



PROSPECTS FOR SAFE- GUARDING BRAZIL'S NAVAL NUCLEAR PROPULSION PROGRAM

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Cover Photo: USS *Alexandria* is alongside the Brazilian submarine BNS *Tikuna* during a formation sailing event while participating in the War of 1812 fleet exercise.
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EXECUTIVE SUMMARY

The emergence of a new class of “nuclear submarine states” would tend to blur both the psychological and military distinction between nuclear weapons states (NWS) and non-nuclear weapons states (NNWS) created by the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). As in the case of nuclear weapons proliferation, the degree of opposition to such a development on the part of particular NWS depends on the identity of the state.¹

If Brazil ever achieves its goal of commissioning a nuclear-powered submarine (SSN), it will be the first non-nuclear weapons state to do so. Unsurprisingly, existing discussions in the scholarly and policy communities over the safeguard practices that should apply are intertwined with much broader issues of proliferation and counter-proliferation. This issue brief contrasts emerging debate about safeguarding SSNs with the existing realities on the ground in Brazil.

THE EMERGING DEBATE

The last few years have seen a renewed wave of writing in the scholarly and policy communities about the future prospects for the global spread of naval nuclear technology and how best to safeguard them, and the various implications of these new dynamics for the global nuclear nonproliferation and disarmament regime. These publications normally take Brazil to be a core test case. However, the issue is bounded with broader concerns in the global nonproliferation community that an increase in the number of states that possess nuclear-powered submarines may have negative implications for proliferation worldwide.²

A cursory glance at this literature reveals three recurring assumptions on the status and trajectory of Brazil’s nuclear propulsion program, and its potential implications for future safeguards procedures. First of all, there is a sense that the availability of naval nuclear knowledge in Brazil will put pressure on the dyke that has held countries from acquiring nuclear propulsion technologies. According to this view, a Brazilian SSN is likely to inspire, prompt, or energize other nuclear aspirants to follow suit. A chief recurring concern among experts is that many countries – though not necessarily Brazil – will use nuclear propulsion as an excuse to acquire highly-enriched uranium (HEU) that might be used in purposes other than naval propulsion. As a result, they conclude, as Greg Thielmann and Serena Kelleher-Ver-

1 Marvin Miller, “Nuclear Submarines and their Implications for Weapons Proliferation,” in Paul Leventhal (ed.) *Averting a Nuclear Arms Race in Latin America* (1992), p. 163.

2 Greg Thielmann and Serena Kelleher-Vergantini, “The Naval Nuclear Reactor Threat to the NPT,” *Threat Assessment Brief*, The Arms Control Association, 24 July 2013; Sébastien Philippe, “Safeguarding the Military Naval Nuclear Fuel Cycle,” *Journal of Nuclear Materials Management*, XLII, No. 3, Spring 2014; and Naomi Egel, Bethany L. Goldblum and Erika Suzuki, “A Novel Framework for Safeguarding Naval Nuclear Material,” *The Nonproliferation Review*, 22:2, 239-251, 2016; Nick Ritchie, “The UK Naval Nuclear Propulsion Programme and Highly Enriched Uranium,” Federation of American Scientists, mimeo, February 2015; Eugenio Diniz, “Brazil’s Nuclear Submarine: A Broader Approach to the Safeguards Issue,” *Revista Brasileira de Política Internacional* (forthcoming, 2017); Layla Dawood, Monica Herz and Victor Coutinho Lage, “A Nuclear Submarine in the South Atlantic: The Framing of Threats and Deterrence,” *Contexto Internacional*, vol.39 no.2 Rio de Janeiro, May/August 2017.

gantini put it, “Brazil’s pursuit of nuclear submarines makes it easier for other states to use a similar justification for enriching uranium to levels of 20 percent or higher.” They conclude that “Brazil would do itself and the rest of the world a favor by abandoning the nuclear part of its ambitious submarine program.”³

The second assumption running through existing interpretations is that a Brazilian SSN is imminent. Consider the following language, “Brazil will **soon** be the first NNWS to deploy a nuclear submarine... [It is] **on the way** to becoming the first NNWS to deploy military naval nuclear propulsion.”⁴ Or consider, “Brazil is **likely to be** the first NNWS with an operational nuclear naval program.”⁵ (Editor’s note: Bold text is added by the author for emphasis.) What follows from this is the notion that the international community is pressed for time, and it should better speed up the process of formalizing new naval nuclear safeguard rules before other nations follow in Brazil’s steps.

Finally, there seems to be consensus in much of the commentary that Brazil’s future SSN creates renewed demand for action to tighten up the loose ends of the IAEA’s legal framework for monitoring naval nuclear reactor programs in non-nuclear weapons states. If nonproliferation policy is going to work, then the international community should consider a more vigorous set of counter-proliferation instruments to cope with the current decline in the existing barriers to naval nuclear capabilities.⁶ The most ambitious version of this argument advocates that the Brazilian case should be treated as an opportunity to develop a universal safeguards agreement modeled after the Additional Protocol to the IAEA safeguards agreement. This would require the IAEA to extend its safeguards activities into a military environment, opening a complex set of negotiations over the precise terms of the arrangements to be defined between Brazil and the IAEA.⁷

Whether Brazil starts formal nuclear naval safeguard negotiations with the International Atomic Energy Agency (IAEA) in the near future remains to be seen. In the section below I offer an assessment of the assumptions above in face of the recent evolution of the Brazilian nuclear-propelled submarine program.

REALITIES ON THE GROUND

CONTAGION EFFECTS

The notion that Brazil’s SSN should be seen as the spark that lights the powder keg of naval nuclear technology proliferation needs to be taken with a pinch of salt. If Brazil’s attempt at building its own SSN offers any message to other NNWS which might be considering this

3 Thielmann and Serena Kelleher-Vergantini (2013).

4 Philippe (2014), p. 40 and 49.

5 Egel, Goldblum and Suzuki (2016).

6 Philippe (2014) and Naomi Egel, Bethany L. Goldblum and Erika Suzuki (2016).

7 For an overview of the legal implications of nuclear naval propulsion for Brazil, see Laura Rockwood, “Naval Nuclear Propulsion and IAEA Safeguards,” Federation of American Scientists, mimeo, May 29, 2017.

option, it is a story of major technical challenges, massive financial long-term commitments, and high levels of uncertainty; good results are not guaranteed. Furthermore, the slow development of naval nuclear technology in Brazil is unlikely to spread to other nuclear propulsion aspirants. In fact, if past behavior is any predictor of the future then Brazil is likely to remain as committed to protecting sensitive proprietary information regarding its SSN as it has been protective of its centrifuge technology in the past.

Also, it is worth noting that Brazilian authorities have thus far been sensitive to the proliferation concerns regarding its submarine project and have acted upon them. With a view to minimize proliferation risks and curb fears that naval nuclear reactor fuel could be used as a smokescreen for the unmonitored accumulation of fissile material in the future, they have (a) at various points signaled they would be using a low enriched uranium (LEU) once-through submarine fuel cycle and (b) committed to placing its naval reactor fuel under safeguards, as mandated by Brazil's bilateral safeguards scheme with Argentina under the Brazilian-Argentine Agency for Nuclear Accounting and Control (ABACC). To be sure, the commitment to a LEU submarine is unilateral and can therefore be abandoned or reversed. However, Brazilian politicians and nuclear submarine project managers are well aware of the need to build up a reputation of "responsible stakeholders" as the program moves forward, even if the substance of what that reputation may entail in practice remains open to domestic contestation.

IMMINENCE

There is no evidence to support the belief that a Brazilian SSN is imminent. Brazil set up its first nuclear propulsion plans 40 years ago, and the pace of progress has been both slow and uneven. While it is true that plans did progress at relative speed in the 2000s,⁸ it is also true that, starting in 2014, the program received major blows that are likely to retard existing schedules. Economic recession exposed the fiscal frailty of the Brazilian state, and steep cuts dried budgets across the board, casting a long shadow over the future viability of the program. In the process, the submarine program lost qualified personnel, and anecdotal evidence suggests that scarce human resources remains a major hurdle.

The official date for completion has been postponed several times (at the moment it is 2027). To complicate things further, in 2017 a major corruption scandal broke involving allegations that government officials involved in the program had colluded with construction companies to generate kickbacks worth some 70 million euros. While it is too early to assess long-term damage because investigations are still unfolding, it is not inconceivable that legal challenges against core parts of the program will emerge in coming years, further delaying progress and

8 For instance, engineers manufactured a reactor pressure vessel for installation in a land-based submarine reactor prototype (2005); politicians set up a formal body to run the submarine project (General Coordination Program for the Development of a Nuclear-Powered Submarine) with a projected annual budget of \$250 million (2008); France agreed to provide the non-nuclear components to the SSN through a joint venture between Brazil's Odebrecht and France's DCNS (2008); budgets and contracts were allocated to Odebrecht to build a shipyard and naval base at an estimated cost of \$300 million (2008).

tarnishing the entire submarine enterprise in the court of public opinion.⁹ The scandal may also generate new demands for project transparency, financial accountability, and nuclear safety and security that may retard progress further. As of this writing, it remains to be seen how much of a priority naval propulsion will be for the Brazilian administration taking office in January 2019.

Technical difficulties remain a major obstacle to progress, too. Even if Brazilian officials have signaled they will power their submarine with LEU, it remains unclear what degree of enrichment will be adopted precisely in a reactor core that will be composed of several fuel elements. Former president of Brazil's National Nuclear Energy Commission, Odair Gonçalves, and others point to 18 to 19 percent.¹⁰ Others have suggested that Brazil will follow the French model by using less than 10 percent U-235.¹¹

Progress in defining the precise level of enrichment has been slow because of technical difficulties. Brazil built a land-based prototype for the first reactor core on the back of existing knowledge (UO₂ rods with uranium enriched to 5.48 percent). Such a model, however, is too weak to be used in a submarine, which requires fuel that can withstand battle shocks and other extreme conditions deep underwater.¹² Brazilian nuclear scientists have also explored alternative caramel and cermet models, but developing fuel in plates remains a major technological hurdle. (While the French nuclear navy uses a caramel model fuel design, France has only been assisting Brazil with the non-nuclear components of the nuclear submarine program, and it is very unlikely that France will provide help with the Brazilian nuclear fuel design and manufacture.) According to an official privy to current developments, Brazil still lacks mastery of the necessary welding techniques and whatever progress has been made thus far is uneven, given the loss of expertise within the program in recent years.

High costs, declining budgets, corruption allegations, and technical difficulties are likely to delay existing plans yet again. This is not to say that the IAEA should sit and wait to negotiate an agreement until Brazil decides to remove nuclear material from safeguards for its nuclear submarine. However, it does mean that in the absence of urgency there is an opportunity for all stakeholders to engage in thoughtful dialogue about how best to craft the legal and political foundations for a safeguard agreement with Brazil that might in the future inform negotiations with other NNWS that opt to build their own SSNs.

9 For a search mechanism covering all official documents and plea-bargains in the hand of the Office of the Prosecutor (in Portuguese), <https://jota.info/justica/jota-lanca-buscador-para-todos-os-processos-da-lava-jato-12042017>.

10 Interview with Odair Gonçalves, *Arms Control Today*, September 28, 2005; William Huntington, "Brazilian Regulator Denies Uranium Claims," *Arms Control Today*, November 2005, 37; William Freebairn, "Brazil Advances Nuclear Power and Fuel Cycle Programs, report Says," March 27, 2014, *Nucleonics Week*; Togzhan Kassenova, "Nuclear Kaleidoscope" (Carnegie Endowment for International Peace, 2014).

11 "Ata da 2a Reunião Ordinária da CRE do Senado Federal," February 13, 2013.

12 Leonam dos Santos Guimarães, PowerPoint Presentation CEBRI-IPFM (2014).

SAFEGUARDS AGREEMENT

Brazilian officials have stated that they will negotiate some kind of safeguards agreement for its SSN. It is plausible to expect that such an agreement will be negotiated with Argentina under the Brazilian-Argentine Agency for Nuclear Accounting and Control and then between ABACC and the IAEA. While the precise timing and contours of that agreement remain unknown, any such bargain will occur on the basis of Brazil's prior experience and existing practices. In the process, the international community should take the following themes into account:

1. Safeguard negotiations over the Brazilian SSN will have to reconcile two different norms. On one hand, comprehensive safeguards agreements between the Agency and NNWS party to the NPT follow a mechanism to accommodate the use of nuclear material in a non-proscribed military nuclear activity such as nuclear propulsion in naval submarines as specified in Paragraph 14 of INFICIRC/153 ("Non-Application of Safeguards to Nuclear Material to be used in Non-Peaceful Nuclear Activities"). On the other, Brazil is party alongside ABACC to a comprehensive safeguards agreement with the IAEA that is reproduced in IAEA document INFCIRC/435. Differences in these provisions are significant enough to ensure tough negotiations over issues, such as access to military facilities, the point of withdrawal of nuclear materials from safeguards, the provision of information about quantities and composition of nuclear materials, the re-application of safeguards to previously withdrawn nuclear material, the scope of Board of Governor's involvement in the safeguards arrangement between Brazil and the IAEA, etc. Whatever the technical details of such negotiation might be, this is likely to be a politically charged process.
2. The IAEA is likely to demand that nuclear fuel for the SSN is checked before it is loaded into the submarine reactor, ensure the reactor is sealed, and secure authorization to verify such seals each time the submarine enters port and/or is refueled. Brazil is likely to negotiate the terms of the agreement informed by a sense of political-diplomatic bargaining rather than a merely technical approach to greater transparency and accountability. This is likely to make for a difficult (and possibly protracted) negotiation. Brazil will seek to politicize the terms of the negotiation, given its grudges about the state of the global nonproliferation and disarmament regime. It is likely to condition concessions to some progress by the NWS on their disarmament commitments. In doing so, Brazil will voice NNWS disappointment with the pace of disarmament and it will denounce the disproportionality of verification obligations vis-à-vis those of the nuclear-armed states – hence the importance of progress through "quid pro quo" policies that could work as confidence-building measures.
3. None of this is to say that issues of transparency and accountability will not be central in the minds of Brazilian officials. Especially as the current drama involving corruption allegations in the nuclear program unfolds, Brazilian program managers and their political bosses are likely to face some degree of pressure from domestic constituencies as well. While it is too early to say that current troubles in the Brazilian nuclear program are going to open room for greater levels of civilian democratic controls, what we are currently seeing might shift the terms of the debate at home, giving voice to

stakeholders that had previously been mute. For the first time, for instance, high-ranking officials now privately discuss the possibility of Brazil signing on to an Additional Protocol to its existing safeguards agreement with the IAEA as a measure to restore the standing of the submarine program. This was inconceivable only a couple of years ago.

4. Brazil will engage in safeguard negotiations with the Agency alongside Argentina, its partner in ABACC. Within this, Argentina is unlikely to overtly push Brazil towards maximum concessions in the context of any negotiation. In the past, Argentina has defended the notion that nuclear propulsion is not incompatible with a nuclear program exclusively directed to peaceful ends and the principle that military nuclear propulsion does not contribute to the proliferation of nuclear arms.¹³ Like Brazil, Argentina is a staunch defender of the notion that nuclear propulsion for military vessels should be seen as peaceful use of nuclear energy. As it joins Brazil in its negotiations with the Agency, Argentina is likely to see the emerging results as a potential future constraint on its own naval propulsion ambitions. This said, Argentina is likely to privately nudge Brazil towards a negotiated solution. Also, Argentina may well take advantage of global concerns over a Brazilian SSN to insist that Brazil reconsider its current position on the Additional Protocol (Argentina has been acting to this effect since last year).
5. A chief concern for Brazil will be to develop a safeguard agreement that will not reveal sensitive military or proprietary information concerning the design and operation of submarine reactors or allowing international inspectors on board SSN to verify such information. It is uncertain how much information Brazil will withhold about the reactor fuel cycle, or whether inspectors will be able to use material balance accounting to give ex post facto assurance of non-diversion. What seems clear at this stage is that, as Brazil enters negotiations over nuclear naval safeguards, there will be an opportunity for widening the scope of ABACC's responsibilities. How far the institution can go will always depend on Argentina and Brazil, but the issue of safeguards for the Brazilian SSN may open political space to think through what ABACC should look like in the next decades of its existence.
6. Final decisions on where to enrich fuel for the nuclear submarine have yet to be made. Of course, the concern is that Brazil could build uranium enrichment and fuel fabrication plants for the production of nuclear submarine fuel and claim that such plants need not be subject to IAEA safeguards since they are dedicated to non-explosive military use. To make such claims Brazil would have to violate its existing commitments under ABACC, where it undertakes to accept safeguards on all nuclear material in all nuclear activities. Today Brazil houses nuclear fuel cycle-related facilities at the Aramar Experimental Center under Navy control, where it enriches uranium up to 5 percent. This facility is safeguarded under the ABACC/IAEA agreement, and any decision to enrich uranium at a higher level there would have to be approved by both bodies under a special safeguards arrangement. The Brazilian Navy also leases its uranium enrichment

13 For an early statement, see Vice Admiral Carlos Castro Madero, p. 165, in *Averting a Latin American Nuclear Arms Race*.

technology to a state-owned company overseeing the civilian nuclear fuel cycle – Brazilian Nuclear Industries (Indústrias Nucleares do Brasil) – for use at the Nuclear Fuel Factory at Resende (also under safeguards). Enriching uranium for the SSN cannot in principle be done at Resende, given existing safeguards on German-originated equipment. Also, Resende’s license allows for enrichment up to 5 percent only and changing the regulations would require applying for relicensing. Global concern over the location of Brazil’s fuel facility for the SSN should be tempered by the fact that the country has thus far placed its one military facility (Aramar) under safeguards. It has also made verbal commitments to placing its nuclear naval reactor fuel under safeguards (though it has never stated how and when in the fuel cycle), and there is no evidence to date that it will reconsider this policy moving forward.

LESSONS FROM THE PAST

In recent years, Brazil has refused to sign an Additional Protocol to its IAEA safeguards agreement, has gone as far as preemptively rejecting negotiations over such an agreement in its national defense strategy, and has tied possible accession to the Additional Protocol to NWS making significant progress on their disarmament pledges under the NPT. Moreover, Brazil never came clean from the years of its unsafeguarded uranium-enrichment program from the 1970s and 1990s (no list of facilities was ever published), and its move towards compliance with international norms has been slow. Top-echelon politicians and officials have questioned the legitimacy of the NPT, and some have issued utterances to the effect that Brazil should have never become a treaty member. Some have even argued that Brazil should master the technology to develop a nuclear explosive.

For all those reasons, many nonproliferation experts have questioned Brazil’s identity as a “responsible stakeholder” in the global nuclear order. Even if Brazilian authorities in the past 30 years have made a constitutional commitment to the exclusive use of nuclear energy for peaceful purposes and have tied themselves to multilateral nonproliferation commitments like the NPT, Quadripartite Agreement, ABACC, Treaty of Tlatelolco, Nuclear Suppliers Group, and Comprehensive Test Ban Treaty, suspicions remain. In international scholarly circles, for instance, Brazil is commonly codified as a “roll back state” – a country that set out to develop nuclear weapons but for some reason decided to stop and walk back – even if the existing evidence suggests Brazil did explore the nuclear weapons option but never set up a nuclear-weapons program.¹⁴

Such a state of affairs suggests that any negotiations over nuclear submarine safeguards will be bound up with issues that go well beyond the actual submarine and its nuclear fuel. But if the past is any guide, it may be worth remembering that Brazil has always resisted nuclear diplomacy demands that smacked of imposition. And, by the same token, it has always accommodated demands for more commitments when these were presented as part of a wider bargain, where tit for tat was a core component of the talks. Any approach that fails to acknowledge this complicated past is unlikely to fly very high.

14 Matias Spektor, “Is Brazil a Case of Nuclear Rollback?,” working paper, 2017.

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