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Techno-Scientific Sovereignty and Echoes of the Cold War? Specific Compensation Policy and Uranium Ultra-Centrifugation in Brazil

¿Soberanía tecnocientífica y ecos de la Guerra Fría? Política de compensación específica y ultracentrifugación de uranio en Brasil

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ABSTRACT

Recent reports from the International Atomic Energy Agency (IAEA) highlight the alignment of the agency's interests with Brazil's atomic energy program, emphasizing its professionalism, transparency, and receptiveness. However, IAEA inspections have not always been free from political tensions in Latin America, incidents reviewed here. If there was a historic transition in international governance and

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Brazilian sovereignty based on uranium enrichment, when and how did it occur? Documentary analyses allow us to infer that the period 2003-2004 was crucial for guaranteeing Brazil's industrial property rights and normalizing diplomatic, defense and energy relations with the IAEA and the USA.

KEYWORDS: *technological sovereignty, International Atomic Energy Agency, specific compensation policy, Brazilian ultracentrifuges, Cold War.*

RESUMEN

Informes recientes del Organismo Internacional de Energía Atómica (OIEA) destacan la alineación de los intereses de la agencia con el programa de energía atómica de Brasil, enfatizando su profesionalismo, transparencia y receptividad. Sin embargo, las inspecciones del OIEA no siempre han estado libres de tensiones políticas en América Latina, incidentes que se analizan aquí. Si hubo una transición histórica en la gobernanza internacional y la soberanía brasileña basada en el enriquecimiento de uranio, ¿cuándo y cómo ocurrió? Los análisis documentales nos permiten inferir que el período 2003-2004 fue crucial para garantizar los derechos de propiedad industrial de Brasil y normalizar las relaciones diplomáticas, de defensa y energéticas con el OIEA y los Estados Unidos.

PALABRAS CLAVE: *soberanía tecnológica, Organismo Internacional de Energía Atómica, política de compensación específica, ultracentrífugas brasileñas, Guerra Fría.*

Introduction

The general objective of this study is to discuss political and historical aspects, in the context of international relations, regarding the actions to defend Brazilian industrial property on uranium ultracentrifugation technology during the visits of the International Atomic Energy Agency (IAEA) between 2003 and 2004. It is worth examining here whether there was a historical transition in international governance and Brazilian sovereignty, considering these inspections and identifying when and how it occurred.

In the global context of 2003-2004, the IAEA intensified its inspections in various countries that claimed peaceful purposes for their nuclear programs. This period was marked by significant international tensions, especially regarding Iran and North Korea. Iran was under scrutiny for its uranium enrichment program, while North Korea had withdrawn from the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and was advancing its nuclear program. The IAEA sought to ensure that the nuclear programs of these countries were not diverted towards the production of nuclear weapons, promoting transparency and international trust.

The present problematization of the non-strictly technical aspects behind an industrial dynamic in the field of energy engineering reveals the complexity

and often invisible fabric of relations between sovereign states and international governance bodies, especially in the field of atomic energy, which inspires concerns and disputes between countries. The research is documentary in nature, justified by the importance of the historical shift from tensions to friendly cooperation in relations between Brazil and the IAEA (Lopes, 2024; Rosas, 2024; Da Rosa Muñoz, 2024).

It is worth noting here that, although the echoes of the Cold War were heard by some observers within this context, 20 years ago, in June 2024, it was recorded that "at the Angra 1 Nuclear Power Plant, IAEA experts praised processes to evaluate and improve the management of the aging of facilities, use of artificial intelligence, and IT solutions" (Verão, 2024, p. 1). Similarly, "after visiting the Angra 1 nuclear power plant in Brazil, the UN agency sees examples for the world" (UN, 2024), highlighting "the professionalism, openness, and receptiveness" of the Brazilian team, "in the sense of making improvements to meet and exceed IAEA safety and operation standards" (UN, 2024).

Analysts emphasize that, with the dissolution of the military dictatorship, "Brazil adopted a strategy of progressive criticism and active participation in the discussions of the future of the regime in different international forums" (Souza, 2013, p. 2). Although the US's actions were decisive in getting countries like Brazil and Argentina to sign non-proliferation agreements (Teixeira, 2007), Brazil was often firm. For example, when the IAEA proposed the Additional Protocol (AP) to its Member States, in 1997, changing the purpose and expanding the scope of the comprehensive safeguards in force, the Brazilian reaction was clear. Recently, one of the Brazilian Members of the Permanent Advisory Group to the Director-General of IAEA, L. Guimarães, recalled that this initiative was "much more intrusive, giving rise to interpretations that could violate both the principle of national sovereignty and the principle of industrial property" (Guimarães, 2022, p. 1), highlighting:

> *The National Defense Strategy (END), approved by DECREE No. 6,703, OF DECEMBER 18, 2008, establishes that Brazil «will not adhere to additions to the Treaty on the Non-Proliferation of Nuclear Weapons designed to expand the restrictions of the Treaty without the nuclear powers having advanced in the central premise of the Treaty: their own nuclear disarmament».* (Guimarães, 2022, p. 10)

This article looks back at one of the decisive moments of the current virtuous diplomatic-industrial cycle, discussing issues related to national sovereignty in the face of its strategic technological inventions, while also pointing out the geopolitical vectors of Brazil's rise as a global player among countries producing fission energy.

Industrial property rights and sovereignty

In the early 2000s, the IAEA conducted inspections of the raw uranium enrichment unit in Resende, Rio de Janeiro state, which was known to be destined for a power generation plant, in collaboration with the Brazilian government. The inspection was conducted, but not without setbacks. The then Minister of Defense, José Viegas, had reiterated to the press, before the inspection visit, that such visits are provided for in the international agreements signed by Brazil, even though access to the Resende factory was initially denied to international inspectors.

The Brazilian government claimed, on this occasion, that several other inspections of the plant had already been authorized to allow inspectors access to both the uranium entering (input) and leaving (output) the unit. It also claimed, at that time, that it had provided ample evidence that our nuclear project has always had "strictly peaceful" or "economic energy" purposes, and that the development of nuclear weapons is even prohibited by the Federal Constitution.

In an Official Note, the government also emphasized that the country's nuclear program - which is intended, as provided for in the Constitution, for strictly peaceful purposes - has been under comprehensive safeguards by the Brazilian-Argentine Accounting and Control Agency (ABACC) and the International Atomic Energy Agency (IAEA) since 1994, without any doubt ever being raised regarding the absolute fulfillment of our obligations in light of the international instruments that regulate matters of disarmament and non-proliferation to which Brazil was and is a full party: the Treaty of Tlatelolco and the NPT, as well as the Comprehensive Nuclear-Test-Ban Treaty (CTBT), although the latter instrument was not yet in force, as it had not been ratified by countries that have advanced technology and even nuclear weapons. None of these statements met with diplomatic or even international institutional resistance. The central issue gradually revealed itself to revolve around the uniquely efficient Brazilian process of enriching uranium through ultracentrifugation, developed with effective and genuinely Brazilian technology at a cost of one billion dollars: technological secrecy was threatened.

This could have been just a common industrial secrecy incident, and there are many civil protocols for its containment, but it was not. Geopolitics in the high-tech and atomic energy sectors is based on the disparity of power among the agents involved, which created an institutional environment for dialogue that was then defined as paradoxical:

> *[...] how can weaker parties negotiate with stronger parties and still get something? Or more specifically: how do known (or perceived) weaklings negotiate at all with known (or perceived) heavies and emerge satisfied with the results?* (Zartman, Rubin, 2000, p. 3)

Import substitution

Uranium enrichment by genuinely Brazilian ultracentrifuges was developed in the 1980s and 1990s and was governed by a contract between the Brazilian Nuclear Industry (INB) and the Navy Technological Center in São Paulo (CTMSP), which had foreseen, since July 2000, the modular implementation and installation of the first operational unit in the country. In 1988, the aforementioned INB – active in strategic areas such as extraction, treatment, and industrial processing of uranium and production of heavy minerals – succeeded NUCLEBRÁS and, in 1994, incorporated its subsidiaries (Nuclebrás Enriquecimento Isotópico SA – Nuclei, Urânio do Brasil SA, and Nuclemon Minero-Química Ltda.), starting to develop and explore the industrial processes of the nuclear fuel cycle. A cutting-edge technology company, INB produced at the Fuel Elements Factory (FEC), in addition to the Angra I refills, outputs such as the mechanical assemblies used in the first and second Brazilian Data Collection Satellites (SCD 1 and SCD 2) and equipment for the Embraer AMX fighter. The environment for a change in the sector was thus created.

Although the country had the sixth-largest uranium reserves in the world, it continued to depend on imports for the Angra I and II plants, since part of the enrichment process was still carried out outside the country, from where the product was sent in containers to the Nuclear Fuel Factory - Reconversion (FCN) in Brazil, boosting the industry. The then Minister of Science and Technology, Roberto Amaral, announced in October 2003 that Brazil would begin uranium enrichment in 2004, with the aim of saving approximately US$ 12 million every 14 months. It was estimated that R$ 250 million would be invested in the project, with completion estimated for 8 years.

Our reserves were estimated at 309.3 thousand tons, calculated by INB based on data from June 2001. Our main deposits were in the states of Bahia, Minas Gerais, Ceará, and Paraná. The largest uranium reserve in the country (142.5 thousand tons) is in Itatiaia (inland Ceará). In Bahia, the reserves - estimated at 100.7 thousand tons - were in the municipalities of Caetité and Lagoa Real. In Caldas (MG), 4,500 tons were estimated. Worldwide, reserves were estimated at 4.4 million tons, according to INB. The largest reserves in the world, measured in tons, were in Kazakhstan (957 thousand), followed by Australia (910 thousand), South Africa (369 thousand), the United States (355 thousand), and Canada (332 thousand). INB reported that exploration studies covered only 25% of the country's territory. In the mid-1970s, the country's known reserves totaled only 9,400 tons. Uranium deposits associated with other minerals were also discovered, such as in Carajás (PA) and Pitinga (AM). Among the uranium deposits held by INB, it should be noted that in the Planalto de Caldas Complex in Minas Gerais, it extracted and processed yellow uranium (yellowcake); in Lagoa Real in Bahia, it had reserves of around 100,000 tons, with a production capacity of 300 tons/year of uranium concentrate. There was also another mining-processing complex, which occupied

an area of 1,200 hectares, 756 km from Salvador, Bahia. Detail: in April 2000, a leak of 5,000 liters of uranium liquor into the environment was recorded, a fact kept confidential; INB was fined R$119,130.00.

According to INB president, Roberto Franca, the plans called for an annual production of enriched uranium sufficient to meet half of the needs of the Angra I and II plants, saving up to US$12 million per year. INB's goal was to increase the unit's production to 100,000 SWU in eight years, when it stated:

> *To become independent, however, we will need one more reactor in operation – in this case, Angra III – and increase production capacity to 200 or 330 thousand UTS per year for each set of recharges, which would represent an estimated saving of US$ 33 million per year, referring to the acquisition of enrichment services abroad.* (INB, 2024, p. 1)

Initially, the new enrichment unit would be installed in Unit II, existing at INB in Resende, and would take advantage of, in addition to safe engineering and architecture (a building capable of withstanding earthquakes of up to 7.5 on the Richter scale), uranium reception equipment and both "auxiliary" and "utility" systems belonging to the extinct Nuclei.

The fuel elements were produced by INB at FEC in Resende. Nominally, FEC could process 100 tons of uranium and manufacture 145 fuel elements. Since 1997, INB has been part of the group of global producers of uranium powder and pellets, with two complete production lines: "reconversion of uranium hexafluoride into powder" and "transformation" of this into pellets. A single stage of the nuclear fuel cycle continued to be conducted abroad, namely the conversion of yellowcake into uranium hexafluoride. The possibility of such an internal supply set an important precedent for our future economic-energy-nuclear opportunities. The Ministry of Science and Technology announced, on October 6, 2003, that by 2014 the country would be exporting enriched uranium. It is said that Brazil's uranium reserves, at the time of the agreements with the US and Germany, were insufficient for the Brazilian nuclear program. In 1978, at the 30th Geology Congress held in Recife, it was finally announced that our reserves were not only larger but sufficient to supply 35 large reactors for 40 years. This Brazilian perspective of ascension to a Nuclear-Exporting State (ENE), far from having an exclusively technical and economic tone, was undoubtedly a "state issue," requiring, for its achievement, not only political pride but a powerful set of diplomatic-institutional safeguards, given the strong and multilateral explicit politicization of the market, in addition to its implicit ideologization.

Technoscientific-industrial siege and Cold War

Álvaro Alberto dismissed from the specific compensation policy

In 1953, the guidelines for Brazil's national atomic energy policy were officially drawn up by Major Antônio Carlos de Andrada Serpa and approved by the government that same year. However, the person who drafted those guidelines, the then president and founder of the National Council for Scientific and Technological Development (CNPq), Dr. Álvaro Alberto, was the one who had opened the dialogue with the German scientists who

> *[...] were at the forefront of this enrichment process, long abandoned by the Americans. Thanks to the efforts of researchers such as W. Grothe and K. Beyerle, especially the latter, ultracentrifuges offered a yield five times higher than the primitive ones developed during the war.* (Motoyama, 1996, p. 92)

The scientific-technological articulations of Dr. Álvaro Alberto

> *[...] resulted in the purchase of three ultracentrifuges intended for the production of enriched uranium and the formation of a committee of German scientists and industrialists to study the possibility of developing their manufacture in Brazil. He negotiated the purchase of the ultracentrifuges with the Physical-Chemical Institute of Bonn.* (Motoyama, Garcia, 1996, p. 231)

However, a systematic foreign ban took place:

> *The request for permission from the occupation commission was denied. Even so, negotiations continued in secret. In 1954, when they were to be transferred to Brazil, they were seized by order of the United States Atomic Energy Commission.* (Motoyama, Garcia, 1996, p. 231)

Author of a series of proposals and reports, action programs, and policies in the nuclear area for successive governments, Álvaro Alberto became best known as the creator of the policy of specific compensations, which provided for the inalienability of nuclear energy mineral wealth except in exchange for equally nuclear technology. A policy that was never implemented, "if that was precisely what the United States feared most", despite the astute nationalism of the intent, "wasn't Álvaro Alberto's point of view too naive?" (Motoyama, Garcia, 1996, p. 67).

In 1955, under strong internal and external pressure and amid an insidious campaign launched in the press, Álvaro Alberto was dismissed from the CNPq. Nélson Werneck Sodré recorded that Álvaro Alberto, "because he was a patriot, the Americans fought him hard" (Salles, 1958, p. 134-40).

> *The head of the Military Cabinet himself had sent four secret documents to the CSN Secretariat, supposedly originating from the American embassy, which criticized the policy adopted by the CNPq and the actions of its President, suggesting his dismissal.* (Motoyama, 1996, p. 96)

Precedent recorded by N.W. Sodré, A. Alberto, "defended the interests of Brazil and came into conflict with the United States because of monazite sands" (Salles, 1958, p. 87).

> *He emphatically repeated: "The same thing that happened with gold must not happen to the other riches of our land. When our atomic wealth is exhausted, what will be left of our nationality? We must, therefore, ensure that this wealth leaves a real and effective contribution to the country's progress." [Annals of the CNPq, 16th Session of the Deliberative Council, July 5, 1951]. This was a matter of honor for him. However, the opposing forces were powerful and obstinate. The '1945 Agreement' [proposed by the National Security Council (CSN) at the beginning of the Eurico Gaspar Dutra government with the aim of defending the national heritage of nuclear energy mineral wealth] was theoretically at a standstill, since it had not been renewed. But in practice, the export of monazite continued normally, as if nothing had happened. Between 1945 and 1947, 4,281 tons of monazite were exported to the United States, while in the period from 1948 to 1951, when, in theory, not a single gram of material should have left, the figure was 5,860 tons, higher than at the time the adjustment was in force.* (Motoyama, Garcia, 1996, p. 59)

The first draft of the "specific compensation policy" is recorded in the minutes of the Brazilian Academy of Science (ABC) dated December 21, 1948, when it no longer considered, in view of the regular alienation of Brazilian nuclear energy resources, "that a remunerative price constituted a sufficient condition, while we inflexibly maintained that other compensations would become indispensable"[1].

> *The essence of the 'policy of specific compensations' has not aged. It just needs a modern look. Perhaps it is time to rethink the lessons of Álvaro Alberto, if we want to believe in a better future, a hope that must never die.* (Motoyama, Garcia, 1996, p. 104)

[1] It should be noted that, around physical treatment of heavy minerals, the Brazilian Nuclear Industry (INB) currently produces monazite, zirconite, ilmenite and rutile at the Buena plant, in the North of Rio de Janeiro. Incidentally, INB has developed a beneficiation process designed to the production of rare earth elements, intrinsic to the production of a significant number of high-tech components, integral to cell phones and high-performance ceramics.

In the words of Chester Barnard, president of New Jersey Bell Telephone Company, the "deadliest of illusions" - the monopoly of knowledge of the production of fissile material - was fueled by the USA, for example, with the Baruch Plan that "reinforced the hegemony of a single country", until the "Soviet Union had frantically thrown itself into the task of unraveling the American 'great secret'." (Motoyama, Garcia, 1996, p. 73). This was yet another chapter of the Cold War, in the field of nuclear technology and energy, given that the world's first power plant based on energy released in nuclear reactions ('atomic power plant') was built in the Soviet Union, in the city of Obninsk, in 1954 (Frish, Timoreva, 1962, p. 662). The origins of this problem therefore go back to the struggles between imperialism and socialism (Hobsbawm, 2014).

Neocolonialism, mercantilism and the Cold War

In addition to the domestic reasons for the 1964 coup d'etat in Brazil, there was a set of political-economic vectors from the North Atlantic, not always explicit, but active:

> *The main aspect of Nixon's entire inter-American policy was the formation of alliances with the most conservative forces in Latin America. One of its essential elements was the widespread support and, in a certain sense, the flirting of the United States with the military regime in Brazil.* (Antiásov, 1985, p. 102)

The metaphor of this "flirting" can be translated into industrial and strategic terms:

> *The governments of Presidents Truman and Eisenhower [...] condemned above all the interference of the Brazilian State in the economy (it had gone from 17.1% in 1947 to 23.9% in 1956) and associated nationalist initiatives with threats to American security and business. Treasury Secretary George Humphrey maintained that the United States had no reason to subsidize a potentially competitive development. American policy during this period was documented in 1989 by Gerald Haines, a member of the Central Intelligence Agency's team of historians. In his severe Americanization of Brazil, he wrote: «Advocating a neocolonial and neomercantilist policy, American officials wanted to create and maintain a flow of Brazilian raw materials. They did not want Brazil to develop a competitive industrial capacity, especially in relation to strategic materials». [Haines, 1991]. This circumstance sterilized the thinking of the military right. They were on the side of the United States in the Cold War and agreed with the philosophical bases of its capitalism. They assumed they had a partner in the ally, but they did not know the extent of its disinterest in Brazilian industrial expansion. Captured by the ideological*

> *conflict, this thinking associated itself with an American project that offered them any kind of solidarity, except accelerated industrialization. As Haines would observe: «American policy toward Brazil was based on images, values, myths, stereotypes, and distortions of reality. It was a combination of political calculation, self-interest, paternalism, and evangelism. Yet, it worked ».* (Gaspari, 2003. p. 131)

A geopolitical "agreement" that was anything but casual in the entire Southern Cone and Latin America (Fajnzylber, 1983), the "relationship between big international capital and the Brazilian economy changed profoundly after 1964" (Singer, 1985, p. 90).

> *The new regime showed interest in attracting multinationals, offering them the most solid economic and political guarantees. Restrictions on the remittance of profits were practically abolished and formal guarantees against expropriations without "adequate" compensation were given, even in the form of international treaties. At the same time, a credit policy was initiated that favored foreign-owned subsidiaries and a policy of incentives (in the form of generous subsidies) for the export of manufactured goods, which naturally benefited the same subsidiaries. Brazil's new relationship with large international capital, which began in 1964, meant, in a way, the reversal of the import substitution process. Given the limited resources for investment, Brazil began to allocate an increasing portion of them to export sectors – from iron ore to shoes, fruit juices, and infrastructure services such as the much-vaunted "export brokers" – neglecting the expansion of activities aimed at the domestic market. Our notorious delay in the expansion of the steel industry, and in the production of non-ferrous metals and fertilizers, to mention just a few examples, attests to one of the consequences of the new emphasis given to Brazil's performance in the world market. Above all, the delay of our capital goods industry in a period of strong expansion of investments, such as that from 1968 onwards, explains the growing dependence on foreign countries that translates into a more than proportional expansion of our imports.* (Singer, 1985, pp. 90-93)

The theoretical inference was inevitable:

> *Throughout the history of relations between imperialist powers and underdeveloped countries, they have recognized that occasional or external methods of pressure were not enough. In order to ensure their long-term policies, they needed to count on internal support in each country. Most of the time, this support in underdeveloped countries is provided by landowners and monopoly capitalists, who constitute a small group of the population, but who direct the state apparatus, the armed forces, the police, the legal and administrative institutions, etc. When these groups are unable to establish*

> *clear domination, the imperialist countries do not hesitate to use their influence to produce the emergence of military groups that give them greater guarantees of stability.* (Harnecker, Uribe, 1972, pp. 46-47)

An enormous effort was needed to historically and analytically reconstruct the events of the final period of the military cycle, which would reconstruct at least the most significant parts of the circumstances that, in a word, "would lead to this: the structural crisis of the dependent economic model, coupled with the international economic crisis and aggravated by an external crisis" (Santiago, 1981, p. 13), a situation so unstable that, sounding the death knell of militarism, it forced it to negotiate, in its death throes, its survival with the most complete renunciation of the national project; that is, the crisis that had then been established

> *[...] left no other alternative for the regime's survival than to hand over to international monopoly capital those sectors of the economy in which it does not yet predominate: oil, land, forests, fuel alcohol production, etc. This is the meaning of Figueiredo's guidelines to the National Energy Commission, based on the plans of former minister Simonsen.* (Santiago, 1981, p. 13-14)

It would even be necessary to reexamine against the grain, this cataleptic period of the military regime, even to understand "the origins of the surrender policy in our history and how it was intensified after the 1964 coup" (Bueno *apud* Bueno, 1981, p. 9).

> *Finally, it is necessary to verify one of the striking characteristics of the Cold War that was revealed with extreme clarity in Latin America. The ideology of the anti-communist struggle served as a glove for the Latin American ruling classes to justify their presence in power. What was - and is - the result of the miserable internal situation and external exploitation came to be considered as the result of the "international communist conspiracy". Discontent and the popular movement were intensely repressed by governments that justified themselves internationally, raising the tattered banners of the Cold War.* (Barros, 1985, p. 3)

Ideologically there would still be much to say, but here it will suffice to follow the synthesis of historian E. Barros (1985), according to whom, since the post-war period, Brazil

> *[...] was completely trapped in the Cold War and aligned, almost unconditionally, with the United States. In Brazil, after the Second World War, American economic and military penetration changed habits and customs, patterns of behavior, consciousness, and language. Consumer goods, superheroes, and American leaders were symbols of good, of the way of life, of the*

> *superior morality of the USA. In August 1946, General Eisenhower visited Rio de Janeiro, displaying the halo of liberator of Europe, and former Foreign Minister Otávio Mangabeira kissed his hand publicly, in a spectacular gesture of humility and servility. In 1947, influenced by the Truman Doctrine, General Dutra threw the Brazilian Communist Party back into illegality and unleashed a fierce repression of the unions. In short, we had a good image of "a backyard of the USA". Of course, today one cannot speak so simply about the relations between Brazil and the United States; times are substantially different, but there is no doubt that US foreign policy continues to have intense repercussions in our country.* (Barros, 1985, p. 2 et seq.)

The way in which these repercussions became implicit is of great analytical interest, but for another study, with the next section simply following the logical thread of the dialogues and negotiations between Brazil and the IAEA in 2003-2004.

Information asymmetry and overcoming the impasse

Brazil was not the only country to develop ultracentrifuge technology for industrial-scale uranium enrichment, having been preceded at least by the Germans and the US, nor was it the first to suffer international institutional pressures regarding this same technical progress or others. On the other hand, the US, Russia, and Urenco (a consortium formed by Germany, England, and the Netherlands), among other countries, freely develop ultracentrifuge technology, proven to be the most economical, among others such as gaseous diffusion - used by the US, France, and Russia - and centrifugal jet - already tested in Brazil and abandoned as economically unviable, using 45 times more energy per unit of enriched uranium.

In contrast, and in parallel, Iran's Foreign Minister, Kamal Kharrazi, was urged to give detailed explanations about the nature of the Iranian nuclear project precisely because new centrifuges for uranium enrichment were being developed, and he also agreed to repeated UN inspections of his nuclear industry, although assurances that plutonium processing based on uranium enrichment through centrifuges were evident, including the agreement to even interrupt his nuclear project, by external decision, as well as to allow more rigorous inspections of his factories, stretching his sovereignty to the limit.

> *Although the NPT encourages [since 1968] inspection and control of developing countries with nascent nuclear plans, it makes no demands on countries with expanding nuclear arsenals. Since then, the notion of non-proliferation has been the seed of a normative conception and diplomatic praxis designed to protect the commercial leadership and military supremacy of the nuclear industry club of the core economies.* (Hurtado, 2023, p. 1)

In view of the Brazilian technology protection policy, the then Director-General of the IAEA, the Egyptian Mohamed El Baradei, despite having admitted his own lack of knowledge about the type of centrifuges produced in Brazil, as well as having admitted that they may be among the most efficient, said that knowledge of ultracentrifuge technology is already widespread and insisted on free inspection by the IAEA in Brazil, even going so far as to state that there is still no "negotiation market" for centrifuges that would justify Brazilian concern, which denotes a certain asymmetry of information.

In an interview given in Moscow, El Baradei stated: "We inspect uranium enrichment plants in many countries, without revealing any industrial secrets. Brazil will not be the exception." Agência Brasil reported, in this regard, that the Brazilian Defense Minister at the time, José Viegas, considered: "However, it is necessary to negotiate with international agencies the specific characteristics of the future agreement that will guide the inspections of the production units in Resende."

A memorable episode of these negotiations occurred on May 14, 2004, when Brazilian Ambassador Roberto Abdenur adamantly defended the uranium enrichment project in Brazil and, in a debate with nuclear experts and representatives of the US Congress and Executive Branch, did not hesitate to suggest that the US should not interfere in the matter. When asked what his position was regarding the IAEA Directorate General's proposal to multinationalization control of uranium reserves, its enrichment, etc., he replied:

> *We want all countries to be under the control of the United Nations, including the United States. When that happens, we will accept multinational control. Until then, we stand firm in defense of our autonomous program and the sovereign right to use our own technology.*

This led to the emergence of a diplomatic crisis, which, although officially mitigated, remained silent. The Director General of the IAEA was forced to state, regarding Brazil-IAEA relations: "Our relationship is not marked by tension or crisis. It is based on mutual respect, on understanding each other's points of view. I hope we can reach an understanding." Negotiations proceeded cautiously.

When asked if he was concerned about China's known interest in the Brazilian ultracentrifugation process and in purchasing its own enriched uranium in Brazil, Baradei admitted:

> *It is good for Brazil. We are in favor of expanding the peaceful use of technology. Brazil is a large country with industrial capacity. If it is expanding its export market, it is good for Brazil. It does not concern us. Brazil is a valuable member of the IAEA. It is a large country with good non-proliferation credentials. Our efforts to conduct verifications in Brazil are not guided by any specific concern.*

The impasse had since been overcome, with inspectors being allowed to visit on the condition that they could only observe the uranium input and output pipelines to provide repeated proof that there had been no "diversion" of enriched uranium nor, consequently, its unconstitutional storage for the possible future manufacture (and/or proliferation) of atomic weapons.

Of course, Brazil has been just one case among others around the world. But it would not be appropriate to broaden the scope of this discussion globally, so we will conclude this section by focusing on the contemporary geopolitical atmosphere in Latin America, in a word:

> *In the current context of an exacerbated reaction to China's emergence in the hegemonic dispute, the United States vetoed – with humiliating words and actions – Argentina's access to the purchase of a nuclear power plant from a Chinese company (see Béliz, el radiativo; El lobby estadounidense…). The Argentine government seems to be secretly accepting the veto, with the effect of evaporating nuclear policy and dismantling the sector. This sign of weakness suggests the imminent intensification of pressure for Argentina to unilaterally sign the PA [Additional Protocol] as a final pledge of subordination. Apparently, for nothing. This step would be lethal for the strengthening and development of the Argentine-Brazilian Agency for Accounting and Control of Nuclear Materials (ABACC).* (Hurtado, 2023, p. 1)

Three nuclear power plants operate in Argentina: Atucha I, Atucha II and Embalse, which already account for 9% of the country's energy consumption. In addition, the National Atomic Energy Commission (CNEA) had "a SMR (modular reactor) project very close to completion called CAREM, recognized in international analyses as one of the most advanced, with an expected start of operations in 2028", highlighted the former president of CNEA, A. Serquis (2021-2024). (AFP, 2024). CNEA has been developing this project for 20 years. The current Argentine government announced, in 2024, the intention of promoting nuclear energy in the country, however, for observers such as A. Serquis, this is a "tremendous contradiction". Indeed, since the current government took office, with its ultra-neoliberal measures, "the construction of CAREM was slowed down to its virtual standstill", signaled the former Secretary of Planning and Policies of the Ministry of Science, D. Hurtado (2019-2023) (AFP, 2024).

Finally, a concise analysis is needed regarding the third Latin American country that produces nuclear energy, Mexico, which began its nuclear program in the 1960s, with the creation of the National Nuclear Energy Commission (CNEN). Mexico has the Laguna Verde nuclear power plant located in Veracruz, which began operating in 1990 with two boiling water reactors (BWR-5) of 654 MW(e) net each, which account for about 4.8% of the country's electricity production (IAEA, 2021; Planas, 2021). National and technological sovereignty has been a sensitive issue in the development of nuclear energy in

Mexico. Mexican legislation stipulates that nuclear energy can only be used for peaceful purposes, and the exploitation of uranium is exclusive to the State. However, the dependence on foreign technologies and the need for international cooperation have sparked debates about the country's autonomy in this sector. The United States has played a significant role in nuclear cooperation with Mexico. In 2018, both countries signed a cooperation agreement on the peaceful uses of nuclear energy, which came into effect in 2022. This agreement facilitates the exchange of technologies and information but also raises concerns about U.S. influence on Mexican energy policies (O'Boyleda, 2022; Mexico, 2018).

The IAEA, in turn, has been a crucial partner for Mexico, providing technical and regulatory support. However, the IAEA's oversight can also be seen as a form of interference, limiting the country's autonomy in some strategic decisions. The most serious diplomatic incident related to atomic energy production in Mexico occurred in 2011, when the IAEA conducted a surprise inspection at the Laguna Verde nuclear power plant. The inspection was prompted by concerns about safety and nuclear waste management at the facility. During the inspection, several deficiencies in safety protocols were identified, leading the IAEA to issue a critical report on the plant's operation (IAEA, 2021b). The Mexican government's response was immediate, with the National Commission for Nuclear Safety and Safeguards (CNSNS) contesting the IAEA's findings and claiming that the inspection had been conducted improperly and without prior communication. (México, 2021). The diplomatic repercussions included a series of negotiations between Mexico and the IAEA to address the issues raised, resulting in an agreement to implement improvements in safety practices and waste management at the Laguna Verde plant. This incident highlighted the importance of international cooperation and transparency in the management of nuclear facilities, while also underscoring the challenges of maintaining national sovereignty in a context of global oversight (México, 2021b).

In summary, the development of nuclear energy in Mexico is marked by significant technological advancements, a close relationship with the IAEA, and ongoing challenges related to national sovereignty and external influence. These factors shape the country's trajectory in the nuclear sector and its diplomatic implications on the international stage.

Conclusions

Relations between international regulatory bodies for atomic fission industries and sovereign countries, especially in their legitimate fight against the proliferation of nuclear weapons, have not always been friendly or equal between central and peripheral economies. These relations have been motivated by geopolitical, political, military, and economic interests, among others.

The current negotiations and reports of the International Atomic Energy Agency (IAEA) regarding Brazil can be considered politically sound, especially when compared to the tensions and negotiations surrounding the conditions of inspection visits concerning the country's industrial rights in uranium enrichment through ultracentrifugation, a technology developed from negotiations dating back to the mid-20th century.

The political and institutional interference of the United States in the administration of the CNPq, due to its legitimate positions regarding strategic energy raw materials and the proposal of the Specific Compensation Policy, as well as the support of the United States for the military regimes that emerged in Brazil and multiple Latin American countries, favored the actions of multinational companies. These actions, among other artificial processes of deepening economic dependence during the long Cold War, whose echoes are still felt today in the economy, institutions, and regional mentalities, indicate the extent to which the sciences, consciences, political superstructures, and sovereignties of states have been rectified, adapted, and conditioned by neocolonialist interests, internally articulated by civilian and military representatives, especially in strategic areas.

Apart from the hypothesis of information asymmetry, which suggests that Brazil would not have had reasons to ensure the protection of its industrial rights in terms of uranium enrichment when they were being negotiated with China, being a technological route to energy self-sufficiency and participation in the global nuclear market, Brazilian diplomatic intelligence, since 2003-2004, ensured that IAEA inspections were limited only to inputs and outputs, but not to the unique process of uranium enrichment by centrifugation. This approach balanced the country's sovereign technological interests with those of regulatory agencies, opening a spiral of new relationships.

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