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AN UNUSUAL PARTNERSHIP: BRAZILIAN-ITALIAN FORMS OF COOPERATION IN THE NUCLEAR FIELD (1951-1986)

Since the beginning of the nuclear age, Brazil has manifested a deep interest in mastering nuclear energy. Rich in atomic minerals – such as thorium and uranium – the Latin American country traditionally sought external cooperation to develop its own nuclear sector. Like other Third World countries, Brazil looked at the more advanced *North* to acquire knowledge, equipment and materials useful for its nuclear projects. As the main civilian nuclear power and traditional ally of Brazil, the United States was considered the natural partner to begin such an endeavor. However, during the long history of the Brazilian nuclear program, the limitations imposed by Washington to its external partnership pushed Brasilia to find the collaboration elsewhere. France, (West) Germany, and the United Kingdom are usually considered the other partners for Brazil's nuclear plans. The traditional literature on Brazil's nuclear history highlights, in fact, the association of Brazil with West Germany in the 1950s and, above all, in the 1970s, when a major deal was signed to transfer the whole nuclear fuel cycle.¹ Similarly, France played a central role in Brazil's nuclear plans. As is known, hundreds of Brazilian nuclear scientists and technicians were trained in both France and West Germany, and crucial technologies, knowledge and machineries were acquired in those countries. This occurred when Washington was not available to cooperate. Over the last sixty years, however, Brazil has also sought collaboration with other countries of the so-called *North*, such as the Netherlands, Norway, Sweden, and Italy. The Italian case appears particularly important. While the Brazilian authorities collaborated sporadically with the other European countries, the history of Brazil's nuclear program can be interpreted as a constant attempt at collaboration with Italy from the early efforts to set up a nuclear program in Rio de Janeiro, until the end of the Italian nuclear program in the late 1980s.

This chapter aims to shed light on a little-known story of cooperation between Brazil, a developing country, and Italy, that became one of the major industrialized countries

1 Guilherme Camargo, *O fogo dos deuses. Uma história da energia nuclear* (Rio de Janeiro: Contraponto, 2006).

during the period analyzed in this study. Until now the Brazilian-Italian cooperation has not been the object of a detailed study, and little mention has been made in general works on the history of nuclear energy in Brazil. The object of this study is to explore the history of the cooperation, or attempts at cooperation, between Brazil and Italy in the period 1951-1986. Three specific episodes will be analyzed: the contacts between Italian and Brazilian scientists in the early 1950s; the attempt to acquire knowledge over a sensitive dual-use technology, such as uranium enrichment, in the late 1960s-early 1970s; and finally, the Brazilian-Italian talks about a possible sale of low enriched uranium to Brazil from the Italian share in the European consortium EURODIF, and the cooperation on fast breeder reactors. The three episodes will correspond to different phases of the evolution of the Brazilian nuclear program: the initial attempt to establish a program in the early 1950s; the planning of a new civilian nuclear program in the early 1970s, and specifically the choice of the best method for the uranium isotopic separation; and a more mature phase of implementation of the Brazilian nuclear plans, in the late 1970s-early 1980s. This study will also highlight the participation of Italian scientists in the planning of the Brazilian nuclear program. This research relies on primary sources from Brazilian archives, oral history interviews, and on a limited existing literature on the topic.

THE ORIGINS OF THE BRAZILIAN NUCLEAR PROGRAM AND THE COOPERATION WITH ITALY

Immediately after receiving the news of the bombings in Hiroshima and Nagasaki, Brazilian scientists, politicians, and the military began a long debate over the possible use of nuclear energy in the country, both for peaceful and military ends.² As a provider of nuclear minerals for the Manhattan Project in 1945, Brazil was thought to own one of the largest reserves of thorium, and American geological surveys indicated a rich presence of uranium in Brazilian soil. Aware of this abundance, the Brazilian government finally decided in 1951 to begin a nuclear program through the creation of a national research council, the Conselho Nacional de Pesquisa (CNPq). The establishment of a nuclear project and the centralization of the Brazilian research activities followed, consequently, a common path. Brazil, at that time a small power with an economy depending mainly on the export of coffee, was passing through a slow process of industrialization.

² *Ofício de Orlando Rangel à Diretoria do Material Bélico do Exército Brasileiro*, August 8, 1945, Arquivo Álvaro Alberto, Centro Interunidade de História da Ciência, Universidade de São Paulo, São Paulo, Brasil (hereafter AA/USP). In March 1946, after several months of internal debate, the Brazilian Congress created a commission for discussing the establishment of a national nuclear program. The first results of the discussions were submitted to the Brazilian National Security Council in the early 1947.

With the democratic election of Getúlio Vargas as President of Brazil in 1950, who had been the country's authoritarian ruler between 1930 and 1945, the transformation of Brazil from a rural to an industrial economy became one of government's main priorities. Since the first speech of Vargas to the Brazilian Congress, the peaceful use of nuclear energy was considered crucial for the future development of the country. While Brazil was rich in mineral resources, the country lacked an advanced research sector, technologies, and industrial equipment. However, as the prominent Brazilian nuclear scientists José Israel Vargas noted in a recent interview, Brazil had a young generation of brilliant scientists, such as the Italian-descendent Cesare (César) Mansueto Lattes and José Leite Lopes.³ Lattes had discovered in 1945 the *meson-pi* during his stay in the United States, a fact that turned the young Brazilian researcher into a recognized scientist at international level. The Brazilian effort to explore nuclear energy relied, consequently, on a young group of scientists who had studied a few years before at the University of São Paulo, under the direction of two Italian *émigrés*: Giuseppe Occhialini and Gleb Wataghin. The two scientists, in fact, had left Italy during Fascism and found refuge in Brazil, where they contributed to the foundation of the Department of Physics in the Faculty of Philosophy at the University of São Paulo. It was the first serious effort to create a scientific sector in Brazil. While that moment marked the Brazilian history of science, the second one can be found in the aforementioned effort to create a research council that had the main purpose of developing nuclear energy. The protagonist of this endeavor was Rear-Admiral Álvaro Alberto da Motta e Silva, chosen as the first chairman of the Brazilian National Research Council. He had been previously the President of the Academia Brasileira de Ciência (ABC), but, above all, the Brazilian representative within the United Nations Atomic Energy Commission (UNAEC). It was thanks to this experience that he became the main promoter of nuclear energy in Brazil and a member of an international network of nuclear scientists. His plan, approved by the Brazilian President in November 1953, was to master the atoms in an autonomous way. The Brazilian nuclear project involved the full control of the national mineral atomic resources and the implantation of a nuclear sector thanks to the cooperation with foreign countries. Alberto's effort was not the first step toward deeper studies in the nuclear field. Indeed, a few years earlier the Centro Brasileiro de Pesquisas Físicas (CBPF) had been founded in Rio de Janeiro under the supervision of the aforementioned Cesar Lattes.

The quest for external collaboration was not an easy task. As is known, the period was not propitious for acquiring knowledge and technologies abroad. The United States, the most advanced country in the nuclear field at that time, substantially banned partnership with other countries, even with suppliers of nuclear minerals, such as Brazil. Even

3 Carlo Patti, *O programa nuclear brasileiro: uma história oral* (Rio de Janeiro: FGV, 2014), 110.

though in 1951 the United States amended the national legislation on nuclear energy allowing a limited cooperation in the academic field, Brazil could not rely on collaboration with Washington. Thanks to an agreement signed in 1952, the Latin American country was only able to train nuclear scientists in the United States and to acquire a small synchrocyclotron. The Brazilian National Research Council, under the leadership of Alberto and the full support of President Vargas, elaborated a strategy to look for other partners in Western Europe. Alberto and his closest collaborators visited the main research centers in Norway, France, West Germany, United Kingdom, Switzerland, the Netherlands, and Italy. Thanks to agreements with the French and West German institutions, the Brazilian government attempted to acquire facilities for refining and enriching uranium. Many Brazilian scientists were also to study in Saclay (France), Bonn and Göttingen research centers.

Italy played a relevant role in the first phase of the Brazilian nuclear project. The country was considered a model for Brazil both for the structure of its research council, and above all for the similarities between the two nuclear programs. Brazil, like Italy, wanted to exploit its national nuclear minerals and aimed at acquiring the necessary knowledge and equipment. For this reason, after a visit to Italy, Alberto and one of his closest collaborators, Luiz Cintra do Prado, underlined the need to cooperate with Italian research centers and nuclear energy organizations. Between July and August 1953, Cintra do Prado spent several weeks in Italy. The Brazilians recognized the high level of physics centers in Rome, Milan, and Turin, where the former professor of the University of São Paulo, Wataghin, was one of the leaders of the Italian Istituto Nazionale di Fisica Nucleare (INFN). The “magnificent centers”, as Cintra do Prado wrote in his reports to Brazil, were a reference for their empirical and theoretical research on pure nuclear physics. However, it was in the organization of the nuclear field that the Brazilian scientist exalted the Italian progress. The Centro Informazioni Studi ed Esperienze (CISE), a private-public initiative in Milan, was considered the “Italian Organization for Atomic Energy”. In a few years, noted Cintra do Prado, the CISE had advanced rapidly in fundamental research. Moreover, it owned a facility for producing heavy water on a semi-industrial scale and metallic uranium. Finally, the organization had acquired all the elements for designing a research reactor (fueled by natural uranium). The CNPq counselor concluded his report with enthusiastic words for the CISE: “CISE constitutes a very useful example for Brazil being a certification that, in applied science, a perseverant work can lead to significant practical results, even if material resources are scarce and in apparent disproportion with the stated goals”.⁴

⁴ *Relatório geral das observações colhidas pelo Conselheiro Cintra do Prado na Itália, França, Espanha e Grã-Bretanha*, n.d., AA/USP, QO45003.

Italy, and particularly the CISE, was considered a model to follow by the incipient Brazilian program. The two countries were, in fact, following parallel paths in the nuclear energy field. If one compares the aims of Italian activities in the late 1940s and early 1950s, it is possible to find a parallel between the Italian and the Brazilian experience. In a context of limited cooperation offered by the United States, the main partner of the two countries, Italy and Brazil attempted to rely on other partners and reach significant results in an autonomous way. Like Italy, Brazil aimed at acquiring the capabilities for setting up a nuclear program and exploiting national resources with the clear goal of researching and building power reactors.

It is also for this reason that in early August 1953, Italian and Brazilian authorities signed a cooperation agreement to exchange researchers. Following the model of the Italian-French cooperation, that allowed to avoid costs in foreign currency, Alberto and Professor Gustavo Colonnetti, the chairman of the Italian Consiglio Nazionale delle Ricerche (CNR) agreed to begin a fruitful collaboration between Italian and Brazilian nuclear scientists.⁵ It was a clear continuation of the strong Italian presence in the creation of a scientific sector in Brazil. Another important step was the signing of a memorandum of understanding between the Istituto Nazionale di Fisica Nucleare (INFN) of Turin and the CNPq. It allowed a Brazilian scientist, such as Cesar Lattes, to work again with his mentor, Wataghin.⁶

Even if the two countries aimed at beginning a fruitful collaboration, a deep change in the international and Brazilian domestic context impeded the start of a strategic partnership. Internationally, the Atoms for Peace program together with the reform of the US Atomic Energy Act, led both Brazil and Italy to establish a deeper cooperation with Washington. Domestically, a political crisis that led to the end of Vargas' nationalist rule brought about a reorientation of the atomic program. Because of US and domestic pressures Alberto resigned and the nuclear program was reformulated to work together with the United States, abandoning or downscaling the partnership with European countries. Brazil, in fact, deeply modified the guidelines of the program, and in 1958 acquired a research reactor in the Atoms for Peace context. Despite a reorganization of the nuclear sector, and the creation of the Brazilian Comissão Nacional de Energia Nu-

⁵ *Convênio com a Itália para a permuta de cientistas e pesquisadores*, Álvaro Alberto to Vicente Ráo (Brazilian minister of Foreign Affairs), Ofício 1989. 524. 26 (96). September 29, 1953, Arquivo Histórico do Ministério das Relações Exteriores, Brasília, Brasil (hereafter AHMRE), folder 563.80 Energia Atômica ou Nuclear, tomo 1, 1951-1953 (hereafter tomo 1).

⁶ *Brazilian Embassy in Rome to Álvaro Alberto*, Secret, August 3, 1953, AAI, Q088007; *Parafrase da comunicação feita ao Itamaraty*, July 28, 1953, AAI, Q088015; Alberto met with both Colonnetti and Wataghin on July 27, 1953, *Missão do Almirante Álvaro Alberto à Itália*, Brazilian Embassy in Rome to the Brazilian Foreign Ministry, De/DPo/524.26, Secret, July 28, 1953, AHMRE, tomo 1.

clear (CNEN), the Brazilian program was downscaled. Even if between 1956 and 1968 there existed a vague project to acquire nuclear power plants, Brazil limited its activities to research.⁷ In its relations with Italy, it continued to cooperate in the academic field, but on a very limited scale. During this period, however, prominent Brazilian nuclear physicists spent long periods in Italy to work in research centers in Rome and Naples. This was the case of Hervásio de Carvalho, counselor of the CNPq and future chairman of the CNEN, who had been highly appreciated by his colleagues in Italy.⁸ It was only in the late 1960s and early 1970s that Italian and Brazilian authorities began to discuss possible forms of cooperation between the two countries in a crucial area such as uranium enrichment.

ITALY AND THE BRAZILIAN QUEST FOR URANIUM ENRICHMENT TECHNOLOGIES

After more than ten years of substantial stasis, the Brazilian government adopted a new nuclear policy. Marshal Arthur da Costa e Silva, second President of the Brazilian military regime, authorized, together with the Brazilian National Security Council, the elaboration of a new nuclear plan. As a result of the strong economic growth – between 1968 and 1974 the Brazilian economy boomed up to 12 per cent per year – Brasilia decided that in order to support its industrialization it was necessary to integrate nuclear energy in the Brazilian energy matrix, dominated by hydropower. A possible drought, in fact, could heavily affect the Brazilian production of electric power. Energy, but also military ambitions, led the government of Costa e Silva to an elaborated and detailed Brazilian nuclear project. The final aim was to build an unspecified number of nuclear power plants, master the entire nuclear fuel cycle by exploiting the national reserves of uranium, and acquire the capability to build a peaceful nuclear device. The purpose, not differently from 1953, was to reach autonomy in the nuclear field. The plan, submitted

7 However, it should be noted that the Italian company AGIP Nucleare participated in the international bid in early 1962 for the construction of the first nuclear power plant in Brazil. A Brazilian commission selected a French company, but financial reasons impeded implementing the project. *Companies qualified to Bid on Brazil's South Central Nuclear Power Plant*, US Embassy in Rio de Janeiro to Washington, Air Pouch, Unclassified, January 23, 1962, 2, National Archives and Records Administration, Washington, DC, United States (hereafter NARA), Aid and Assistance Programs, 1, Equipment Grants Brazil, 1959-62, S/AE.

8 Carvalho, considered one of the protagonists of the Brazilian nuclear program between the 1950s and the 1980s, spent almost two years in Italy in Naples and at the national center of nuclear research in La Casaccia (Rome). On Carvalho's stay in Italy see the letter sent by Edoardo Amaldi to Marcelo Damy de Souza Santos (chairman of the CNEN) on February 15, 1965. The letter is present in Amaldi's personal archives at the Università "La Sapienza" in Rome. I would like to thank Professor Giovanni Battimelli for having kindly provided a copy of these documents.

and approved in 1968, determined the acquisition of power reactors and of nuclear fuel from external partners as a first step in the endeavor. A few years later, in 1972, Brazil signed a contract with the US company Westinghouse and the US Atomic Energy Commission (USAEC) to acquire a nuclear power plant and the fuel supply, with the option for a second power reactor.

The first oil crisis, in autumn 1973, led Brazil to accelerate its nuclear plans. The Second National Development Plan of 1974, along with the energy plan Plano 90, determined the acquisition of up to nine nuclear power plants to be built until 1990. Nuclear energy should integrate hydroelectric power and compensate the loss of thermoelectric energy produced by oil power plants. Relying for more than 80 per cent on external supplies of oil, Brazil, like other countries, chose nuclear energy as a possible alternative. The atomic plan elaborated in 1973 was ambitious: acquiring nuclear power plants, the capability to build nuclear reactors, and mastering all the phases of the nuclear fuel cycle. The Companhia Brasileira de Tecnologia Nuclear (CBTN) was established in 1972 with the specific purpose of stimulating the creation of a national nuclear industry and elaborating the most appropriate nuclear strategy for the country. With an activity substantially reduced to academic research in São Paulo, Belo Horizonte and Rio de Janeiro, the CBTN presented a detailed plan to collaborate with external partners. One of the main purposes was to acquire the knowledge and the capability to master a crucial technology to produce nuclear fuel: uranium enrichment. As noted earlier, Brazil had already attempted in the mid-1950s to obtain a new method for uranium isotopic separation: ultracentrifugation. In 1958 the Brazilian Nuclear Energy Commission received three ultracentrifuges from West Germany and a few scientists were trained in how to use them. However, with the end of the first phase of the Brazilian nuclear program, in 1955, the Brazilian nuclear authorities decided to opt for natural uranium reactors, discarding the option for enriched uranium. The West German ultracentrifuges had been, consequently, partially abandoned at the Instituto de Pesquisa Química (IPQ) of the University of São Paulo. During the period 1958-1966, however, a small research group, led by Professor Ivo Jordan, used the equipment to reach the first isotopic separation in 1966.⁹ Despite this important outcome, the University suspended the research effort and in 1968 the Brazilian government declined an important West German offer to collaborate on a most advanced ultracentrifuge isotopic uranium separation method. Thanks to the decision to acquire nuclear power plants fueled by low enriched uranium, Brazil gave increased attention to all the possible methods for enriching uranium, such as gaseous diffusion, the jet nozzle. Starting from 1972, though, it gave preference to

9 Odete Maria Oliveria, *Os descaminhos do Brasil nuclear* (Unijuí: Ijuí, 1998), 240.

ultracentrifugation.¹⁰ As is clear from recently declassified documents, the Brazilian nuclear strategy, elaborated in 1973, considered Italy, among other countries, a possible partner to acquire such capabilities.¹¹

The Brazilians were aware of the Italian effort to master the uranium enrichment technology and had known about their interest in the ultracentrifuges since the late 1950s.¹² For this reason in 1971, Brazil and Italy signed an agreement of cooperation in the nuclear field.¹³ One of the main aims of the deal consisted in the visit of Brazilian scientists to Italian uranium enrichment facilities. The above-mentioned Jordan was one of the first to be sent to Italy. In this case, however, the exchange of information was bi-directional. The Italians, in fact, were interested in Jordan's studies of the ultracentrifuge method for isotopic separation and obtained a copy of his Master's thesis on the topic. Between 1973 and 1975, when Brazil decided to acquire uranium enrichment technology from West Germany and to train its nuclear scientists in the Jülich research center, several Brazilian scientists were sent to Italy to be trained in the field. Both Brazil and Italy were particularly interested in the ultracentrifuge method, and considered it the most efficient in the field of uranium isotopic separation.¹⁴ Brazilians considered Italians particularly advanced in that sector, and a Nuclebrás internal document remarked that Italy had mastered such technology on a semi-industrial scale.¹⁵ As is clear from the available documentation, in 1972 the Casaccia research center received four Brazilian technicians who spent a semester in Italy.¹⁶

From the perspective of the CBTN the collaboration was fruitful. Several documents describe the Italian-Brazilian relationship as a possible strategic partnership for the future of the Brazilian nuclear program. The personnel trained in Italy, in fact, represented

10 *Estágio de desenvolvimento do processo de enriquecimento por jato centrífugo de gás (nozzle jet) em junho de 1974*, CNEN internal document, n.d., Arquivo Paulo Nogueira Batista, Centro de Pesquisa e Documentação sobre a História Contemporânea do Brasil, Fundação Getúlio Vargas, Rio de Janeiro, Brazil (hereafter APNB), pn c 1969.12.01, 136/3528.

11 *Programa Nuclear Brasileiro*, October 1974, CBTN internal document. Document kindly provided by Professor Maurício Grinberg.

12 Álvaro Alberto to Wilhelm Groth, December 12, 1957, AA/USP, Q071047.

13 *Enriquecimento de urânio*, CNEN internal document, n.d., APNB, pn c 1976.04.29, 288/315.

14 *Tecnologia de Enriquecimento de Urânio in Estágio de desenvolvimento do processo de enriquecimento por jato centrífugo de gás (nozzle jet) em junho de 1974*, CNEN internal document, APNB, pn c 1969.12.01, 139/3528.

15 Nuclebrás internal document, n.d., APNB, pn c 1969.12.01, 2286/3528. The same document also highlighted the Italian effort in the laser in the laboratory scale.

16 Four Brazilian scientists were trained in Italy. They were: Duilio Russo, an electronic engineer, who worked for NUCLEI; José Wellington Dias Lemos, an industrial chemist, who worked for NUSTEP; Dante Leonardo Zoratto, a mechanical engineer, who worked for Nuclebrás; and Raad Yahya Qassim, a chemical engineer, who worked for Nuclebrás. *Pessoal da Nuclebrás treinado na área de enriquecimento*, Nuclebrás internal document, n.d, APNB, pn c 1969.12.01, 435/3528.

the core of the future group of scientists and technicians that constituted the Brazilian Nuclebrás Enriquecimento Isotópico (NUCLEI), a public company established in 1975 to produce nuclear fuel. Even if Brazil obtained the knowledge and the technologies of the jet nozzle separation method from West Germany, the cooperation with Italy appeared crucial. Starting from 1981, the NUCLEI worked with the Italian company Nuovo Pignone in the construction of special compressors needed for uranium isotopic separation through the jet nozzle.¹⁷

NEW ATTEMPTS IN COOPERATION WITH BRAZIL: FAST BREEDER REACTORS AND NUCLEAR FUEL

The cooperation with Italy was not limited to uranium enrichment, but also comprised fast breeder reactors, especially in the late 1970s and the early 1980s. Since the end of the 1960s, a group of Brazilian scientists at the Federal University of Minas Gerais in Belo Horizonte had started studying fast breeder reactors. The Brazilian nuclear sector, in fact, was interested in acquiring technologies and knowledge for the next generation of reactors. The strategic partner in this case was not West Germany, but France and, later, Italy. Starting from 1974, Brazil began a strong cooperation with France, to construct the *Cooperação Brasil* (COBRA) reactor. However, since France could not supply the plutonium needed to fuel the reactor, the two countries ended their collaboration. In order to continue research in that field, the Brazilian Nuclear Energy Commission signed a new cooperation agreement with the Italian Nuclear Energy Commission in 1981. As the then President of Nuclebrás, Paulo Nogueira Batista, declared, Italy represented the best substitute for France. Even if some Brazilians opposed the cooperation with the Italians, because of a supposed Italian lack of expertise, Nogueira Batista highlighted that Italy was playing a crucial role in the construction of the Superphénix reactor in France, by supplying parts for the tests and systems developed for the reactor. For this reason, Brazil could acquire important skills thanks to the cooperation with Rome, even if it could not receive plutonium.¹⁸ The deal consisted in training Brazilian personnel in Italy and establishing standards for the thermo-hydraulic circuit of metallic sodium. The Brazilian program was incipient, but the collaboration with Italy appeared at that time essential.¹⁹ Stefano Moretti, an Italian nuclear scientist and former advisor of the Italian

17 *Minuta de reunião*, Nuovo Pignone, Florença (Itália), September 25, 1981, APNB, pn c 1969.12.01, 2525/3528.

18 *Entrevista "O Estado de São Paulo"*, November 9, 1981, APNB, pn n 1975.11.11, 601/1877.

19 *Tecnologias avançadas in Relatório Final da Comissão de Avaliação do Programa Nuclear Brasileiro* (CAPNB), August 6, 1986, APNB, pn na 1975.11.11, 1087/1877.

CNEN secretary-general, left Italy to work in the Brazilian group. As he recalled in a recent interview, he joined the Brazilian nuclear program and worked for a few years in Belo Horizonte, on the fast breeder reactor project.²⁰ Brazilians and Italians collaborated in that field until the conclusion of the Italian nuclear program in 1987.

Another important episode of Italian-Brazilian relations concerns the Brazilian presence in the market of nuclear fuel. With a project to build up to eight nuclear power plants until 1990, Brazil attracted the suppliers of low enriched uranium, including Italy, an associate to the European consortium EURODIF for uranium enrichment. As reported by a secret Brazilian diplomatic record in 1978, Colombo, chairman of the Italian National Committee of Nuclear Energy offered Hervásio de Carvalho, his Brazilian counterpart, to transfer part of the enrichment services owned by the Italian company AGIP Nucleare in EURODIF.²¹ The downscale of the Italian nuclear program in the late 1970s, with a substantial reduction in the power plants to be built, allowed Italy to sell 120,000 uts/a to Brazil. In 1978, the Brazilian government did not take a clear position on the issue, but Italy renewed the offer in 1980, on the occasion of the International Atomic Energy Agency (IAEA) General Conference in New Delhi, for a lower amount of enriched uranium and a more convenient price. However, Nuclebrás, declined the Italian offer. Thanks to the existing contracts with the Uranium Enrichment Consortium (URENCO), the US Department of Energy, and the future Brazilian capability to produce nuclear fuel, the Brazilians estimated that they did not need to contract new enrichment services until 1990.²² Brazilian estimates were to be reduced in the near future, since the deep economic crisis that affected Brazil from 1982 onwards led to a substantial cut in the number of reactors to be built.

CONCLUSION

This chapter has highlighted unexplored aspects of the history of Brazil's nuclear program: the cooperation with Italy. During the three periods considered in this study, Brazilian authorities considered Italy an important partner for the development of their national nuclear program. Many parallels exist between the Brazilian and the Italian efforts at the beginning of the nuclear age. Italy, particularly CISE, represented a model for Brazil to structure its own nuclear program. Moreover, Brazilians considered the quest of autonomy in the nuclear field a shared goal with the Italian institution. As we

20 Stefano Moretti, interview with the author, July 28, 2014, Rio de Janeiro.

21 *Energia nuclear. Itália-Brasil. Enriquecimento de urânio*, 20 de janeiro de 1980, Secreto, DEM/DE-I/01/644.2, B46, F31, APNB, pn a 1973.05.18, 23/50.

22 Nuclebrás internal document, APNB, pn a 1973.05.18, 25/50.

have seen, the cooperation between the two countries was limited to the academic field, but it began a long tradition of exchange. In the following phase, in the early 1970s, Italy and Brazil attempted to collaborate in the study of uranium enrichment. Thanks to an agreement signed in 1971, Brazilian scientists spent periods in Italian research centers. As appears from the Brazilian nuclear strategy elaborated in 1973, Italy was considered one of the possible strategic partners for the future ambitious nuclear program that aimed at acquiring nuclear power plants and mastering the nuclear fuel cycle. The attempt in cooperation was frozen in 1975, after the signing of a major deal between Brazil and West Germany, which led the Latin American country to opt for a West German method for uranium isotopic separation: the jet nozzle. At the end of the 1970s, in a more mature phase of the Brazilian nuclear program and with a more consolidated nuclear sector, the two countries started new talks. Brazil was seen by Italy as a buyer of low enriched uranium, at a time when the latter revised its future consumption of nuclear fuel. The last important field of cooperation between Rome and Brasilia was an agreement on fast breeder reactors. Brazilian institutions were, in fact, active in researching the future generation of power reactors and Italy represented a strategic partner until the end of the Italian nuclear program in 1987.

Future research should focus on the Italian documentation and explore new topics of analysis. It would be particularly interesting to understand whether Brazil and Italy discussed the possible transfer of nuclear minerals to the European country, as France and West Germany did, during the 1950s. Moreover, it would be useful to understand if Italian authorities and scientists collaborated with Brazil in the so-called civilian-military parallel nuclear program, which began in 1979 and ended in 1990 with important achievements for Brazil, such as mastering uranium hexafluoride production and ultracentrifuge uranium enrichment technology. Given the interest of the Brazilian Navy in the ultracentrifuge enrichment method starting from the mid-1970s, it would be possible for the Brazilian and Italian individuals to continue to collaborate in the area, as happened with the West German experts. Some documents of the early 1980s, show that on the occasion of the limitation of the cooperation with the United States, the Brazilian authorities recommended strengthening the collaboration in the nuclear area with Italy, which they considered to be one of the most advanced countries in the field.²³

²³ *Relações Brasil – Estados Unidos do campo da energia nuclear*, CNEN internal document, 1980, APNB, pn n 1976.04.14.