

Nuclear Cooperation in South America: The Role of Scientists in the Argentine–Brazilian Rapprochement

PAULO S. WROBEL^a AND JOHN R. REDICK^b

^a*Royal Institute of International Affairs, 10 St. James's Square, London SW1Y 4LE, United Kingdom*

^b*Charlottesville Albermarle Community Foundation, P.O. Box 1767, Charlottesville, Virginia 22902*

INTRODUCTION

To any observer of arms control in South America it is clear that the last ten years have witnessed extraordinary progress, especially in the area of nuclear weapons proliferation. Until the early 1990s, Argentina and Brazil—the two nations with the most advanced nuclear programs in Latin America—were consistently included in every study about the prospects for nuclear weapons proliferation. Either because of their alleged motives to “go nuclear,” such as regional competition and prestige, or because of the existence of unsafeguarded or secret nuclear installations, they were considered to be in the process of crossing the nuclear threshold.

In 1983 and 1987, respectively, Argentine and Brazilian authorities announced that they had indigenously enriched uranium on a pilot scale. The announcements appeared to confirm the suspicions held by many experts who closely monitored nuclear developments in South America. Uranium, enriched above a certain level, may be employed for nonpeaceful purposes, either in a nonexplosive military application such as fuel for a nuclear-powered submarine, or diverted to weapons use.¹ The public acknowledgement of secret nuclear installations in Argentina and Brazil, especially enrichment facilities, raised the level of suspicion further. In addition, the persistent opposition of Argentina and Brazil to the treaties, agreements, and norms that constitute the nuclear non-proliferation regime,² and in particular their vocal criticism of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as unjust and discriminatory, seemed to justify the perception that Buenos Aires and Brasilia were seeking to introduce weapons of mass destruction into South America.

Despite these bleak predictions, however, in a very few years Argentina and Brazil have taken significant steps to end their nuclear opacity. Beginning cautiously with the “Joint Declaration on Nuclear Policy” issued at a presidential summit held in late November 1985, Buenos Aires and Brasilia have developed a series of bilateral confidence-building measures in the nuclear area. These measures have created a new reality, totally different from their earlier nuclear competition. The changes adopted in their established domestic and foreign nuclear policies represent, *inter alia*, virtual recognition of the nuclear non-proliferation regime. They have even gone so far as to accept the implementation of full-scope safeguards on all their nuclear installations and materials, something relentlessly opposed by both nations for more than two decades.

Currently, Argentina is a full party of the regional Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco), by which Latin America became the first inhabited nuclear-weapon-free zone. In addition, Argentina is now a party to the NPT (as of February 1995), the Missile Control Technology Regime (MCTR), and the Nuclear Suppliers Group. Brazil is also party to these treaties, agreements, and conventions, which provide the basic structure for multilateral efforts aimed at preventing the spread of weapons of mass destruction.³

In this chapter we do not seek to explain in detail how these changes in established policies came about.⁴ Instead, we focus on the role played by one important social group—the scientists, and in particular the communities of nuclear physicists in both countries—in changing deeply ingrained opposition to national, regional, and multilateral forms of supervision and control of nuclear activities.

Domestic, regional and changing international circumstances all influenced the views held by key local decisionmakers and contributed to the reversal of nuclear policies in both nations. One often-cited explanation for the changing policies in both countries was the leverage exerted by some nuclear suppliers, primarily the United States and the Federal Republic of Germany. Certainly, foreign pressures exerted on Buenos Aires and Brasilia to sign the NPT and adopt full-scope IAEA safeguards contributed to the policy reversals. Nonetheless, Washington and Bonn's leverage alone cannot fully account for the extraordinary changes. Domestic political and economic factors, which led to the decision taken in both capitals to initiate an extended project of bilateral economic and political cooperation, hold the key to explaining the unexpected turn of events. In fact, the turning point in reversing opposition to comprehensive safeguards under multilateral control came about as a result of a bilateral rapprochement, which created mutual confidence. An Argentine–Brazilian common system for accountability and control of all nuclear activities along with a joint agency to monitor the system were established, paving the way to normalization of their bilateral relationship, as well as their relationships with the major supporters of the non-proliferation regime.⁵ These unprecedented changes in nuclear policies have helped accelerate and deepen economic, military, scientific, and political cooperation between the two South American rivals. This, in turn, has contributed significantly to the peace and security of the entire Latin American region.

Tracing the contributions of Argentine and Brazilian scientists, particularly physicists, to this historic process, we argue that the role of the scientific communities in the two nations in many ways differed relative to involvement in, and support for, the national nuclear program, the degree of political persecution by previous military governments, and the impact of foreign organizations. Ultimately, however, we conclude that scientists played a valuable role in educating the public and influencing the leadership in both nations as to the need to avoid militarization of the nuclear programs and to establish effective national, bilateral, regional, and international nuclear control mechanisms.

CONCERNS ABOUT PROLIFERATION IN ARGENTINA AND BRAZIL

Since the NPT entered into force in 1970, there have been two major modalities for monitoring the activities of potential nuclear proliferators worldwide. One meth-

od, routinely carried out by the International Atomic Energy Agency (IAEA), and used for members of the NPT, is to monitor the civilian nuclear activities of a given country, through routine or special on-site inspections, to assure that there is no diversion of nuclear materials from peaceful to non-peaceful purposes.⁶

Another approach, directed toward non-NPT parties, is to gather as much information as possible, through public or intelligence channels. The information allows the observers to estimate intentions and capabilities of a possible proliferator. In this process, a careful monitoring of the regional security context (which includes understanding the major regional conflicts, rivalries, and competitions, as well as the local initiatives for arms control) is fundamental in assessing motivations and devising strategies to deter potential proliferators.

From the earliest stages of their nuclear programs in the mid-1950s, the governments of Argentina and Brazil systematically denied any intention to develop nuclear weapons. However, until the recent policy reversals, both nations resolutely opposed the development of the multilateral nuclear non-proliferation regime, and declined to fully cooperate with it. The two countries vigorously opposed the 1968 NPT because, in their view, it divided the world between “haves” and “have nots,” thereby legitimizing nuclear weapons and maintaining an unjust distribution of power. Non-participation in the main treaties, agreements, and informal groups that constitute the nuclear non-proliferation regime became their standard policies. The two nations also refused to enter into negotiations with the IAEA to apply comprehensive full-scope safeguards to all their nuclear activities.⁷

While an unambiguous assessment of intentions is difficult, there is much evidence to suggest that neither Argentina nor Brazil had a clear-cut policy, with proper budget allocation, time-frame and working groups, to master the complex scientific and industrial tasks required to acquire nuclear weapons, nor was there any security rationale to incorporate nuclear or other weapons of mass destruction into their defense practices.⁸ In terms of capabilities, based on information from public sources, it appears that neither Argentina nor Brazil possessed sufficient highly enriched uranium from indigenous sources for a nuclear explosive device. Nevertheless, both nations did develop programs to produce nuclear energy. While they accepted IAEA safeguards on installations, equipment, and materials purchased abroad, as demanded by the suppliers, there were several indigenously built nuclear research and industrial facilities not subject to IAEA safeguards or regional oversight. Furthermore, both nations lacked adequate and accountable national control, because there were no independent agencies or institutions established with this goal. Therefore, Argentina and Brazil’s self-exclusion from the regional and the multilateral institutions which monitor the diversion of nuclear technology from peaceful to non-peaceful activities, and their lack of independent national oversight bodies, resulted in widespread suspicion of their intentions and concern over the possibility of nuclear weapons proliferation in the region.

BILATERAL NUCLEAR COOPERATION

The evolution of nuclear cooperation between Argentina and Brazil must be seen not in isolation, but as part of a process leading toward a new economic and political

partnership in South America.⁹ In this context, the successful implementation of bilateral confidence-building measures in the nuclear area was but one component of a broader agenda for Southern Cone economic and political rapprochement. The final goal was to establish a common market (Mercosur)¹⁰ an ambitious project for economic integration, inspired by the successful example set by the European Economic Union. The first successful step was taken when Mercosur—a free-trade area, with a common external tariff—became operational on 1 January 1995, according to the timetable agreed upon in 1991 by the Treaty of Asunción. The goal of economic integration depended foremost on a series of concerted political measures taken at the presidential level, with the firm support of the respective foreign ministries. The intention was to end several decades of rivalry, misunderstandings, and unfulfilled promises, and to finally achieve regional economic integration.

Among the series of political measures taken, nuclear rapprochement became prominent. Bilateral nuclear cooperation between Argentina and Brazil was purposefully singled out by the presidential leadership as a way to foster mutual confidence through a highly visible security issue while, at the same time, appeasing foreign demand for comprehensive IAEA safeguards under multilateral supervision.

No one single cause led to bilateral nuclear cooperation on the scale finally achieved. Buenos Aires and Brasilia began their nuclear collaboration while both were still under military governments, following a visit to Buenos Aires in 1980 by General João Figueiredo, the last Brazilian military president. The process, however, accelerated only after the transition to civilian-led governments, which took place in 1983 in Argentina and in 1985 in Brazil. To a certain degree, nuclear cooperation resulted from a shared perception that both were being penalized by a concerted U.S.-led effort of technological denial. Despite the different technologies of their respective nuclear programs, both nations were determined to master the complete nuclear fuel cycle in order to avoid dependence on foreign-enriched uranium or heavy water. Total independence in the nuclear fuel cycle required the capability to enrich uranium indigenously and, in the case of Argentina, a capacity to produce heavy water. Both nations also mastered reprocessing technology.

Five years of intense negotiations and diplomatic activities took place between the first 1985 joint declaration and the November 1990 announcement calling for a bilateral inspection system, full-scope IAEA safeguards, and full implementation of the Treaty of Tlatelolco. A series of presidential meetings and mutual visits to formerly secret and unsafeguarded nuclear installations were arranged in order to enhance mutual confidence. The meetings and mutual presidential visits created a climate of trust, a necessary precondition to on-site inspections of the respective nuclear activities. While the presidents were publicly meeting and announcing fresh joint initiatives, the diplomats and scientific experts worked behind the scenes to transform trust and confidence into concrete measures.

EVOLUTION TOWARD A COMMON SYSTEM OF CONTROL

The task of designing a system of control of nuclear activities in South America was not straightforward. Initially, there was a virtual consensus in Argentina and Brazil against full-scope IAEA safeguards, which were viewed as the product of a

discriminatory NPT. Moreover, there was resistance by some elements in both nations to national or regional nuclear control, which was considered to be intrusive on activities requiring a considerable degree of secrecy.

It was the foreign ministry in both nations that provided the leading force behind the process of bilateral nuclear cooperation. Under the guidance of their respective foreign ministers, confidence-building measures evolved from joint declarations to mutual presidential visits to nuclear installations—including the secret enrichment facilities at Pilcaniyeu in Argentina and Iperó in Brazil—to a progressive exchange of information. As this process occurred, the political leadership of both nations gradually came to an understanding that, in spite of the evolution of mutual confidence, a bilateral system alone would not be enough to satisfy the international community. As will be discussed below, scientists in both nations contributed to the evolution of the views of the political leadership regarding bilateral and multilateral nuclear cooperation.

The idea of a bilateral or common system was first put forward in 1985, soon after both nations ended military rule. Argentine President Raul Alfonsín proposed to the Brazilian President José Sarney that they should negotiate a bilateral system of control of nuclear materials and installations. At that time, however, Brazil was not prepared to enter into negotiations. Opposition, especially by the military, to any form of control was very strong in Brazil, and as an appointed president, Sarney lacked the legitimacy, or indeed the will, to exert presidential control over the Brazilian nuclear program. Nevertheless, a “Joint Working Group” was formed at that time to discuss nuclear issues. And, in 1988 further progress was made with the establishment of a Permanent Committee composed of foreign ministry and nuclear energy commission officials. There was now a permanent body to further the negotiations and propose directions. Diplomats and technical experts were assembled to explore all avenues for nuclear cooperation, including industrial collaboration, safety measures, a data-bank for information exchange, and application of safeguards to nuclear activities.

The initial work of the Permanent Committee was based on the presumption that full-scope IAEA safeguards should be avoided. The posture against intrusive full-scope IAEA safeguards had widespread support among foreign ministry and nuclear experts alike, but some on the Committee were also aware of the limits of a national and a bilateral system of inspections, and sensitive to the demands of the international community for comprehensive safeguards. However, the decision on which level of international control was feasible and acceptable was made ultimately by the political leadership at the highest level.

After the transition to civilian government in both nations, the evolution of the negotiations depended foremost on presidential leadership. As the presidents advanced the process, a crucial moment approached with the presidential elections in Argentina in 1989, and in Brazil in 1990. In Argentina, the economic disaster which beleaguered the Alfonsín administration facilitated the electoral victory of a Peronist candidate, Carlos Menem. Menem’s victory raised widespread uncertainty over Argentina’s commitment to cooperation with Brazil, particularly regarding the continuity of the nuclear confidence-building process. It was feared that Menem would follow the Peronist tradition of nationalism and isolationism in foreign affairs. It was also uncertain which kind of economic policy the new administration was prepared

to follow. The fears were unfounded. As president, Menem assumed a pragmatic posture and encouraged continued cooperation with Brazil. He understood that Argentina needed to undertake measures to change foreign perceptions in order to definitively end years of economic stagnation, mismanagement, and erratic foreign policy (particularly the legacy of the Malvinas–Falkland War). Soon after taking office, President Menem announced his commitment to continued economic and political cooperation with Brazil, including the nuclear confidence-building process.

Despite Menem's firm commitment to pragmatism, it was unclear how the newly elected president of Brazil would proceed regarding cooperation with Argentina. The 1989 Brazilian presidential election was the first since 1960. After twenty-one years of military rule, and five years of a civilian president selected indirectly by congress, Brazil elected Fernando Collor de Mello, a young and untested politician from a small and impoverished state in Northeast Brazil, lacking roots within any established political party. While Collor de Mello's victory represented a certain degree of continuity in Brazil's political and economic policies (because he himself belonged to the traditional political elite), the newly-elected president took a series of surprising political and economic initiatives. Similar to President Menem, he strongly supported continued cooperation with Argentina, and endorsed the nuclear confidence-building process. On the domestic level, he moved swiftly to gain control over the Brazilian nuclear program, appointing trusted aides and nationally respected personalities to key positions in the nuclear policymaking agencies, including nuclear physicists who openly favored a national system of nuclear control and enhanced cooperation with the non-proliferation regime.

The most important result of the two presidential elections was the irreversibility of rapprochement. Years of economic instability and mismanagement, stratospheric annual rates of inflation, sluggish economic growth, and deteriorating living standards created the right conditions for abandonment of long-established economic and foreign policies. International trade, investment and economic liberalization, including a new partnership with international finance, became high priorities in both nations. As a result, both nations undertook measures to resolve contentious issues with the main foreign suppliers of technology and investment. In the context of becoming predictable and reliable international partners, adhering to the international norms of the non-proliferation regime became a part of their ongoing bilateral confidence-building process.

This new international posture was evidenced by a highly public exercise carried out by President Collor de Mello at the General Assembly of the United Nations in September 1990. Only five months after assuming office, President Collor announced very important unilateral nuclear measures, including renunciation of so-called "peaceful nuclear explosions," and a national commitment to pursue nuclear activities only for peaceful purposes. This symbolic gesture, taken in the highly visible UN General Assembly setting, was meant to underscore his ability to control Brazil's nuclear policies, and to present Brazil as a reliable partner.

Deepening the effort, Collor de Mello and Menem prevailed over domestic opposition and accepted full-scope IAEA safeguards. They understood that their joint initiative in the nuclear area provided a useful platform to integrate their nations into a more favorable position within the new international order. Through hastily concluded negotiations, the two presidents announced, in November 1990, the creation of a

Common System of Control and Accountability (Sistema Comum de Contabilidade e Controle, SCCC) of nuclear activities, conducted through a Brazilian–Argentine Agency for Accounting and Control of Nuclear Materials (Agência Brasileiro-Argentina de Contabilidade e Controle de Materiais Nucleares, ABACC), and a Quadripartite Agreement among Argentina, Brazil, ABACC, and the IAEA. The Quadripartite Agreement was signed in December 1991 at IAEA headquarters in Vienna, in the presence of both presidents; it subjected *all* nuclear installations and materials in both nations to inspections by ABACC and the IAEA.

Argentine and Brazilian nuclear scientists made a distinct contribution to the aforementioned politico-diplomatic process by which national, regional, and multi-lateral forms of nuclear control were established. In order to understand the role of Argentine and Brazilian scientists as a relevant and effective pressure group, it is necessary to first understand the broader background of their participation in nuclear activities in South America.

NUCLEAR ACTIVITIES IN ARGENTINA AND BRAZIL: THE ROLE OF THE SCIENTISTS

The introduction of modern science and technology, especially nuclear energy, was widely supported by all sectors in Brazil and Argentina. From the 1950s until the 1970s, the nuclear field was considered the quintessential advanced technology, and was jointly undertaken by civilian and military experts. The Argentine National Commission for Nuclear Energy (Comisión Nacional de Energía Nuclear, CNEA) and the Brazilian National Council for Research (Conselho Nacional de Pesquisas, CNPq) were founded in the early 1950s as a result of pressure from the still-small scientific communities, and some military officers interested in research.¹² Public bodies, they were established as governmental institutions to design and coordinate national policies for scientific and technological development.

It is important to note that, in most developing countries, it is very difficult to maintain the long-term momentum and continuity of science and technology public programs. Moreover, the complex relationship between scientists and the state is a product of fragile and unstable political systems. On the one hand, governments need scientific advice to design public policies for modern technology and to conduct the appropriate research. On the other hand, the lack of infrastructure, in particular a solid base of independent research and training facilities, results in the dependence of scientists on public funding. As a consequence, political interference, patronage, and insecurity characterize scientist–government relations in developing nations, and this was certainly the case in Argentina and Brazil as well. Scientists operating in such an environment are more likely to become entangled in the ongoing political competition, and to actively participate in national political debates. Consequently, it is not surprising that a great number of scientists in developing nations embrace nationalistic causes.¹³

The prevailing view among scientists in Argentina and Brazil in the early 1950s was that nuclear energy represented a panacea for national improvement. This was reinforced by President Eisenhower's 1953 "Atoms for Peace" program.¹⁴ The promise of cheap and abundant energy caught the imagination of those who believed

that all progress resulted from scientific and technological development. Therefore, policies to expand the national scientific and technological base became embroiled in a comprehensive notion of national security; autonomy in advanced technology became a policy goal to be attained at any price. Nuclear independence came to symbolize most vividly these assumptions and beliefs.

Despite the enthusiasm of a small number of scientists, military officers, and government officials, nuclear activities remained modest in both countries throughout the 1950s and the early 1960s. The education and training of experts, the establishment of nuclear physics research institutes, and the purchase and construction of research reactors (i.e. the initial step in a nuclear infrastructure), were the principal activities undertaken by Argentina and Brazil. Nevertheless, nuclear scientists made significant contributions to both the establishment of national nuclear institutions and to the development of public nuclear policy. In Argentina, it was an obscure Austrian nuclear physicist, Hans Richter, who persuaded president Peron, in the early 1950s, to establish a research institute in Bariloche, with the promise that in a few years hydrogen energy would be derived from water. While the episode was a fiasco, it helped create awareness about nuclear research and raised the profile of nuclear technology. In Brazil, the military officer most responsible for establishment, in the mid-1950s, of public policies for nuclear research, Admiral Alvaro Alberto, was also a chemist knowledgeable in nuclear matters. Nuclear scientists, in concert with the armed forces (which had a traditional role in professional technical training), were the driving force for establishment of public policies as the nuclear programs developed and matured.

By the end of the 1960s both nations completed feasibility studies for their first nuclear power reactors. Argentina signed a contract with the German company, Siemens, and began construction in 1968 of a natural uranium/heavy-water power reactor (Atucha I). A second natural uranium/heavy water power reactor, Embalse, was purchased by Argentina in 1977 from Atomic Energy Canadian Limited in a consortium with the Italian firm, Italiampianti.

Similarly, Brazil signed a 1970 contract with the U.S. firm, Westinghouse, to build a pressurized water-power reactor (PWR) using slightly enriched uranium as fuel (Angra I). This was followed by an extensive nuclear contract with the Federal Republic of Germany for the construction of as many as eight nuclear power reactors, also fueled by slightly enriched uranium.

As noted earlier, opposition to the NPT and full-scope IAEA safeguards, and a desire to avoid excessive intrusiveness, national scrutiny, industrial espionage or dissemination of information, all led to a decision in the 1970s by both nations to keep part of their nuclear programs secret. Much of the military in both nations viewed nuclear technology as a key component of national development and international influence. The military's significant resources and expertise were employed to assure that sensitive portions of the nuclear program remained secret, both from international scrutiny and their fellow citizens. In both nations the uranium-enrichment facilities were, for example, well-kept secrets, and were operated without the knowledge of their respective Congresses and most of the scientific community.

Resentment in both nations regarding a perceived unequal and unjust international non-proliferation regime was widely shared among all sectors, including the scientists. These nuclear scientists were committed to an ideology of national

development which envisioned nuclear technology as an essential tool for industrial and societal progress. According to this ideology, shared by most South American scientists, developing nations were struggling to progress in a highly competitive, zero-sum international game. Possession of modern technology, especially nuclear technology, was viewed as the entry gate to the developed world, and it was felt that this technology was consistently and deliberately denied by the advanced nations.

To be sure, there were differences among nuclear scientists, particularly in Brazil, about the best means to achieve technological independence in the nuclear field, and regarding the nature and degree of technological cooperation with the developed countries. Nevertheless, from an early stage there was a broad consensus among nuclear scientists that the national government should actively promote nuclear development and protect the nuclear program from foreign pressure. In this respect, most Argentine and Brazilian nuclear scientists were products of their own time, but they gradually evolved into a more internationalist perspective regarding the need for bilateral, regional, and international monitoring of nuclear activities.

Further, it was frequently observed that the same multilateral regime that denied access to sensitive nuclear technologies, allowed the nuclear weapon states the privilege of possessing unsafeguarded sensitive technologies. Thus, there was a widespread view, strongly held in the scientific community, that nuclear supplier export restrictions represented "technological colonialism," and that only the strong profited from the non-proliferation regime. In both nations political leaders used nationalism, in a mild or virulent form, to justify nuclear policy options. Military officers with scientific training, scientific advisors, diplomats, and mid-rank government officials all shared the view that there existed a concerted international effort to deny less-developed countries the means for economic improvement. This perception contributed further to misunderstandings, between Argentina and Brazil on one hand, and supporters of the non-proliferation regime on the other, concerning mutual intentions.

Despite similarities in both the role of nuclear scientists and in the general evolution of nuclear programs in Argentina and Brazil, there were important differences. A major contrast was the degree of public support, especially from the nuclear scientists, for their respective nuclear programs. In Argentina, the nuclear program had the overall support of society, and was an object of national pride. There existed very little opposition to the program, either on technological or environmental grounds. On the other hand, in Brazil, nuclear activities were very controversial, and major decisions taken by different administrations were sharply criticized by leading scientific organizations, in particular those led by nuclear physicists.¹⁵

Two main reasons may be cited for the contrasting level of support for the nuclear programs: first, the different technological path chosen by both nations when they purchased nuclear power reactors and; second, the model by which they organized and institutionalized their respective nuclear activities.¹⁶ Argentine officials chose for their power reactors technology based on natural uranium and heavy water, which allowed an incremental growth of local expertise and a gradual development of nuclear activities. In contrast, Brazilian officials chose to purchase a commercial pressurized water-power reactor (PWR) based on enriched uranium, on a turn-key basis, which was not as conducive to the gradual growth of local expertise and indigenous industrial development.

In organizational and institutional terms, the main contrast was the fact that in Argentina the administration of the nuclear program was based on continuity of personnel and long-term planning. The CNEA, directly subordinated to the president's office, had sufficient autonomy to design and implement policies and was able to retain its personnel on a long-term basis. In Brazil, the National Commission for Nuclear Energy (Comissão Nacional de Energia Nuclear, CNEN), founded in 1956, became one protagonist among many in designing and implementing nuclear policies. Nuclear policy in Brazil evolved through twists and turns, resulting in a lack of continuity in personnel and an absence in long-term planning. Policies initiated by one Brazilian administration were interrupted by the succeeding one, in the name of better technologies or economic reasoning. This discontinuity permitted neither personnel stability nor the maturation of long-term investments. Moreover, there were also striking differences in terms of educational and training policies, and in the capacity of the two main agencies to carry out centralized decisions.

As an example, prior to the Brazilian decision to purchase its first PWR nuclear power reactor, Brazilian scientists, funded by the CNEN, had experimented with an indigenous nuclear fuel cycle technology using thorium and natural uranium. With the decision to buy a PWR power reactor, Brazilian authorities virtually abandoned any original research, including the development of indigenous nuclear fuel cycle approaches, and the role of CNEN was minimized. As a consequence, most of the nuclear scientists, associated with research programs hitherto supported by public funds, were dispersed and ceased to play any prominent role in the nation's nuclear program for a considerable period of time.

On the other hand, in Argentina the relative continuity and organizational stability of the CNEA allowed continuous training and stimulated support from private industries. This resulted in the continued support of nuclear scientists for public policies designed and conducted by CNEA, in spite of the highly polarized political conditions which predominated in Argentina during most of the period being examined.

Political persecution of nuclear physicists by repressive military governments took place in both countries, and a number of physicists fled or were simply "disappeared," due to their political persuasion and activities. Indeed, a significant number of physicists became, in both nations, highly involved in political activities.¹⁷

In Argentina, a great number of nuclear physicists suffered political persecution during the most repressive years of military rule—in the mid-late 1960s and again a decade later. The CNEA was, however, reasonably successful in protecting nuclear physicists involved in its programs and associated research centers, in contrast to university-based scientists, who were specifically targeted by military governments.¹⁸ Despite this protection, however, many nuclear physicists did flee Argentina, looking for better working conditions and a more benign political environment.

In Brazil, political persecution of this sort was on a much smaller scale. In contrast to Argentina, many Brazilian nuclear scientists were strongly critical of the national nuclear program, especially the so-called "parallel," military-led nuclear program. In Brazil, a vocal group of scientists, initially led by the Brazilian Society for the Advancement of Science (Sociedade Brasileira para o Progresso da Ciência, SBPC), and later by the Brazilian Physics Society (Sociedade Brasileira de Física, SBF), was the leading force behind the critical appraisal of the 1975 nuclear agreement with the Federal Republic of Germany. Under the agreement, Brazil was to re-

ceive several power reactors using slightly enriched uranium, as well as enrichment and reprocessing technology. The SBPC and SBF pressed for congressional scrutiny of, and public debate over, the nuclear deal. In the ensuing process, significant members of the scientific community were totally alienated from nuclear decision-making and sharply criticized the nuclear agreement as unnecessary and unduly costly. This opposition to the nuclear deal ultimately became an important galvanizing force in favor of democratization of the country. Moreover, during the 1980s, as reports of secret military nuclear activities began to surface, the SBF sought to sensitize the Brazilian congress while it was in special session preparing a new constitution. The SBF tried to persuade congress of the need to implement institutional mechanisms to control nuclear decision-making, including legislative supervision and approval of decisions taken by the executive. The SBF also argued for specific constitutional guarantees against non-peaceful uses of nuclear energy. While the Brazilian congress was unable to implement concrete measures of legislative control over the executive on nuclear matters, it did include in the new 1988 constitution, a paragraph which requires that nuclear activities in Brazil be pursued only for peaceful purposes.

In Argentina the role of nuclear scientists and scientific organizations was less prominent than in Brazil in that they did not question, in a open and concerted fashion, the established nuclear policies. As noted earlier, this was due, in part, to the fact that many prominent university-based Argentine scientists emigrated to avoid persecution, while others were incorporated into the CNEA. Understandably, the latter group appreciated the political protection and career continuity afforded by the well-funded CNEA and were less inclined to be critical of the national nuclear policies.¹⁹ It was the new civilian political leadership under Alfonsín which initially led the process for legislative control over the nuclear program. As an illustration, after the November 1983 announcement by Admiral Castro Madero (President of CNEA) that Argentina had indigenously enriched uranium, newly elected President Alfonsín moved swiftly to exert personal authority over the nuclear program by appointing loyal aides to head the main positions at CNEA. This included the appointment of engineer Alberto Constantini as the new CNEA president, the first civilian in a generation to hold this post.

While the contribution of Argentine and Brazilian nuclear scientists to public nuclear policy development is indisputable, measuring the impact of specific nongovernmental scientific organizations is more difficult. It is possible to identify certain scientific figures who gave expert advice about particular scientific and technical problems, but scientists represented one group among many involved in the endeavor of bringing modern industrial production to their countries. In a broader sense, efforts to establish an indigenous nuclear industry in Argentina and Brazil, and indeed in other cases of high tech industry such as computers, required the commitment and enthusiasm of a generation of scientists and experts, and the long-term involvement of scientific organizations. How to measure their relative success, however, remains highly controversial.²⁰

Ultimately, as regards nuclear policy, the principal contribution of the nongovernmental scientific organizations during the early years may have been to help facilitate the liberalization and democratization process in both nations. The Brazilian Society for the Advancement of Science (SBPC) became, in the mid-1970s, a source of political opposition to military rule, while civil liberties were still restricted, and

their annual meetings attracted thousands of enthusiastic professionals and students. Led by nuclear physicists, it became the most vehement critic of the 1975 German–Brazilian nuclear deal, and more generally of the overall nuclear program. The critical stance of the SBPC (and subsequently the SBF) was widely reported in the Brazilian press, and coupled with appeals for a more open political system, had a powerful public impact.

ESTABLISHMENT OF A COMMON ACCOUNTING AND CONTROL SYSTEM: THE ROLE OF NUCLEAR PHYSICISTS

As civilian governments in Argentina and Brazil began, in the mid-1980s, to reduce secrecy surrounding nuclear issues, nuclear physicists and their professional organizations in both nations became more proactive in their efforts to influence nuclear policymaking. In Argentina the stability and relative autonomy of the CNEA was, as previously noted, very important to preserving nuclear policy continuity. The CNEA's insularity also meant that there were certain aspects of the nuclear program that remained secret from all but a small group of government officials. With the election of Alfonsín, and his assertion of control over the nuclear program, the Asociación Física Argentina (AFA) attempted to influence the course of events. During a 1983 meeting between the AFA and the Sociedade Brasileira de Física (SBF), the former raised the issue of a possible joint nuclear accounting and inspection arrangement. In November 1983, a first declaration by the two physics societies was issued that contained (after generalities about the need for nuclear disarmament and against an arms race in South America) a paragraph asking both governments to exchange nuclear information and to establish mutual inspections of nuclear facilities.²¹ At this point, for the first time, both physics societies began to share the view that some societal control over their respective nuclear programs was desirable, and that they should work to establish this objective.

In the following year (1984), in a meeting of the Latin American Federation of the Physics Societies (Federación Latino-Americana de Sociedades de Física) held in São Paulo, Brazil, a declaration was submitted jointly by the societies of Argentina, Brazil, and Mexico in favor of nuclear disarmament and mutual controls in Latin America and the Caribbean.²² In the context of the ongoing liberalization in both nations, and the early stages of official confidence-building measures, the AFA and the SBF began to issue annual joint declarations in favor of mutual nuclear controls. This helped establish closer links between the two organizations and helped educate public opinion and influence policymaking.

As the process developed, a subgroup was formed within the SBF in 1985 to deal specifically with nuclear issues. This subgroup contacted the Federation of American Scientists (FAS) of Washington, DC, requesting help in developing expertise on military nuclear issues, and in monitoring nuclear activities. An initial delegation of U.S. scientists was sent by FAS to Brazil, with the objective of educating their Brazilian peers about these issues. While in Brazil the FAS group made numerous contacts with Brazilian nuclear scientists and exchanged information on mechanisms for control. They also trained a group of Brazilian physicists on the relationship between civilian and military aspects of nuclear issues. As a follow-up to this first contact, a

delegation of Brazilian physicists later visited the United States under the invitation of the FAS and, escorted by U.S. scientists, visited facilities and learned about U.S. national mechanisms of control. A similar relationship was also established between the FAS and the AFA, and a delegation from the FAS visited Argentina,²³ where contacts and exchange of information occurred. At a later point, this visit was reciprocated by an Argentine visit to Washington.

The FAS continued, from the mid-1980s to 1990, to facilitate discussions and visits with Argentine and Brazilian scientists active in their respective physics societies. This collaboration focused particularly on the need for more effective congressional oversight of the nuclear program.²⁴ In Brazil the SBF was particularly active in proposing an article for the new (1988) constitution forbidding any national involvement in projects leading to the development of nuclear weapons.²⁵ Ultimately the SBF actions contributed to public receptivity and support for both congressional and presidential responsibility for the nuclear program.

Participation in certain international organizations and international fora also contributed to changes in perception on nuclear issues by nuclear officials and scientists in both nations. For example, Argentine and Brazilian nuclear officials and experts actively contributed to both the technical and safeguards operations of the International Atomic Energy Agency (IAEA) in Vienna. Their national delegations to the IAEA's Board of Governors and General Conference have frequently included high-level officials from the nuclear energy commissions. The professional and collegial relationships developed through participation in IAEA activities contributed to changes in certain long-held positions on such issues as full-scope safeguards.²⁶

International meetings organized by nongovernmental organizations helped sensitize Argentine and Brazilian nuclear experts and officials on the desirability of both bilateral and multilateral nuclear control mechanisms. One such event was a 1989 meeting in Montevideo organized by the Nuclear Control Institute, based in Washington, DC. The meeting, which involved leading Argentine and Brazilian nuclear officials and scientists, along with U.S. counterparts, was convened to discuss prospects for reciprocal inspections, international safeguard arrangements, and other regional measures.²⁷ Occurring at a critical point, the conference contributed to an appreciation by Argentine and Brazilian participants that, in order to assure the international community of their peaceful intentions, the bilateral control system would have to be augmented by multilateral control mechanisms.

The work done by the Permanent Committee on Nuclear Policy facilitated political support in favor of progress towards mutual and international inspections. When the political decision to establish a SCCC and the ABACC was taken, two respected and experienced nuclear physicists, Jorge Coll from the CNEA representing Argentina, and Carlos Feu Alvim, a professor of Physics, representing Brazil, became the director and deputy director, respectively, of ABACC. An important factor, however, in the establishment of ABACC was the great number of personal contacts made over many years between Argentine and Brazilian scientists, technicians, and other officials associated with the nuclear programs. In particular, among the relatively small community of nuclear physicists, close personal relations evolved toward mutual trust and shared knowledge acquired from joint participation in bilateral or multilateral technical meetings. This helped to end decades of long-held suspicions against foreign interference. After commencing operation in July 1992, ABACC in-

initiated on-site inspections, and entered into negotiations with the IAEA to undertake joint inspections and avoid duplication of efforts. The very successful work done thus far by ABACC was masterminded, and conducted, by nuclear physicists, with the full support of both governments.

CONCLUSION

After years of being considered one of the world's troubled and proliferation-prone regions, South America is now viewed as a successful model for other regions. The establishment of this new South American security environment resulted foremost from the desire of the Argentine and Brazilian leadership to improve relations and deepen security commitments through confidence-building measures in order to achieve a new economic and political partnership in the region. In this process nuclear cooperation did play a most important role by facilitating the mutual confidence-building and paving the way for better economic and political relations. Furthermore, the establishment of a bilateral nuclear inspection system and acceptance of comprehensive full-scope IAEA safeguards helped decisively to open a new era of trust between South America and the international community, particularly with the main suppliers of technology and finance.

It is difficult to single out one special group, or sector of the government, solely responsible for changing long-established nuclear policies, but the firm commitment of presidential leadership in both nations to pursue enlightened self-interest was the driving force. Foreign ministry officials from both nations worked in tandem with the presidential leadership, and had a very important role in keeping the process alive through the Permanent Committee on Nuclear Policy. The role of the nuclear physicist communities was also very relevant. While they did not have a fundamental role regarding key decision-making—with the exception of some individual nuclear physicists who occupied high government posts—they were very important in educating public opinion and in keeping the issue alive. They provided needed technical expertise and facilitated information exchange between their respective professional societies. While most professional physicists working in the nuclear field were not necessarily convinced of the need for regional or multilateral arms control or inspection measures, a dedicated minority took responsibility for influencing public opinion, advising congress, and offering expert knowledge.³⁰

The Argentine–Brazilian nuclear rapprochement, and acceptance of the non-proliferation regime, occurred in the context of political transition to democracy from years of military rule. Certainly the present situation in both nations is much improved over that of an earlier era, when secrecy and hidden agendas, in the name of national security, were the norm. However, in neither country has the legislature yet assumed its required responsibility, relative to the executive branch, in the nuclear policy area. Indeed, modern science and technology present a difficult and complex public policy challenge to the Argentine and Brazilian congresses to devise appropriate and effective mechanisms for oversight and accountability. To this end, the modest, but important role of Argentine and Brazilian scientists in establishing national, regional, and multilateral control over nuclear activities is suggestive of future contributions. In this sense, the role of Argentine and Brazilian scientists is part

of an ongoing process of democratization and improved public policy in modernizing societies.

ENDNOTES

1. See Harold Feiveson, Frank Von Hipel, and David Albright, "How to Break the Fuel/Weapon Connection," *Bulletin of the Atomic Scientists* 42,3 (March 1986): 26-31; Gary T. Gardner, *Nuclear Proliferation: A Primer* (Boulder and London: Lynne Rienner Publishers, 1994).
2. The most commonly used definition of a regime is a set of principles, rules, norms, and decision-making procedures around which actors' expectations converge in a particular area of international relations. See Stephen D. Krasner, "Regimes and the Limits of Realism," in *International Regimes*, ed. Stephen Krasner, (Ithaca: Cornell University Press, 1983), pp. 355-368.
3. On Argentina's change of perspective on the NPT see Julio C. Carasales, "A Surprising About Face: Argentina and the NPT," *Security Dialogue* 27, 3 (1996): 325-336. Brazil announced in June 1997 that it was ready to sign the NPT. After Congressional approval, President Fernando Henrique Cardoso officially signed and ratified it in the presence of the UN Secretary General, Kofi Anan, in July 1998. For reasons on why it took so long for Brazil to join the NPT, see Paulo S. Wrobel, "Brazil and the NPT: Resistance to Change?" *Security Dialogue* 27, 3 (1996): 337-348.
4. For details on this process see John R. Redick, "Nuclear Illusions: Argentina and Brazil," *Occasional Paper* 25 (Washington, DC: The Henry L. Stimson Center, 1995).
5. For a detailed description of the process of nuclear rapprochement between Argentina and Brazil see John R. Redick, Julio C. Carasales, and Paulo S. Wrobel, "Nuclear Rapprochement: Argentina, Brazil, and the Nonproliferation Regime," *The Washington Quarterly* 18, 1 (1995): 107-122.
6. See Lawrence Scheinman, "Strengthened IAEA Safeguards and Special Inspections," *Aurora Paper* 23 (Ottawa: The Canadian Centre for Global Security, 1994).
7. At the regional level, however, both countries were prominent members of the diplomatic negotiations which led to the completion of the Treaty of Tlatelolco in 1967. Brazil was the original proponent of the Latin American nuclear-weapon-free zone, but because of disagreement with some aspects of the final text, and the subsequent behavior of the nuclear weapon states, it chose not to become a full party to the treaty until 1994.
8. The much-publicized information that sectors of the Brazilian armed forces masterminded a plan in the mid-1980s to test a nuclear explosive device remains a controversial topic subject to different interpretations. For a discussion on the evidence available see Redick *et al.*, "Nuclear Rapprochement."
9. See Monica Hirst and Hector Eduardo Bocco, "Cooperação nuclear e integração Brasil-Argentina," *Contexto Internacional* 9 (January-June 1989): 63-78.
10. "Mercosur" is the Spanish acronym for Mercado Comun del Sur or Common Market of the South. In Portuguese, it is known as "Mercosul."
11. For more details see John R. Redick, "Nuclear Confidence-Building in Latin America," *Yearbook on Arms Control and Environment Agreements, 1993* (London: Vertic, 1993) and John R. Redick, "Regional Verification and the Integration of Latin America into the Non-Proliferation Regime," *Yearbook on Arms Control and Environment Agreements 1996* (London: Vertic, 1996).
12. On the Brazilian case see Maria Cecilia Spina Forjaz, "Cientistas e militares no desenvolvimento do CNPq (1950-1985)," *Boletim informativo e bibliográfico em ciências sociais* 28 (1989): 77-99. The Argentine case is described in Carlos Castro Madero and Estaban A. Takacs, *Política nuclear argentina: avance o retroceso?* (Buenos Aires: El Ateneo Editorial, 1991); and Leo M. Falicov, "Physics and Politics in Latin America: A Personal Experience," *Bulletin of the Atomic Scientists* 26, 11(1970): 8-10 and 41-50.

13. For an interesting typology on the relationship between scientists and the state along the lines of a political economy of science, see Etel Solingen, "Between Markets and the State: Scientists in Comparative Perspective," *Comparative Politics* 26, 2 (1993): 31–51 and Solingen's edited volume, *Scientists and the State: Domestic Structures and the International Context* (Ann Arbor: The University of Michigan Press, 1994). For a useful discussion of science in twentieth-century Latin America, see Thomas F. Glick, "Science in Twentieth Century Latin America," in *Ideas and Ideologies in Twentieth Century Latin America*, ed. Leslie Bethell (New York: Cambridge University Press, 1996), pp. 287–359.
14. On details of the impact of 'Atoms for Peace' in Latin America see Marcelo Alonso, "The Impact in Latin America," in *Atoms for Peace: An Analysis After Thirty Years*, ed. Joseph Pilat *et al.*, Boulder: Westview Press, 1985), pp. 83–90.
15. Among the nuclear physicists who were critical of Brazilian conduct in nuclear affairs, José Goldemberg, from the University of São Paulo, stood out. On comparing Argentine and Brazilian technological choices, see José Goldemberg, *Energia nuclear no Brasil: a origem das decisões* (São Paulo: Editora Hucitec, 1978).
16. On an evaluation of Brazil's nuclear policies, including comparison with Argentina, see Paulo S. Wrobel, "A política nuclear brasileira," (manuscript, Ministry of Foreign Relations and University of São Paulo, 1992).
17. This was probably rooted in the nature of their expertise, more philosophical and speculative than other branches of modern science. An additional explanation derives from the fact that physicists in both countries (particularly nuclear physicists) were trained by a generation of physicists exiled from Europe, most of them anti-fascist Germans, Austrians, and Italians. Therefore, it is not surprising that many nuclear physicists were caught in the highly polarized political climate of South America in the 1960s and 1970s.
18. Etel Solingen, *Industrial Policy, Technology, and International Bargaining: Designing Nuclear Industries in Argentina and Brazil* (Stanford: Stanford University Press, 1996).
19. Falicov, "Physics and Politics in Latin America;" Solingen, *Industrial Policy, Technology and International Bargaining*.
20. A controversial analysis of the nuclear and computer industries in Argentina and Brazil may be found in Emanuel Adler, *The Quest for Technological Autonomy in Argentina and Brazil* (Berkeley: University of California Press, 1987). For a recent examination of industrial policies in the nuclear field in both nations, see Solingen, *Industrial Policy, Technology and International Bargaining*.
21. "Declaración Conjunta de la Asociación Física Argentina y de la Sociedade Brasileira de Física," San Carlos de Bariloche e Rio de Janeiro, 22 de Novembre de 1984.
22. Federación Latino-Americana de Sociedades de Física, "Anteproyeto de Resolución," São Paulo, Julho de 1984.
23. The first delegation of scientists from the FAS visited Argentina in March 1984. See Federation of American Scientists, *Public Interest Report* 37, 4 (April 1984).
24. See Federation of American Scientists, *Public Interest Report* 42, 2 (February 1989); and 43, 4 (April 1990). In the early 1990s, the Institute for Science and International Security (ISIS) of Washington, DC continued the work of the Federation with Argentine and Brazilian scientists.
25. The efforts of SBF were not fully successful in that the language adopted in the new constitution required that "all nuclear activity in the national territory will only be admitted for peaceful purposes and upon approval of congress." See comments by David Albright in ISIS, "Argentina and Brazil: The Latin American Rapprochement," *Report of Seminar at Nahel Soreq Nuclear Research Center, Israel* (1996).

26. Interview with former CNEA President, Carlos Castro Madero, by John Redick, 12 October 1989, Montevideo, Uruguay.
27. Conference papers and the rapporteur's summary can be found in Paul L. Leventhal and Sharon Tanzer, eds., *Averting a Latin American Nuclear Arms Race* (London: MacMillan with the Nuclear Control Institute, 1992), p. 1.
28. Coll was a director of planning, coordination and control at CNEA, and Feu Alvim was a professor of physics brought to ABACC by José Goldemberg.
29. The contribution of scientific exchange to nuclear confidence-building between Argentina and Brazil was strongly emphasized by Marco Marzo, Planning and Evacuation Officer of ABACC. Marzo, a nuclear engineer who served for nearly two decades with the CNEN (including as Director of the Safeguards Division), notes how systematic scientific and technical exchanges by nuclear experts in the mid to late 1980s led to cooperative research efforts and, ultimately, to discussions of a mutual inspection regime. See comments of Marco Marzo in ISIS, "Argentina and Brazil: The Latin American Rapprochement," *Report of Seminar at Nahel Soreq Nuclear Research Center*, Israel, 1966, pp. 23–28.
30. Luis Masperi, Former president of the AFA and Professor at the Centro Atomico Bariloche, notes the useful contributions of the physics societies in both nations through their discussions "with presidents and congressmen." The joint meetings of the AFA and SBR, and subsequent declarations calling for Argentine–Brazilian nuclear cooperation, and national and bilateral control mechanisms, were an important part of a broader process (letter of 21 August 1996, from Luis Masperi to John Redick). See also "Argentine and Brazilian Nuclear Development and their Relationship," Forum Award Lecture, APS Meeting, 21 April 1992, Washington, DC, particularly comments by Luis Masperi, Alberto Ridner (AFA), Fernando de Souza Barros, and Luiz Pinguelli Rosa (SBF).