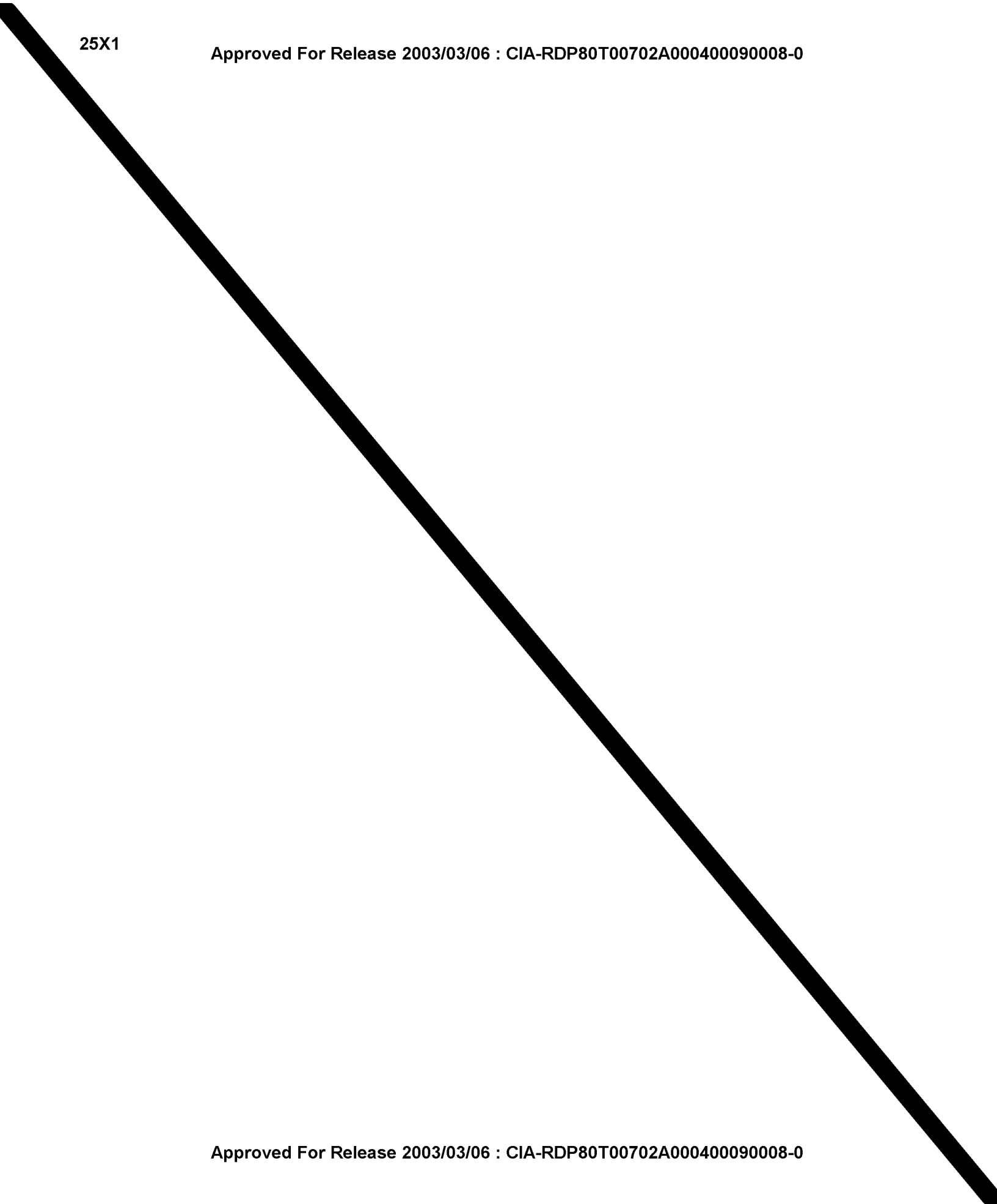
Argentina: The Next Nuclear Power Plant Exporter?

An Intelligence Assessment

Secret

ER 78-10



Approved For Release 2003/03/06 : CIA-RDP80T00702A000400090008-0

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Argentina: The Next Nuclear Power Plant Exporter?

Central Intelligence Agency
National Foreign Assessment Center

September 1978

Summary

By the early 1990s, Argentina should be technically capable of exporting a complete nuclear power plant of the CANDU heavy water, natural-uranium type, including ancillary fuel-supply services. If it exercises this capability, it will join the small group of industrial states now supplying power reactors. Among LDCs, only India stands a chance of matching Argentina's progress.

Argentina's nuclear effort began in 1950 as part of the Peron government's drive for primacy in Latin America and the Third World. All subsequent governments have supported the program, which fits the average Argentine's view of his country as the natural leader of Latin America in science and technology. The cost of the program has never been seen as particularly onerous, largely because Argentina started early (from an already good scientific and industrial base) and stretched the work out over a long period of time.

Much of Argentina's nuclear technology has been developed domestically, including production of research reactors, uranium exploitation, and fuel fabrication. Foreign support nevertheless was—and is—needed for nuclear power projects. Buenos Aires has been very successful in obtaining advanced technology from foreign contractors. We believe that its efforts will be equally successful in the future.

- Argentina supplied engineering, materials, hardware, and labor amounting to 40 percent by value of its first power plant, completed in 1974 under contract with Siemens A.G. of West Germany.
- Buenos Aires is supplying inputs equal to 50-60 percent by value of its second plant, now under construction under a contract with Atomic Energy of Canada, Limited, (with Impianti of Italy furnishing the conventional power sections).
- We expect Argentina to supply as much as 60 percent of the equipment and 90 percent of the engineering and installation work for a third power plant, for which it is negotiating with Canada and West Germany.

As Argentine capabilities have grown, Buenos Aires has begun to export nuclear technology and equipment to other Latin American nations. Argentina has contracted to furnish two research reactors to Peru and is providing a research reactor and a uranium ore treatment plant to Bolivia. While these exports are being undertaken primarily for reasons of prestige and regional leadership, they are also necessary to make full use of Argentine productive capacity and trained manpower. We expect this trend to accelerate.

Argentina's growing reputation as a dependable nuclear supplier in the Latin American region can assist it in establishing a more substantial role worldwide. This is especially true among Third World countries, where its status as a developing nation enhances its acceptability as an alternative to established nuclear suppliers, whose policies may restrict dependable nuclear

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supply. Moreover, supply contracts with its Latin American neighbors permit Buenos Aires to influence their nuclear programs heavily and give Argentina a measure of control over their uranium reserves.

Although foreign support remains indispensable for progress on Argentina's nuclear power program, the country is not dependent on such support for establishing a full nuclear fuel cycle. Facilities are in operation or under construction for all components of a complete fuel cycle free of foreign controls: uranium refining, production of zirconium-alloy cladding, fuel fabrication, and spent-fuel reprocessing. Buenos Aires also is currently attempting to obtain a foreign-supplied plant to produce the heavy water coolant/moderator for power reactors but is encountering difficulties because of nonproliferation considerations. We believe that even without major foreign help Argentina can complete its own heavy water plant by the late 1980s.

By 1990 or soon thereafter, Argentina should be able to produce domestically a heavy water power reactor together with essential supporting services. If it can find a customer, we believe that Buenos Aires may opt to export the plant rather than add it to its own power system, since the country will still have ample hydroelectric potential to exploit.

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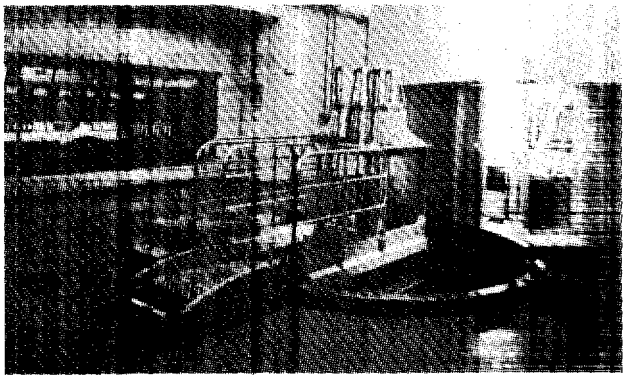
Introduction

Argentina, with a strong technical tradition (including several Nobel Prize winners in the sciences), has long considered itself the obvious leader of Latin America in scientific matters. Thus it was natural that it should enter the nuclear field at an early date. Although the initial decision to establish a nuclear program reflected the Peron government's drive for Third World leadership, the program has been strongly supported by later governments and by the average Argentine citizen. Having achieved considerable success in establishing a sophisticated domestic nuclear industry, Buenos Aires is now beginning to export technology and equipment to other Latin American nations.

Argentina's Nuclear Background

With nearly 30 years of experience in nuclear science and engineering, Argentina has developed a sizable cadre of competent nuclear personnel. Since the founding of the Argentine Nuclear Energy Commission (CNEA) in 1950, the country has established several nuclear research and training facilities and now has the only operating nuclear power plant in Latin America. Its first research reactor, designed and built entirely by Argentines, was completed in 1958. Construction of the first power reactor began in the mid-1960s, with completion in 1974. Argentina now is striving for full nuclear power self-sufficiency based on its large domestic uranium reserves. Its choice of natural-uranium power reactors permits it to exploit these reserves without dependence on foreign enrichment services.

Argentina has done a large share of the work on its nuclear power plants. For the first plant—the German-built pressurized heavy water reactor at Atucha—domestic industry provided civil



The 10,000-kW RA-3 research reactor, Ezeiza Atomic Center. Built entirely from Argentine resources, the reactor was completed in 1967.

engineering, materials, electro-mechanical equipment, and labor amounting to about 40 percent of the plant's total value, and Argentine subcontractors directed about one-fourth of the engineering and installation work. The contract with Canada for a second plant, a CANDU-type reactor now under construction at Embalse in Cordoba Province, calls for a 50-percent domestic input; the share may well reach 60 percent. Buenos Aires intends to build a second reactor at Atucha, to be completed in the late 1980s. Admiral Castro Madero, head of CNEA, has stated that domestic content of this plant will amount to 60 percent,

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Argentina also is taking steps to become self-sufficient in heavy water and in the complete nuclear fuel cycle. Construction is about to begin on a pilot plant for heavy water—used as moderator/coolant in its reactors—and a full-scale facility is planned. A pilot-scale fuel-fabrication

plant was completed last year. A few power-reactor fuel elements have been produced, and technology for producing mixed oxide fuels is being developed. A full-scale plant to produce about 270 metric tons per year of power-reactor fuel elements is being built and should be in production by 1980. Chemical reprocessing of spent fuel was conducted on a laboratory scale as early as 1969, and construction of a pilot plant to reprocess spent fuel elements from the Atucha plant is scheduled for completion by 1981 (see table 1).

Technical Capabilities

There are few gaps in Argentina's nuclear technology base. CNEA has gained practical experience by designing, engineering, constructing, and operating most components of a full nuclear program, from uranium exploration through research reactor development, fuel fabrication, and reprocessing. In moving into the nuclear power plant field, the Argentines are widening their nuclear construction and engineering skills and are providing a growing array of high-technology equipment and components. These capabilities are emerging rapidly from a modest beginning. During construction of the Atucha plant, for example, Argentina's contribution was limited mainly to excavation and site preparation, installation of some of the concrete and nonnuclear-grade pipe work, and some electrical equipment. Practically all the power plant equipment—nuclear and nonnuclear—was imported and installed by the West German contractor, Siemens A.G.

Based on the experience gained from Atucha, the Argentine contribution to the Rio Tercero plant now under construction at Embalse is much greater. In addition to providing most of the nonspecialized electrical installations in the plant and in the switchyard and substation, the Argentines are assembling (from domestic and imported components) and installing steam generators, turbogenerators, and much of the nuclear-grade piping and valves. While the Canadian contractor is providing and installing the nuclear reactor and its critical linkages and controls, even these operations are being carried out with close Argentine support.

Table 1

Argentine Nuclear Production and Export:
The Record and Prospects [1]

	First Production	First Export
Research reactors	1958	1978
Fuel-fabrication services for research reactors	1966	1979/80
Uranium prospecting, mining, and concentration services	late 1950s	1977
Assistance in setting up nuclear research centers	NA	1977
Fuel-fabrication services for power reactors		
Pilot-scale	1977	NA
Full-scale	1980	1990
Heavy water production		
Pilot-scale	1980	NA
Full-scale [2]	1984	1986
Full-scale [3]	1987/88	1990
Heavy water power reactor [4]	1990/92	1990/92
Reprocessing services		
Laboratory	1969	NA
Pilot-scale	1981	NA
Full-scale	1988	1992

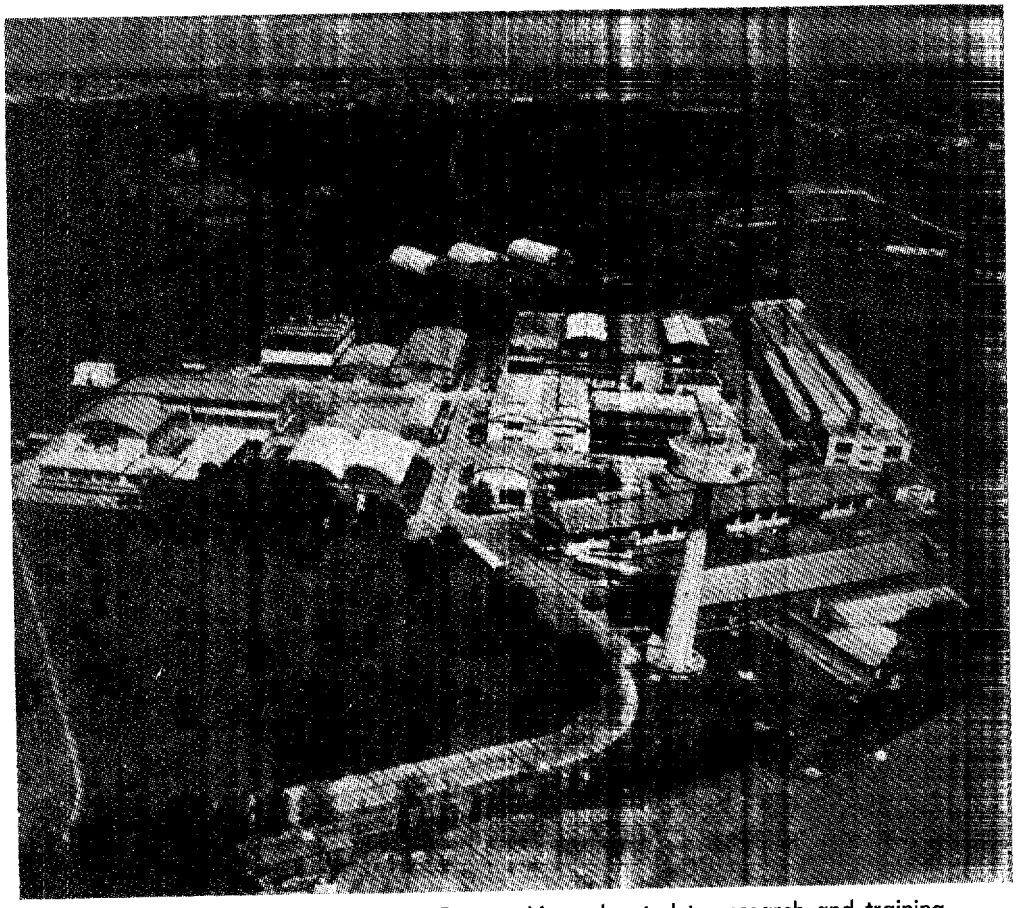
[1] Future dates are CIA estimates.
[2] With purchase of a foreign-built plant during 1978.
[3] Using Argentina's own resources.
[4] 100-percent Argentine-contracted.

For Atucha II, Argentina expects to assemble and install the bulk of the reactor under supervision of the foreign contractor still to be selected. Negotiations are in progress with both Canada and West Germany. The Argentines plan to manufacture many components themselves and will also be responsible for installing much of the imported equipment, such as high-pressure valves, pressure tubes, and control-panel components. The main items that will still have to be provided and installed by the contractor will be pressurizers, custom automatic refueling equipment, and the large nuclear-scale turbines. Table 2 shows the key items Argentina can now produce and those it should be able to manufacture by 1985.

Argentina is accomplishing all this despite an industrial base that, while strong by Latin American standards, is quite narrow when compared with that of developed countries. Although the construction industry is well developed, production of sophisticated equipment is limited and remains heavily dependent on imported components and specialty steels. For example, Argentina still imports a sizable share of its electric power equipment needs. Argentina's nuclear accomplishments reflect mainly the relatively narrow focus of the effort and the country's basic strength in the sciences.

Manpower Resources

The critical element in Argentina's nuclear accomplishments has been the large cadre of trained nuclear personnel that the nation has been able to acquire. Since the nuclear program was launched in the early 1950s, the stock of



Constituyentes Atomic Center near Buenos Aires, devoted to research and training.

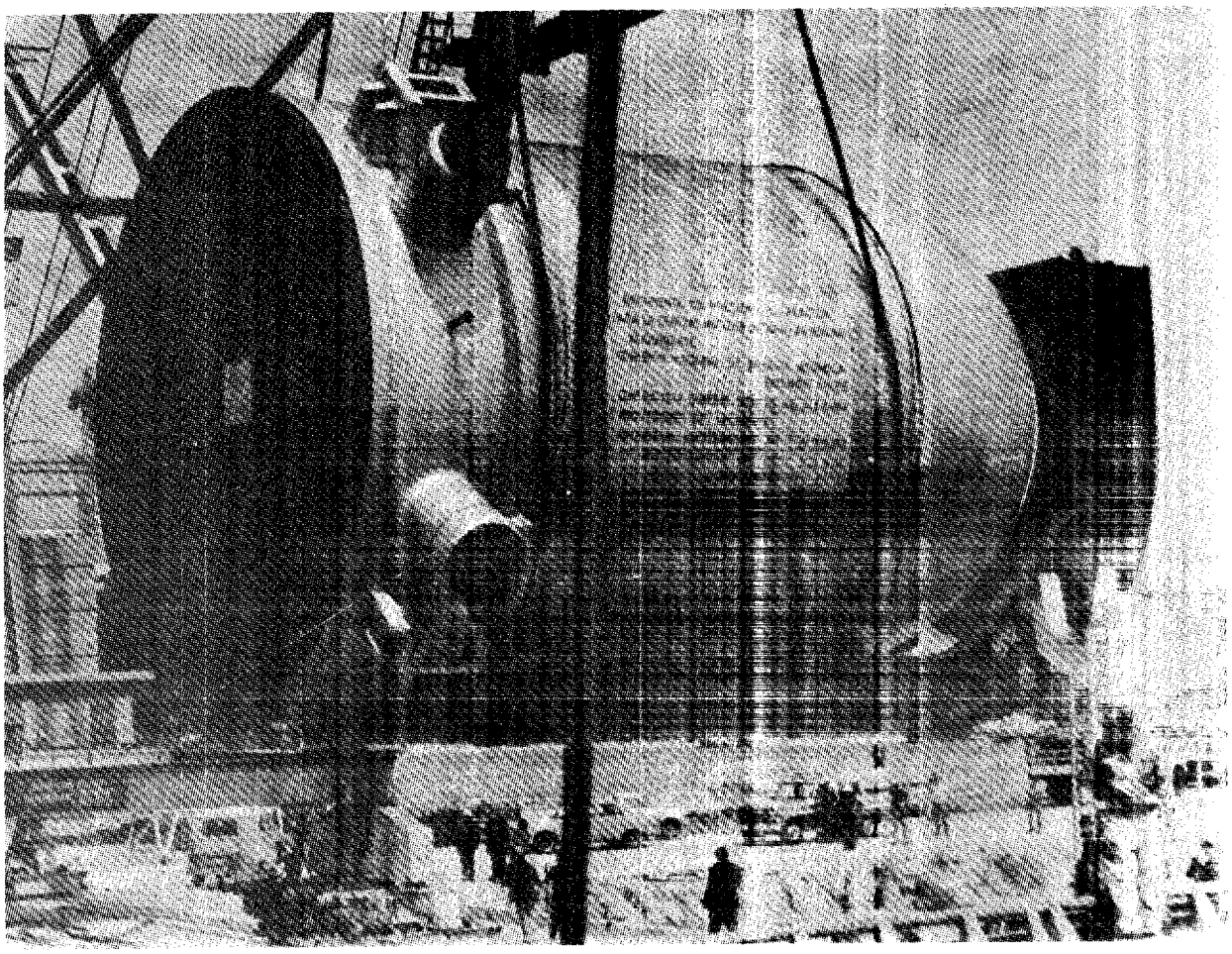
Table 2

Argentina: Production Capabilities for Key Elements of Nuclear Power Stations

	Current	1980-85
Conventional construction and power system		
High-quality welding	Yes	Yes
High-stress concrete	Yes	Yes
Electrical contracting	Yes	Yes
Major electrical		
Switchyard equipment	Yes	Yes
Turbo-generators	Yes	Yes
Nuclear-scale turbines (megawatt)	No	No
Nuclear steam-supply system		
Conventional large-diameter steel piping	Yes	Yes
Valves and pumps, auxiliary	Yes	Yes
Large pumps and valves for reactor coolant	No	Yes
Nuclear steam generators	No	Yes
Internal equipment		
Pressure tubing	No	No
Control rods/drives	No	Yes
Pressurizers	No	No
Support equipment		
Fuel-reload machinery	No	No
Fuel-storage racks	No	Yes
Control panels	No	Partial
Technical skills for reactors		
Operation	Partial	Yes
Safety	Partial	Yes
Design and engineering	Partial	Yes
Nuclear fuel cycle		
Fuel technology		
Mining	Yes	Yes
Concentration	Yes	Yes
Chemical and machine processing for UO_2	Yes (pilot)	Yes
Zirconium cladding (extrusion)	Yes (pilot)	Yes
Fuel assembly	Yes (pilot)	Yes
Heavy Water		
Distillate columns	No	No
Valves	No	No
Design and engineering	Yes	Yes
Reprocessing		
Chemical process	Yes	Yes
Fuel-chopping machines	No	Yes

domestic nuclear personnel has been greatly augmented by sending large numbers of students to Western Europe and the United States for training in nuclear science and engineering. Largely by this means, CNEA by 1974 had accumulated a body of some 600 nuclear scientists and 1,600 professional-level technicians.

The number of nuclear personnel employed by CNEA has since declined substantially, reflecting both a dispersion to private industry and research and a "brain drain" of several hundred who went abroad to obtain higher pay or to escape political repression during the Peron administration and following the 1976 takeover by



Pressure chamber for Atucha arriving from West Germany (1971).

the military government. Current CNEA employment of nuclear scientists and professional-level technicians is estimated at 1,200 persons. Close to another 1,500 professional-level personnel are employed by private Argentine firms, mostly on government nuclear contracts. Many of the several hundred still working abroad may eventually be attracted back to Argentina as the country's nuclear program gains international prestige. An estimated 250 Argentines are currently working in Western Europe, Canada, and the United States. In addition, a sizable but unknown number are employed in Iran.

Academic training and extensive research experience are adding to both the stock and the capabilities of nuclear personnel. Some students still are being sent abroad for training in nuclear science and engineering. The most important domestic academic facility is the University of Cuyo, which conducts a joint educational program with the Balseiro Atomic Institute at Bariloche. It is now graduating some 15 nuclear engineers yearly and awarding doctorates in nuclear science. Nuclear research centers at the Universities of Cordoba and Rosario, both of which have research reactors, also provide academic training. Research experience for the bulk of CNEA personnel—as well as increasing experience in practical applications—is obtained at the three large government nuclear research facilities:

Embalse nuclear power plant, early 1973.

- Ezeiza Atomic Center, near Buenos Aires (at which fuel-fabrication and chemical reprocessing facilities are now under construction).
- Constituyentes Atomic Center, in Buenos Aires (where a prototype plutonium fuel-fabrication line recently has been installed).
- The Bariloche Atomic Center (where the main production facility for zirconium sponge is being constructed).

Capabilities of CNEA nuclear personnel are being further enhanced by a program under which some 150 Argentines have received practical training on the CANDU reactor in Canada.

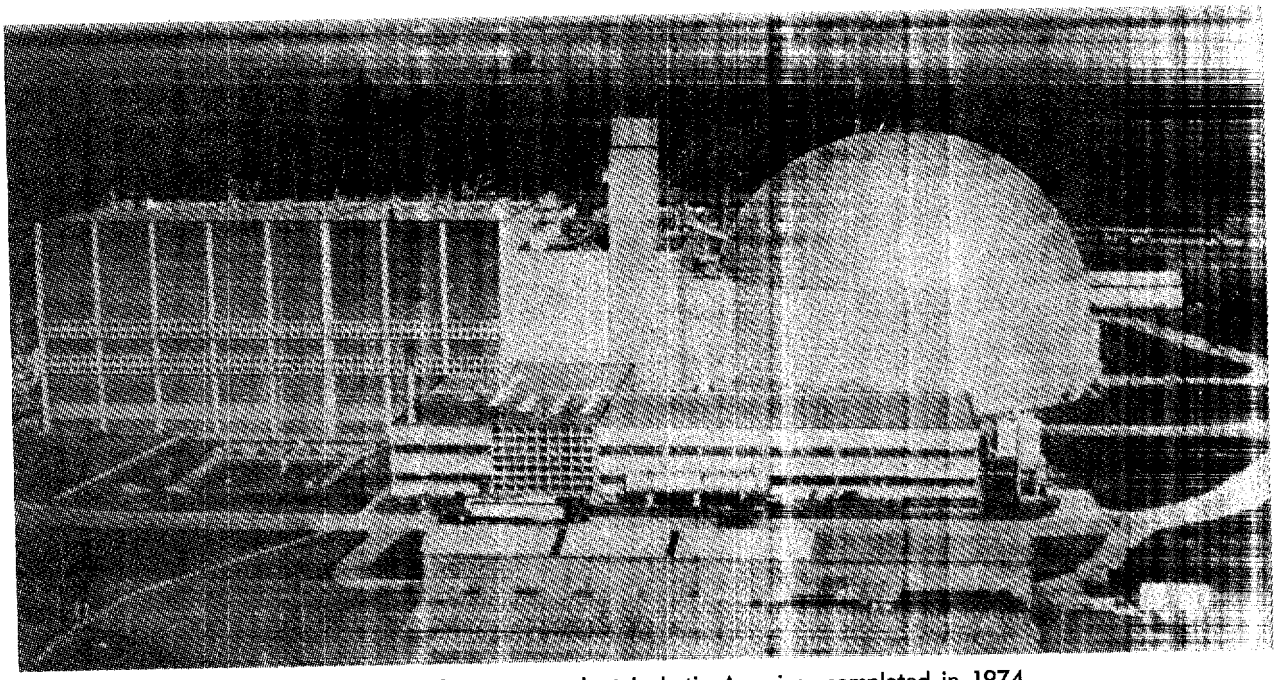
Touching Base Abroad

Although Argentina began supplying nuclear technology and equipment to other Latin American countries as early as 1970, such contacts have mushroomed since the military government came to power in 1976. The main purpose of these contacts is not to increase foreign trade—though this aspect will become increasingly important in the future—but rather to cement relationships with neighboring countries and increase Argentine prestige. Argentina's military government, realizing that the country has little hope of catching up with Brazil militarily or economically, hopes to maintain some degree of Latin American leadership through these contacts.

The nuclear relationship is most advanced with Peru. Under a March 1977 contract, Argentina is providing a complete research center including a zero-power research reactor and a 10-megawatt (thermal) reactor for producing radioisotopes. Also included in the project will be equipment and training in radiation protection, uranium prospecting, ore treatment, and preparation of isotopes for industry and research. Buenos Aires won the contract in competition with France, Spain, and the United Kingdom. The value of the entire deal has been reported as just under $50 million. It is to be financed by a long-term Argentine loan.

Argentina also recently signed nuclear assistance agreements with three other South American countries—Uruguay (March 1977 and April 1978), Ecuador (April 1977 and April 1978), and Bolivia (April 1978). The agreements with Montevideo, whose research reactor—acquired from the United States—was recently activated by CNEA specialists, covers information and personnel exchange, cooperation in radioisotope production, and preparation of studies for a 1-megawatt (thermal) research reactor. The agreements with Ecuador focus on personnel training but also look to the possible installation of a research reactor. The agreement with Bolivia updates and expands a 1970 accord under which Argentina built a pilot concentrating plant at a Bolivian uranium mine. The new contract covers training of Bolivian technicians, planning and possible construction of a research reactor, development of uranium mines and ore-processing facilities, and planning for possible future nuclear power plants.

Argentina also has nuclear exchange arrangements with several other Third World countries, some of which may eventually become customers for Argentine nuclear goods or services. In early 1977 Buenos Aires signed a generalized agreement with Chile providing for personnel exchanges and technical assistance. Argentina also has nuclear cooperation agreements with Paraguay, Venezuela, and Mexico; at present these apparently cover only personnel exchanges but they are likely to be expanded in the future. No official nuclear cooperation exists with Brazil, but personal contact among experts is fairly extensive. Argentina also is discussing possible



Atucha—first nuclear power plant in Latin America, completed in 1974.

arrangements with several countries in Europe, the Middle East, and Asia.

The Continuing Foreign Role

While developing its own capabilities, Argentina remains dependent on foreign support to master the technological skills needed to build its nuclear power plants. For example, although Argentine subcontractors on Atucha II are to assume responsibility for the design, procurement, and installation of much of the equipment, they will need close day-to-day guidance and supervision from the foreign contractor to discharge this responsibility effectively. Argentina is not dependent on foreign support for full-scale facilities for fuel fabrication or for chemical reprocessing of spent fuel, although it is getting some West German help for the former and is studying Indian and Italian technology for the latter. It also is not dependent on such support for its planned full-scale heavy water plant, but foreign help would substantially speed its completion.

Buenos Aires is obtaining the necessary foreign technology for its nuclear power plants primarily from Canada and West Germany. In current negotiations for the Atucha II contract, CNEA is insisting that the contractor provide whatever training and support is needed to assure that Argentina will be able to produce most of the components and assemble all but a few. For some sophisticated items, such as pressurizers and pressure tubing, CNEA plans eventually to acquire the needed skills through a combination of bilateral nuclear cooperation agreements with such countries as Spain, India, and Italy and the hiring of foreign specialists by Argentine subcontractors. At present Argentina has reciprocal nuclear cooperation agreements with at least a dozen countries.

Argentina's footdragging in adopting international safeguards [1] has so far not hampered progress in its domestic nuclear program or its export contracts. Exported research reactors are safeguarded because the enriched fuel they use must

[1] Argentina has not signed the Nuclear Proliferation Treaty. Although it has signed the Treaty of Tlatelolco, designed to keep Latin America free of nuclear weapons, this treaty is not yet binding on Argentina because, like Brazil, it has not yet waived the provision that all Latin America countries must ratify the treaty before it becomes operative.

come from a third country. The Argentine goal of nuclear self-sufficiency, however, is encountering snags on the safeguards issue. The United States and Canada refuse to supply the full-scale heavy water plant that Buenos Aires wants until it adopts full-scope safeguards and, more important, renounces its plans for reprocessing. Although Buenos Aires is likely to give in on the safeguard issue, it almost certainly will not alter its reprocessing intentions. Other countries technically able to supply heavy water technology will probably also refuse aid. Although Argentina has reportedly been negotiating with a West German firm, in the end it will probably be forced to build the heavy water plant itself, relying on such technical assistance as it can acquire by hiring technicians from countries such as West Germany and Italy.

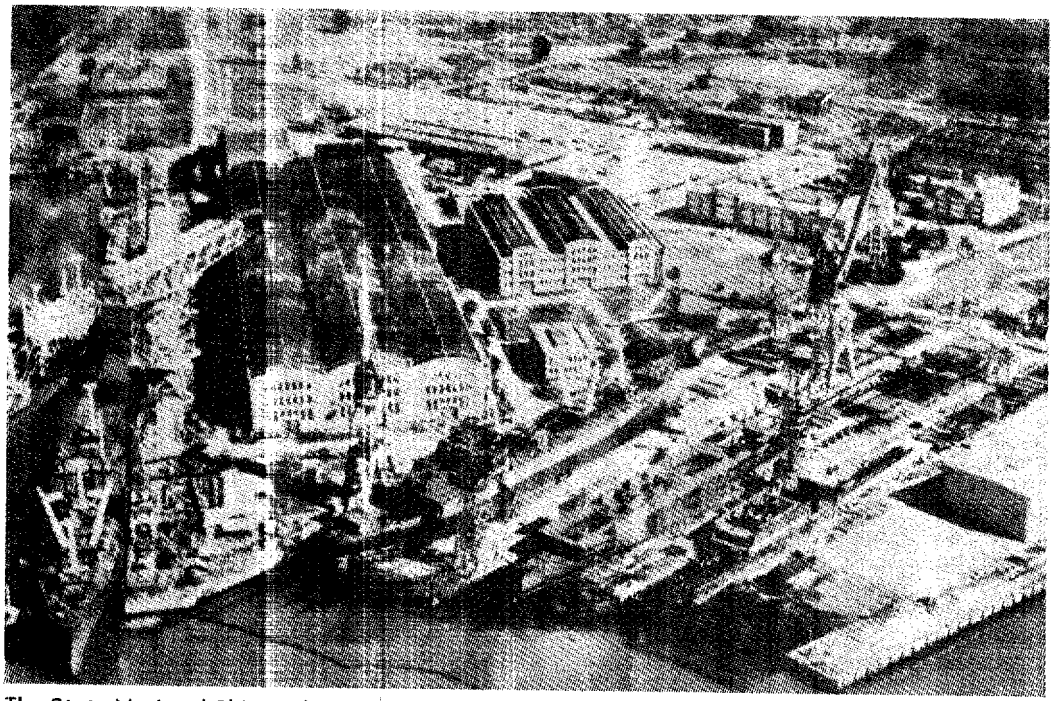
Looking Ahead

CANDU Capabilities

About 1990, Argentina plans to start building a fourth heavy water power plant, presumably of the CANDU type, that is to be entirely Argentine contracted and about 90 percent produced from the country's own resources. Assuming continuation of foreign support, we see no reason why Argentina should not be able to carry out these plans. Technology and components for CANDU-type reactors are less complex than those for light water plants. The engineering of pressurizers and refueling equipment should not prove a major obstacle within this time frame, although the country probably will still have to buy nuclear-scale turbines abroad.

Producing Heavy Water

We believe Argentina can complete by the late 1980s a plant to produce the heavy water required to operate its power plants even if Canada and the United States refuse to supply it. Although Argentina lacks the technology needed to produce the high-pressure valves and distillation columns required for a full-scale plant (250 to 300 tons per year), it should be able to acquire it abroad—possibly from Italy or India. A plant of this size would be able to provide the initial



The State National Shipyards (AFNE) in Rio Santiago. In addition to building ships of up to 60,000 dwt, the plant is supplying equipment for the Rio Tercero nuclear power plant at Embalse.

charge for a new 600-MW power reactor every one to two years as well as to replace the normal losses of about 2 percent annually.

Fabricating and Reprocessing Fuel

Argentina will greatly expand its capabilities for fabricating natural-uranium power-reactor fuel and for reprocessing spent fuel. CNEA already has produced prototype fuel elements for Atucha and expects to complete facilities to produce zirconium-alloy cladding material this year. By 1979 it expects to be able to use the cladding material in a plant that will be able to produce 40,000 meters per year of tubing for fuel elements, using West German technology. Argentina also is expanding its reprocessing capacity to develop a capability that would permit eventual production of plutonium and mixed-oxide fuels for breeder reactors. Despite the sophistication of some reprocessing equipment, such as spent-fuel chopping machines, the country should have little difficulty achieving full-scale operations by the late 1980s.

Selling Nuclear Equipment

Over the next decade, the Argentine export effort will concentrate on research reactors and assistance to other LDCs in setting up nuclear research centers. Argentina also will likely step up assistance in uranium exploration, mining, and ore processing and concentrating. This will be done primarily for reasons of prestige and to gain further experience in nuclear technology.

To support research reactor sales, Buenos Aires is in the process of developing its capacity for fabricating the fuels required to operate such reactors. At present, these fuels must be fabricated from highly enriched uranium, which has high nuclear proliferation potential and is, therefore, difficult to obtain from the London Suppliers Group. To facilitate fuel acquisition and thus to increase the attractiveness of Argentine reactors to potential customers, Argentina is now considering shifting to production of research reactors designed to use low-enriched uranium (LEU) fuels. It is currently exploring possibilities for cooperating with Spain or the United States in developing LEU fuel elements.

Looking farther down the road, Argentina should by the early 1990s have achieved sufficient experience in nuclear construction and engineering and in producing high-technology equipment to consider exporting a complete nuclear power plant. It also might consider participating with an established nuclear supplier in selling a nuclear plant to a third country. Whether or not it will do so will depend heavily on how Buenos Aires evaluates the prestige to be gained from an export sale, which probably would result in a delay of several years in construction of its fourth domestic nuclear power plant. If a market can be found, export would be a practical option, since the country has ample unexploited hydroelectric potential that could be harnessed. Alternatively, a fourth plant could be installed domestically and exporting delayed, perhaps until the mid- to late-1990s.

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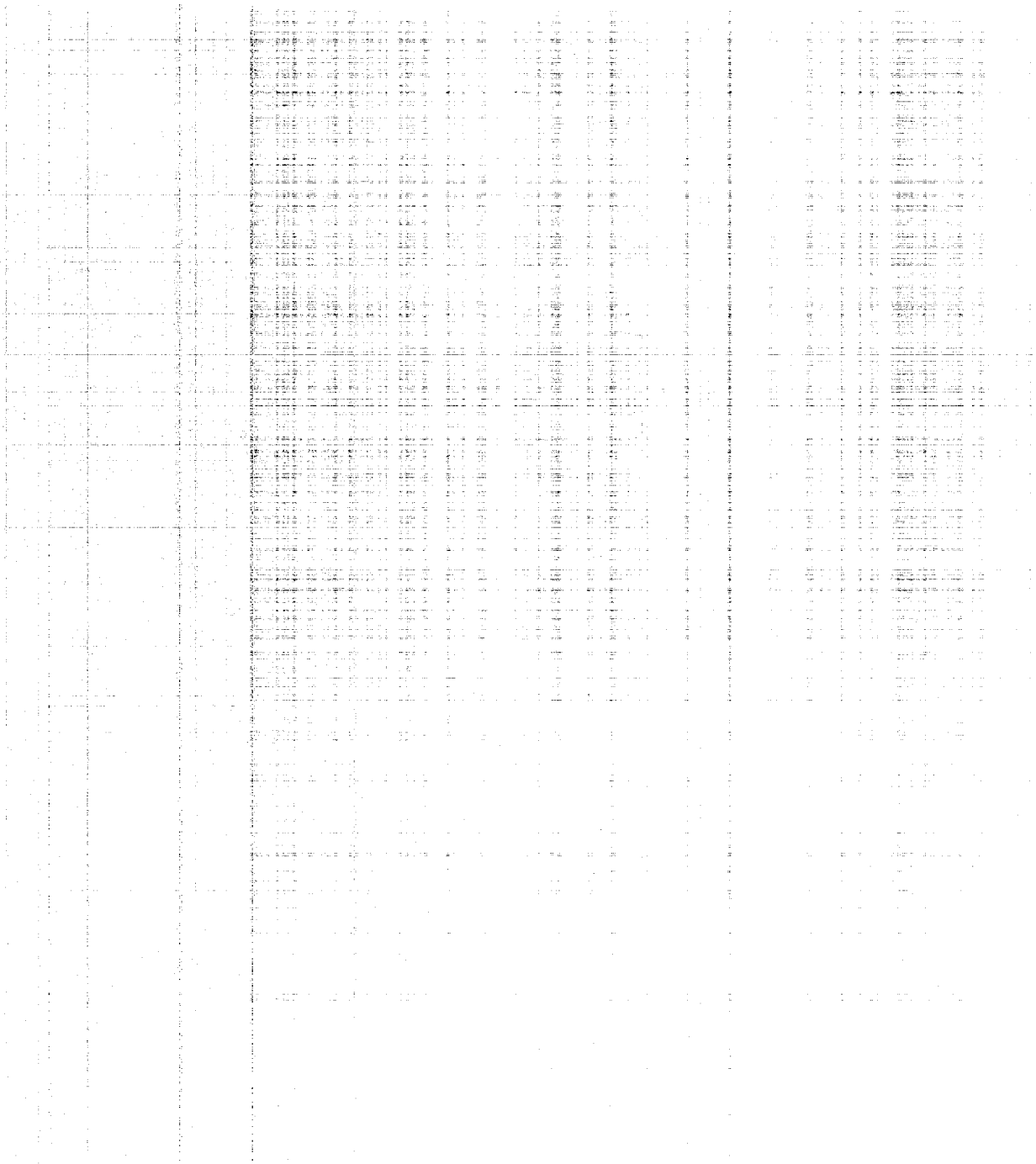

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