposal complied with the specific requirements regarding national participation, both in amount and in the areas of special interest. The contract signed on December 20, 1973, became effective on April 11, 1974, after its ratification by the governments of Argentina, Canada, and Italy. The contractual delivery term was 69 months. The "Technology Transfer Agreement," which was considered by Argentina as an adequate means to acquire the necessary know-how to gradually develop its independent nucleoelectric program, was due to become effective on the same date.

The original turnkey-type contract contained economic considerations characteristic of a basic fixed price contract with determined readjustment formulas and maximum ceilings for items quoted in Canadian and Italian currency. The contract guaranteed the supply of 468 tons of heavy water at a cost of about \$70/kg. It was also a condition for the contract to become fully effective, that, within one year from the date of its signature, Argentina should conclude a safeguards agreement with the International Atomic Energy Agency. Although Argentina fulfilled this obligation within the established term, Canada, invoking new Canadian legal requirements, required new safeguard conditions which were accepted by Argentina by means of an agreement reached the beginning of 1976. Toward the end of 1975, the contractors petitioned CNEA regarding the necessity to proceed with a renegotiation of the economic conditions of the contract in force, basing this request on the world economic crisis that began in 1973, and on the abnormal inflationary situation that prevailed in Argentina during 1974 and 1975.

The contractors argued that the contract, as it had been signed, would imply losses of such magnitude as to prevent continuation of the work, which, in spite of the nearly 20 months that had elapsed since the contract's effective date, was only in the beginning stage. (By the end of 1975, work was only being carried out on the foundations of the reactor and generator buildings.) CNEA, notwithstanding the fact that it had a legally valid contract, decided to renegotiate to avoid eventual interruption of the project. The renegotiation was aimed specifically at modification of the readjustment formulas maximum ceilings corresponding to the accounts in

foreign currency, as well as to a substantial modification in the price of the heavy water.

As to the cost of electromechanical supplies of national origin, they would be handled by a reimbursable cost system, while for erection of the nuclear power station, a cost-plus-fee system was applied. Regarding civil work, engineering and construction management, even though the adjustment concept was maintained, modifications were introduced in the respective price and readjustment formulas. Even if the cost of these CNEA concessions is valued only at the end of the contract, the foreign currency changes will imply an amount on the order of \$100 million. This renegotiation, performed during the first half of 1976, was formally approved by the three governments on February 18, 1977.

In the course of these renegotiations, the contractors recognized that the project had been delayed eight months, and consequently established September 11, 1980 as the new final delivery date.

Nuclear Power Station Construction

As in the case of Atucha, CNEA assumed full responsibility for construction of the plant, and the definition about who would commercially operate it was postponed. As previously mentioned, both in the original contract and at the time of the renegotiation, the CNEA imposed conditions to assure the participation of national engineering and industry, as well as to guarantee participation of its scientific staff in the different stages of the project.

National Engineering Participation: From the beginning, one of the basic objectives established by CNEA was to obtain participation of national engineering in the project. Civil engineering had already been advanced with respect to Atucha, since local firms were awarded the responsibility of developing the detailed engineering of the nuclear plant as well as the basic and detailed engineering of the conventional plant.

Concerning electromechanical design, local firms carried out development of part of the basic engineering of the mechanical and electrical systems of the conventional plant, as well as a great amount of detailed engineering for the nuclear and conventional plants.

Regarding electromechanical erection, CNEA considered it convenient to include in the local participation not only the supply of labor, as in the case of the CNA, but also to extend this participation to all aspects of its organization and management. As a result, at least three national consortiums were constituted by the firms of the greatest capacity and experience in the market. CNEA plans to assign these consortia their respective tasks in the following months. Meanwhile, to allow the necessary time for this integration without affecting progress of the work, CNEA has undertaken some of the erection tasks, acting as a subcontractor to the main contractors. As a result, during the last 12 months CNEA performed shop fabrication and erection of the necessary piping to advance the civil work, as well as performing tasks of shop fabrication and erection of the calandria vault and its subsequent aligning and conditioning. The CNEA considers it convenient to continue in this function even after integration of the above-mentioned consortia, retaining those erection tasks that are closely related to future operation of the plant.

At the same time, a capacity of response is being created in the private national sector regarding non-destructive tests required at the site during erection. Meanwhile, CNEA is performing these tasks to give

contractors the necessary time to define a common philosophy in this area.

The transport of heavy components across 700 km presented engineering problems that were satisfactorily solved in the country. It was necessary to resort to original solutions; for example, construction of a transportable metallic modular overbridge that permitted overcoming obstacles encountered, such as bridges, deviations, etc.

National Industry Participation: In establishing a cost-plus-fee system for electromechanical supplies of national origin, the provisions stipulated in the CNEA contract have led to active participation of the CNEA in all purchasing processes. In general, it may be said that the CNEA is more advanced than the CNA regarding local industry participation. Though it is still too early to tell if the contractual estimates of 33.2% participation will be reached, there is no doubt that the 12% reached by Atucha will be greatly exceeded. The most significant elements built in Argentina are the moderator pumps, the shutdown cooling pumps, the check for reactivity mechanisms, the airlocks, a 380-MT crane for the machine room, 2000-mm-diam valves, etc.

Another aim pursued by CNEA was the manufacture in Argentina of some of the nuclear instrumentation. CNEA developed the corresponding prototypes and afterward assigned the responsibility for manufacture of the reactor's neutron flux detector amplifier system to a consortium of local specialized firms.

The framework developed for this purpose later permitted AECL/IT to place orders along the same lines with the corresponding firm.

The contract also contemplated the possibility of manufacturing part of the first loading of fuel elements in Argentina.

Difficulties with Canada regarding safeguards, which have not yet been completely overcome, have prevented our obtaining the corresponding license, a circumstance that makes completion of this objective materially impossible.

Summarizing, it may be said that reaching the above-mentioned results has been a complex task due not only to the special situation that Argentina went through during most of the development of this project, but also to the way in which the contractors have organized their framework to comply with this contractual obligation.

Contractual estimates regarding the total national participation in the project are shown in Table I.

Participation of CNEA's Technical and Scientific Staff: The importance that CNEA assigned to the "Technology Transfer Agreement" as a fundamental factor in deciding contract award to AECL/IT was, in practice, frustrated. This agreement, which was expected to offer the possibility of wide participation of CNEA's staff in the project, could not be implemented due to safeguards requirements that, until recently, AECL has considered not satisfied. In spite of these limitations, it was possible to attach CNEA personnel to the AECL and IT project offices. Most of these personnel have been assigned to pending tasks of the project and particularly to the erection work CNEA has undertaken. These personnel were thus given the best opportunity to apply their experience and to start to integrate themselves with the reality of the project. This will contribute to forming the staff that will have responsibility for management of future projects.

TABLE I

Items	Percentage over the Total Price of the Item	Percentage over the Total Cost of the Nuclear Power Station
Electromechanical supplies	33.2	17.2
Civil engineering work	100.0	13.0
Erection	94.2	8.7
Engineering	33.2	2.2
Project management, administration, staff training, commissioning, inspection expenses	34.3	5.4
Maritime and land transportation	48.6	1.1
All risks and transportation insurance	100.0	2.1
Total		49.7

Regarding the operating personnel, professional staffs were formed on the basis of personnel with experience in the Atucha Nuclear Power Station. This staff has been in Canada and Italy for approximately nine months, and they are expected to return to Argentina in the near future. Their participation in plant commissioning will be active, and part of their responsibility on their return will be to organize the selection and training of the remaining levels of the operating crew. Later, a second crew of professionals which will ultimately constitute the permanent operating crew of the plant will be trained. It is planned that the crew which is presently being trained will participate in the commissioning stage and run the station during its initial operating period, after which it will be assigned to the Atucha II commissioning. The second group of plant operators, which also includes EPEC's personnel, is presently being trained at the CNA and abroad.

Development of the Project: As mentioned above, the work became rhythmic by the middle of 1976, when pouring of concrete in the reactor building was carried out (June/July 1976). By the end of 1976, as a consequence of the delay in implementing the renegotiated contract, the work lost its rhythm, to recover it again only at the beginning of March 1977.

By the end of 1977, 60% of the civil engineering work had been completed. The nuclear heavy components arrived during the last three months of 1977, and the conventional components arrived the beginning of 1978.

As already mentioned, during 1977 the CNEA had to undertake erection tasks to avoid interrupting progress of the civil engineering work, as well as to carry out preparation of the calandria vault.

The calandria erection is being completed and it is expected that the steam generators will be brought to their definitive positions during the month of April. CNEA has started erection of the reactor nuclear systems in the basement of the reactor building, and the turbine-generator and thermal cycle erection tasks will be awarded soon. Work on the water intake, consisting of a pipeline approximately 800 m long laid on the lake's bottom, has made considerable progress. All efforts are being made at present toward meeting the contractual delivery date, i.e., September 11, 1980, but, while this is not absolutely impossible, it shall no doubt require a series of highly favorable circumstances to be met.

ATUCHA II NUCLEAR POWER STATION

It is planned to construct CNA II about 500 m from the CNA site. CNA II will be equipped with a natural uranium heavy-water reactor and it is expected that, during the second half of 1978, a decision will be made as to which concept will be chosen: i.e., pressure vessel (CNA) or the pressure tube concept (CNE). The station's power capacity will be on the order of 540 to 640 MW(e). Definition of the plant's actual capacity will be made jointly with the decision on the reactor concept.

Nuclear Power Station Planning

The CNEA has always aimed at a program of nuclear power station installation to comply with two basic objectives:

1. Satisfy the country's power demand, analyzing the nuclear alternative in comparison with the other options.
2. Implement an adequate level of domestic capability to carry out the country's nuclear projects.

All projects have been conceived with an aim to satisfy these two objectives. It is appropriate, however, to wonder if, after having reached its own capacity of accomplishment, it is possible to run the risk of losing it, should an intermediate period elapse during which there were no projects approved from analysis of our first objective and without properly weighing the negative implications, which were just mentioned, in that analysis.

This continuity implies a minimum sequence of nuclear installations, according to a schedule that will depend on the evolution of the process. Considering the expected progress of the CNE project, this starting point should be mid-1979. With this hypothesis and accepting a total construction time of seven years as a result of the decision of going from a turnkey scheme to a project of greater domestic responsibility, CNA II could be in operation in the second semester, and be expected to start providing steady power to the system in 1987.

After this scheme was defined, initial approval was obtained from the Executive Power by the end of 1976 to begin negotiations with potential suppliers on the basis of the requirements of our second objective mentioned above.

At the same time, the Secretary of Energy, who was elaborating the first stage (1976-1985) of the electric plant installation program, was asked to analyze if the

project was acceptable from the viewpoint of the first objective.

Although CNA II, as a consequence of its scheduled startup date, would belong to the second stage of that program (1985-2000), the study that the Secretary of Energy finished in April 1977 includes the CNA II from 1987 on. The study presently under development for the specific period will not be finished until the end of 1978 and, although only then will it be possible to know if those forecasts are confirmed, the data already available would seem to confirm them, and would allow coming to the conclusion that it will be necessary to carry out the project because it complies with both objectives.

*Request, Reception, and Evaluation of Proposals—
Contract Award*

The CNEA has analyzed two alternatives:

1. natural uranium heavy-water reactor of the Atucha type
2. natural uranium heavy-water reactor of the CANDU type.

Regarding the first alternative, an agreement was signed with KWU for performance of a feasibility study for this reactor type. The study is expected to be finished by the middle of 1978 and will establish the maximum power capacity that can be reached with this solution, as well as the most important economic parameters.

As to the second alternative, discussions are being held with Canada to determine their interest in participating in future nuclear power projects in Argentina, as well as the scope of supply they would be prepared to cover.

CNEA intends to reach a decision on these two alternatives toward the end of 1978.