Brazil as Litmus Test: Resende and Restrictions on Uranium Enrichment

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Sharon Squassoni and David Fite

Brazil's Nuclear History

Seven years ago, Brazil joined the nuclear Nonproliferation Treaty (NPT). Standing in the gilded treaty room on the top floor of the U.S. Department of State, then-Foreign Minister Luiz Felipe Lampreia formally deposited the instrument of ratification before Secretary of State Madeleine Albright and a small group of nonproliferation experts.

Calling Lampreia the “Sammy Sosa and Mark McGwire of international diplomacy” for ratifying both the NPT and the Comprehensive Test Ban Treaty, Albright noted that Brazil’s NPT accession would have been unthinkable 15 years earlier.

For Lampreia, his appearance in Foggy Bottom symbolized a 30-year odyssey since serving on Brazil’s 1968 NPT negotiating delegation. To him, Brazil’s ratification of the NPT was a natural consequence of its leadership in the area of disarmament and nonproliferation. In fact, Brazil's diplomatic offensive was truly noteworthy: in three short years, Brazil joined the Missile Technology Control Regime, the Nuclear Suppliers Group (NSG), and the Treaty of Tlatelolco, which establishes a Latin American nuclear-weapon-free zone. Weeks before its ratification of the NPT, Brazil and six other states formed the New Agenda Coalition, which has pushed for concrete steps toward nuclear disarmament.

The choice of Brazilian Ambassador Sérgio de Queiroz Duarte to chair the 2005 NPT Review Conference indicates how far Brazil has come in terms of its nonproliferation credentials. Yet, despite its vastly improved record, Brazil’s commissioning of its new uranium-enrichment centrifuge plant in 2004 prompted international concern.

Brazil’s Resende plant is the first centrifuge facility to have become operational since Pakistani scientist Abdul Qadeer Khan admitted last year that he had provided sensitive enrichment technology and equipment to Iran, Libya, and North Korea. Likewise, the Resende facility came online as Iran’s formerly secret centrifuge enrichment program was unmasked. With these revelations prompting calls for new global restrictions on new enrichment, the plant’s commissioning struck a dissonant chord.

Now, the Resende facility could be a litmus test for how far such restrictions should go. Should Brazil be pushed to abandon the plant, to advance efforts to restrict or even roll back enrichment technology, or should the world welcome Brazil’s status as a significant producer of enriched uranium?

Controversy Over Resende

The Resende site, located about 100 kilometers from Rio de Janeiro, contains an operational fuel-fabrication facility, a uranium-conversion plant under construction, and the uranium-enrichment plant. In 2000, state-owned Indústrias Nucleares Brasil (INB) signed a contract with the Brazilian navy to construct a commercial-scale uranium-enrichment facility using navy-designed centrifuges.[1] The first module, which will contain four cascades, is now considered operational. However, the plant is not expected to be operating at full capacity (four modules) until 2015.[2]
International Atomic Energy Agency (IAEA) safeguards, in the absence of an additional protocol, will not be applied until nuclear material is introduced into the plant.

Negotiations with the IAEA on the safeguards approach for the plant were reportedly tense. Differences centered on whether IAEA inspectors would be allowed full visual access within the cascade hall or if Brazil would be allowed to shroud the equipment. Brazil’s concern reportedly was that it would not have enough time (two hours) to shield the proprietary aspects of the centrifuges from foreign inspectors. Brazil maintains that its unique centrifuge design, based on two magnetic bearings rather than one, offers a significant commercial advantage that must be protected.\[^3\]

A compromise apparently was reached in late 2004 allowing Brazil to shroud access to the bearings in the first module, which includes four cascades, but requiring redesign of the casings for subsequent modules.\[^4\] In the meantime, however, the public controversy gained steam. Rarely does the negotiation of safeguards generate Greenpeace protests, official diplomatic protestations, and mainstream press articles.\[^5\] Yet, by the end of 2004, the international community had become increasingly concerned about the proliferation of centrifuge enrichment technology from the Khan network, particularly in the case of Iran. Brazilian officials were reported to have denied IAEA officials access to the Resende facility on two occasions early in 2004, and the comparisons to Iranian inspection difficulties may have been inevitable.

Brazil’s secrecy raised eyebrows for other reasons as well.\[^6\] Despite assertions by Brazil’s minister of science and technology that the Resende enrichment plant is built from “technology that is 100 percent Brazilian,”\[^7\] there were persistent rumors that Brazil was attempting to hide technology it had gained covertly in the past, possibly the Urenco G-2 design from Germany or another design from Pakistan. Brazil’s reluctance to permit IAEA inspectors visual access to the centrifuge cascade hall also seemed a throwback to pre-NPT days when Argentina and Brazil disparaged IAEA inspections for their intrusiveness. At the time, the countries were trying to hide militarily applicable activities from each other and from the world. As such, Brazil’s hedging seemed to undercut the spirit of its NPT/IAEA commitments, parsing its adherence to the letter of its commitments.

For those already skeptical of the ability of safeguards to protect against diversion of material or against a breakout capability at a centrifuge enrichment plant, Brazil’s secrecy suggested negative intent.\[^8\] During negotiations with the IAEA, some observers estimated that Resende could produce enough highly enriched uranium (HEU) for six bombs per year, a charge Brazil has vigorously denied.\[^9\]

The central role of the Brazilian military in the enrichment program also may have inspired doubts about Brazilian motivations. A significant question is whether Resende will ever produce enriched uranium for the Brazilian navy’s troubled nuclear submarine reactor. Although Brazilian naval officials have noted that advanced ceramic technologies no longer require submarines to use 93 percent or more enriched (i.e., weapons-grade) uranium in their fuel, a facility that produced even 20 percent enriched uranium would require significantly more intrusive inspections, containment, and surveillance. Should the Brazilian navy’s reactor program ever reach fruition, the question of how nuclear material could be withdrawn from safeguards for military, non-explosive purposes would be difficult to resolve.

A related concern is that Brazil, Argentina, and the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) have not signed an additional protocol agreement to their safeguards agreement. Brazilian comments to the effect that any such additional protocol would contain a national security exclusion and managed-access provision similar to those of the United States’ additional protocol may further erode confidence.\[^10\] One Brazilian diplomat told Nuclear Fuel in May 2004 that the expanded measures under the Additional Protocol “were not necessary in the case of a country, such as Brazil, with an open democratic society and a strong record of compliance with its nonproliferation commitments.”\[^11\]

**Safeguarding the Future**

Khan’s sale of uranium centrifuge-enrichment technology and equipment to Iran, Libya, and North Korea has sparked a wide-ranging debate about the health of the nuclear nonproliferation regime. At
the existential level, some observers believe that the NPT is inherently flawed and unworkable because it “allows” non-nuclear-weapon states to acquire nuclear technology that can be used to produce fissile material for nuclear weapons. In their view, this paves the way for states to develop a “breakout” capability: a quick path to the bomb after leaving the NPT.

Thus far, two solutions have been proposed, and both seek to restrict the circle of technology holders to the few and trusted. President George W. Bush suggested in February 2004 that states could voluntarily renounce enrichment and reprocessing and proposed that the NSG make enrichment and reprocessing exports available only to those states that already possessed a “fully operational capability.”[12] For the time being, the Group of Eight (G-8) nations—Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States—agreed in 2004 to a moratorium on enrichment and reprocessing sales, although the NSG has not yet been able to implement a similar decision. The June 2005 NSG plenary merely noted that it would continue to discuss the issue. Nonetheless, the NSG has implemented a de facto ban for several years. Many observers are not optimistic that this approach will succeed.[13] For one, it deepens the divide between NPT haves and have-nots and transgresses on what some states see as their inalienable right to pursue peaceful nuclear technology. For example, Japan has spent more than a decade and $20 billion building a plutonium reprocessing plant at Rokkasho, scheduled to open at the end of this year. Is Tokyo expected simply to abandon this sizable investment without compensation or return? Some have noted that the policy creates a third set of states: those that do not have nuclear weapons but are “trusted” to have sensitive technology.

A second solution is to promote multilateral arrangements for the front and back ends of the fuel cycle: fuel production and fuel disposal. As noted above, IAEA Director-General Mohamed ElBaradei appointed an experts group in June 2004 to consider issues and options for multilateral approaches, and that group reported its findings in February 2005.[14] The experts identified five basic options ranging from reinforcing existing commercial market mechanisms through commercial fuel banks and fuel leasing to multinational or regional fuel-cycle facilities.[15] The IAEA has not yet endorsed or recommended a particular option.

At the practical level, some doubt whether safeguards developed for gas-centrifuge uranium-enrichment plants are adequate to provide assurances of the absence of undeclared activities. The IAEA, which has 20 years’ experience safeguarding gas centrifuge plants, is considering updating the safeguards approach agreed on in the Hexapartite Safeguards Project.[16] Much of that experience comes from IAEA and European Atomic Energy Community (EURATOM) safeguards on gas centrifuge plants in Germany, the Netherlands, and the United Kingdom; safeguarding the Rokkasho-mura and Ningyo-toge enrichment plants in Japan; and, more recently, safeguarding one plant in China. Experiences in applying new technologies and approaches in EURATOM centrifuge plants have not been particularly smooth.[17] Nonetheless, IAEA officials reportedly are confident that the approach devised for Resende is adequate. The plan calls for additional containment and surveillance measures at key points where uranium gas is fed into and withdrawn from the cascades.

**Future of Brazilian Enrichment**

Still, Resende’s commissioning comes at a time when the broader future of Brazil’s nuclear energy complex is in doubt, raising questions about its economic viability. Last year, President Lula da Silva commissioned the National Energy Policy Council to make recommendations on Brazil’s nuclear program. Although a decision was expected in April 2005, there is apparently no consensus among the six ministries involved in the decision. The Ministry of the Environment and the Ministry of Mines and Energy oppose new nuclear power plants, while the Ministry of Science and Technology supports them. This could spell trouble for the Resende enrichment plant because it is widely believed that Resende is not commercially viable without completion of a new power reactor (Angra-3) or without sales of enriched uranium abroad at a time that future global demand for uranium-enrichment services is not certain. INB reported in 2000 that its profitability hinged on completion of Angra-3 and foreign fuel sales.[18] The Angra-3 plant will need about $1.6 billion funding for completion. Some estimates suggest that Brazil will save $10 million to $12 million annually by providing its own fuel for the existing Angra-1 and -2 plants, but this hardly pays for the new reactor.

Brazil’s science and technology minister Eduardo Campos has called the nuclear program “a
strategic issue for Brazil.”[19] Last year, he stated that “we now command the uranium-enrichment cycle…. We know that over the coming 20 years, 25 percent of all the electricity generated worldwide will come from a nuclear source, and Brazil could be one of the few countries supplying the fuel.”

Campos appears to be banking on assessments that Brazil’s centrifuge technology is more efficient than Russian centrifuges, which provide 30 percent of the world demand for enriched uranium, and U.S. and French gaseous-diffusion enrichment, which provide 55 percent of world demand. However, the actual efficiency of the Brazilian plant is unknown given the secrecy surrounding its centrifuge technology. Another complicating factor is how the blend-down of supplies of former Russian weapons HEU affects the market.

Twenty years ago, Brazil had planned to sell low-enriched uranium to Argentina and China. The plan for exports fell through for many reasons, and at present, the uranium Brazil mines and mills is sent abroad for conversion (from raw uranium into uranium hexafluoride) and enrichment and then returned to Brazil for fabrication into fuel for nuclear plants. A pilot-scale uranium hexafluoride conversion plant is under construction in Ipêro, but reportedly there are no plans for a commercial-scale plant. By 2010, Resende is estimated to be able to produce about 60 percent of the fuel needs of Angra-1 and -2. Brazil reportedly does not plan to export LEU until 2015, which fits with the IAEA projections that worldwide enrichment capacity will exceed demand for the next 10 years, but that the next two decades may witness rebuilding and expansion of enrichment capabilities in response to higher world demand for enrichment. Secondary market prices for enrichment services are between 10 percent and 30 percent higher now than they were in the late 1980s.[20]

Recommendations

Brazil and Argentina made remarkable political decisions 15 years ago to stand down from nuclear weapons programs, facilitated by the return of civilian rule to both countries. Nonetheless, prestige still appears to be a prime motivation for continued development of their nuclear fuel cycles. Recently, Argentine officials stated they would not allow proposals to restrict enrichment and reprocessing to technology holders to go forward, presumably because they may not want to be left in Brazil’s shadow without their own enrichment capability.

Brazil has been a vocal proponent of disarmament for many years, but its rhetoric rang hollow until the last decade when it finally embraced the nonproliferation system. Hastily conceived proposals to limit fuel cycle capabilities have breathed fresh life into Brazil’s old criticisms that the international nonproliferation regime is designed to protect the civil and military nuclear advantages of the developed nations rather than to achieve true nonproliferation and disarmament. The North made the game; it cannot change the rules after the South finally decides to play.

Brazil’s insistence on the right to a peaceful nuclear infrastructure is entirely consistent with its historic belief that advanced developed nations are recognized by their advanced, civil nuclear capabilities. Indeed, Brazil’s accession to the NPT was predicated on three assumptions. First, Brazil would not assume any more safeguards obligations or restrictions than it had already agreed to under the Treaty of Tlatelolco and the Quadripartite Safeguards Agreement. Second, Brazil would be guaranteed the right under the NPT to develop peaceful nuclear energy. Finally, Brazil would therefore be able to retain and expand its nuclear infrastructure, which has consumed so much financial and political capital over the years. Abandoning Resende now is not the nonproliferation bargain Brazil struck.

Although Brazilian officials acknowledge that new approaches may be needed to provide greater confidence in the nuclear nonproliferation regime, particularly where centrifuge enrichment is concerned, they see no reason they should be singled out as a test case. According to Brazilian Ambassador José Maurício Bustani, it is “unacceptable to compare Brazil with countries which have recently admitted to secret or undeclared nuclear activities.”[21] In other words, Brazil is not Iran. Brazil, despite its admission of “secret or undeclared activities” 15 years ago, was not then a member of the NPT, nor had it ratified the Treaty of Tlatelolco. Although some early statements by the president and by his science and technology minister raised questions about the depth of Brazil’s commitment to the NPT, there is today no evidence or reason, especially given the end of the
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military competition with Buenos Aires, to question Brazil’s basic commitment to remaining a non-
nuclear-weapon state.

Persuading Brazil to abandon the Resende enrichment plant would require significant incentives by
the United States and others. These could include cooperation with the Brazilian navy on naval
reactors (perhaps provision of HEU for fuel or HEU fuel or fuel development technology for lower
enrichment levels), fuel contracts for INB, and possibly further aid to help complete Angra-3.
Brazilian leadership in a new regional, multinational fuel-cycle center (front or back end) could be
necessary, or Resende could be put under international control, perhaps as an expansion of Brazilian-
Argentine cooperation. On the political level, support for Brazilian permanent membership on the UN
Security Council could sweeten the deal. Creation of a national strategic partnership between the
United States and Brazil, along the lines of the global partnership technology cooperation agreement
with India, announced in July 2005, could address the need for prestige.

However, it may also take more than additional inducements to persuade Brasilia to abandon
Resende, especially because the latter is increasingly perceived as Brazil’s bid to play on a global
technological stage as a supplier of nuclear fuel, competitive with the technologically most-advanced
nations. If Brazil, as a member of the NPT in good standing, is going to be asked to sacrifice prestige
and investment in a new enrichment plant, then so too, perhaps, should others. The United States
could offer to cancel its two planned enrichment facilities and enter into a joint ownership
arrangement with Brazil at the Resende plant. This presumes that Brazil’s technology is efficient,
although likely not on par with U.S. or Urenco centrifuge technology. Regional solutions would need
to consider the role of Argentina.

U.S. official statements support Brazil’s enrichment capability, based on Brazil’s record both in
nonproliferation and democracy. These two criteria were also used to justify a July 18 U.S. proposal
to engage in nuclear cooperation with India. This proposal, which overturns 30 years of U.S.
nonproliferation policy requiring a state to have full-scope safeguards to receive significant nuclear
supply, could dampen international enthusiasm for restricting the fuel cycle. The United States is
unlikely to provide assistance in either enrichment or reprocessing to India, but the offer, which must
be approved by Congress, threatens to undermine the basic NPT bargain: forswear nuclear weapons
in exchange for peaceful nuclear cooperation.

Will NSG states, which have required full-scope safeguards as a condition of nuclear supply since
1995, now support U.S. proposals to restrict technology even among NSG members, while the U.S.
extends its cooperation to a state outside the NPT and the NSG?

Weakened international resolve to further restrict technologies like enrichment and reprocessing
could very well be a by-product of a target nonproliferation policy that attempts to ban the
possession of fissile material in certain states such as Iran, Iraq, and North Korea. And while Brazil
and U.S.-Brazilian relations may benefit from such a development, so too might Iran and North
Korea. Further retreat from global nonproliferation norms runs the risk of creating loopholes that
other states might all too readily exploit.

Brazil's Nuclear History

Sharon Squassoni and David Fite

Over the last 60 years, political and military rivalry with Argentina colored Brazilian politics
and national identity. In the nuclear arena, mastery of all applications of the atom was
equated with political mastery of the Southern Cone and beyond.

In August 2005, former Brazilian President José Sarney confirmed that more than two
decades ago the Brazilian military had sought to develop nuclear weapons to counter
political and military competition from Argentina. More surprisingly, a former president of
the Brazilian atomic energy agency recently claimed that the military allegedly continued to
develop a nuclear bomb after the program had been terminated by Brazilian President Fernando Collor de Mello. He said the military had even obtained sufficient enriched uranium from an unspecified source, a claim vehemently denied by the current Brazilian government.[1]

Brazilian scientists began experimenting with nuclear fission in the 1930s, but efforts began in earnest after Argentina’s president, Juan Perón, made the stunning and false claim in 1951 that his country’s scientists had mastered thermonuclear fusion in the laboratory.[2] In response, Brazil created a nuclear research program under Conselho Nacional de Pesquisas (CNP), its national research council.

Two years later, a CNP agent secretly persuaded several West German scientists to manufacture several centrifuge machines clandestinely, an operation reminiscent of the Abdul Qadeer Khan nuclear black-market network. Delivery of those centrifuges was thwarted by British occupation authorities acting in concert with the United States.[3] However, some sources report that Brazil acquired three German centrifuges in the 1950s.[4]

Brazil also reportedly sought but did not obtain uranium gaseous-diffusion assistance from the French.

Like Iran today, Brazil had an ambitious vision for developing nuclear energy. A 1955 nuclear cooperation agreement with the United States under the Atoms for Peace Program facilitated the purchase of several research reactors. In 1971, Brazil obtained its first power reactor, the 626-megawatt Angra-1, from Westinghouse, which began commercial operation in 1985.[5]

It was a 1975 agreement with West Germany for a complete nuclear fuel cycle, however, that stunned the world. The West German deal included two power reactors and plans for six more, as well as plants for uranium processing, conversion, enrichment, and reprocessing. Brazil’s determination to obtain a complete nuclear fuel cycle quickly can be traced to the oil shocks of 1973, military and technological competition for prestige with Argentina, and the Nixon administration’s announcement that it would soon shut the order books for future supply contracts for enriched fuel.

The West German deal, however, provoked a strong negative U.S. reaction, particularly in the wake of India’s 1974 “peaceful” nuclear test. Although the United States was unable to prevent the deal entirely, it persuaded West Germany to require bilateral safeguards on the technology it transferred. By 1978 the U.S. Congress passed the Nuclear Nonproliferation Act, which made full-scope safeguards a prerequisite for significant nuclear transfers, thus closing off U.S. supply.[6]

In the end, the Brazilian-West German deal produced modest results compared to its original scope. Construction of Angra-2 and -3 fell monstrously behind schedule and overbudget. The German “Becker jet-nozzle” enrichment technology, experimental at best, proved unworkable in practice; and a pilot cascade at Resende was ultimately shut down before uranium was enriched. Only Angra-2 was completed, which began operating in 2000. By 2002, nuclear power provided just 4 percent of Brazil’s total electricity production.[7]

**Brazil’s Parallel Program**

Brazil’s increasing dependence on foreign equipment and material and the restrictions of international safeguards attached to the German transfers, as well as the suspicion that the jet-nozzle process would enrich little but German pockets, worried and frustrated the military leadership.[8]

In 1979 the military government created a secret and autonomous parallel program to develop the nuclear fuel cycle outside of international safeguards. Under the stewardship of Coordenadoria de Projetos Especiais (COPESP), the Brazilian navy’s special projects
commission, the program initially focused on developing a small light-water reactor for submarine propulsion and an indigenous uranium-enrichment capability using centrifuges.

Soon, however, all three services had active nuclear research programs, including the Brazilian army’s large graphite-moderate reactor, which would have been well suited for production of weapons-grade plutonium, while the Brazilian air force investigated laser enrichment and breeder reactors. By 1982, Brazil had managed lab-scale enrichment. COPESP began construction of a pilot enrichment plant at Aramar in Ipere in 1987. At the inauguration of the plant, authorities said the facility would produce low-enriched uranium (5 percent enrichment) for existing power and research reactors and for nuclear submarine reactors.[9]

In 1989 they announced that the first module of the plant had produced small amounts of 20 percent U-235.

In From the Cold

With the return of civilian government in 1985, Brazil took significant steps to increase transparency in the activities of the parallel program and ultimately to terminate it. In 1988 the Brazilian Congress approved a new constitution, which mandated that all nuclear activities were to be conducted for peaceful purposes only. For example, in 1988 the Sarney government arranged for Argentine President Raúl Alfonsín to tour the sensitive Aramar pilot-scale enrichment facility, building on earlier efforts with Argentina to foster mutual nuclear cooperation and transparency. In September 1990, Collor dramatically exposed and closed a secretly prepared nuclear test site at an air force base in the Cachimbo Province in north-central Brazil, shoveling dirt into the test shaft. Under Collor, the parallel program lost its privileged funding status. The air force laser enrichment and the army’s graphite reactor programs became quick casualties of the government’s new spending priorities and then were terminated altogether.

In 1991, Brazil and Argentina signed a bilateral agreement in Guadalajara to use nuclear energy for peaceful uses only. Since then, full-scope safeguards have been applied in both countries by the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and the International Atomic Energy Agency (IAEA) under the Quadripartite Safeguards Agreement.[10] Brazil and Argentina sought to model ABACC after the European Atomic Energy Community, particularly with respect to its relationship with IAEA inspections.

A key question was how to trade off the desire to avoid unnecessary duplication with the IAEA’s need to retain its ability to draw independent conclusions based on independent measurements and observations. The tension in this trade-off is evident in discussions of safeguards approaches for the Resende plant.

Sharon Squassoni is a specialist in national defense with the Congressional Research Service and David Fite is a member of the Democratic professional staff for the House International Relations Committee. The views expressed in this article are the personal opinions of the authors only and do not necessarily reflect the positions of the Congressional Research Service or the House International Relations Committee.

ENDNOTES


3. Ibid. Three years later, several centrifuges were shipped to a research facility in Sao Paulo to be reverse-engineered. Jean Krasno, “Non-Proliferation: Brazil’s Secret Nuclear Program” ORBIS, Summer 1994.

5. Angra-1 has been, at best, an inconsistent producer of electricity, so much so it was dubbed “the Firefly” by environmentalists for its propensity to go offline.

6. Argentine officials stated that the 1978 Nuclear Nonproliferation Act (NNPA) contributed to Argentina’s decision to build the Pilcaniyeu gaseous-diffusion uranium-enrichment plant, which was completed in 1983. The NNPA (See Sec. 128 of the Atomic Energy Act) prevents the United States from exporting source or special nuclear material, production or utilization facilities, or any sensitive nuclear technology to states without International Atomic Energy Agency (IAEA) safeguards on all nuclear material used in peaceful nuclear activities.

7. Most of Brazil’s electricity is provided by hydropower. A drought in 2000 and 2001 caused shortages of electricity, leading some to urge the development of more nuclear power.


10. Argentina and Brazil signed a bilateral agreement in Guadalajara in July 1991 that established the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC). Argentina, Brazil, ABACC, and the IAEA then signed the Quadripartite Safeguards Agreement later that year, which entered into force in March 1994. See IAEA, INFCIRC/435, March 1994.

ENDNOTES

1. INB is the state-owned company that provides all fuel services to Brazil’s nuclear power reactors.

2. The plant began introducing uranium hexafluoride for testing in February 2005; the testing phase was expected to last six months. Only the first cascade of the first module has been commissioned; the second cascade is under construction. Resende will produce enough low-enriched uranium (LEU) for one 1,000-megawatt reactor annually. Thus, its annual production is about half the fuel loads of Angra-1 and -2.

3. Some critics dispute this, stating that Urenco experimented with such an approach and discarded it because it was not efficient. Mark Hibbs, “Bearing Design Prompted Brazil to Withhold Centrifuge Data From IAEA,” *Nuclear Fuel*, December 6, 2004, p. 1. The IAEA director-general’s experts group on multinational approaches noted the sensitivity of technology in centrifuge enrichment plants. Ibid., p. 53.


8. Critics of the safeguards system devised by the Hexapartite Safeguards Project note that the IAEA does not verify the individual separation capability of centrifuges, enabling operators to understate
the throughput of the plant and use excess capacity to produce undeclared LEU.


11. Ibid.


16. The Hexapartite Safeguards Project was initiated to establish a system of safeguards for centrifuge enrichment plants. Participants included Australia, Germany, Japan, the Netherlands, the United Kingdom, the United States, the European Atomic Energy Community (EURATOM), and the International Atomic Energy Agency (IAEA). Under the system, enrichment facilities with a stated enrichment of 5 percent or less require inspections inside and outside the cascade. Inside the cascade, the Limited Frequency Unannounced Access inspections are designed to detect enrichment levels higher than stated amounts. See IAEA, INFCIRC/640, February 22, 2005, p. 53.

17. Bruno Pellaud, “A Look at Nuclear Diplomatic Hardball,” Nuclear Fuel, May 19, 1997. European legislators leaked a copy of a memorandum Pellaud prepared when he was the deputy director-general for safeguards at the IAEA on his negotiations with the EURATOM safeguards directorate. It details, among other things, difficulties encountered by the IAEA in attempting to use new kinds of verification technologies at Urenco enrichment facilities.


20. IAEA, INFCIRC/640, p. 49.


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