



Calhoun: The NPS Institutional Archive
DSpace Repository

Theses and Dissertations

1. Thesis and Dissertation Collection, all items

2014-09

Iran: the next nuclear threshold state?

Maurer, Christopher L.

Monterey, California: Naval Postgraduate School

<http://hdl.handle.net/10945/43952>

Downloaded from NPS Archive: Calhoun



Calhoun is a project of the Dudley Knox Library at NPS, furthering the precepts and goals of open government and government transparency. All information contained herein has been approved for release by the NPS Public Affairs Officer.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

<http://www.nps.edu/library>



**NAVAL
POSTGRADUATE
SCHOOL**

MONTEREY, CALIFORNIA

THESIS

IRAN: THE NEXT NUCLEAR THRESHOLD STATE?

by

Christopher L. Maurer

September 2014

Thesis Advisor:

James Russell

Second Reader:

James Clay Moltz

Approved for public release; distribution is unlimited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE September 2014	3. REPORT TYPE AND DATES COVERED Master's Thesis	
4. TITLE AND SUBTITLE IRAN: THE NEXT NUCLEAR THRESHOLD STATE?		5. FUNDING NUMBERS	
6. AUTHOR(S) Christopher L. Maurer		8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB protocol number ____N/A____.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		12b. DISTRIBUTION CODE A	
13. ABSTRACT (maximum 200 words) A nuclear threshold state is one that could quickly operationalize its "peaceful" nuclear program into one capable of producing a nuclear weapon. This thesis compares two known threshold states, Japan and Brazil, with Iran to determine if the Islamic Republic could also be labeled a threshold state. Furthermore, it highlights the implications such a status could have on U.S. nonproliferation policy. Although Iran's nuclear program is mired in controversy, it relates to those of Japan and Brazil. While not maintaining as robust of a program and often conflicting with the international community, Iran has the capabilities to produce weapons grade material and could be considered a nuclear threshold state. Dozens of countries in the world have similar nuclear capabilities and maintain the Nuclear Non-Proliferation Treaty rights to advance their nuclear programs so long as they are peacefully applied. Unfortunately for nonproliferation advocates, these capabilities make fuel for both energy and weapons. To prevent proliferation and eliminate the world's nuclear weapons arsenal, the United States will need to alter its policy and convince the world that nuclear weapons should be abolished. Although this task includes a multitude of variables, incremental steps can be taken toward the administration's final goal.			
14. SUBJECT TERMS Iran, Japan, Brazil, nuclear threshold, proliferation, nonproliferation, dual-use, NPT, IAEA, safeguards, additional protocol, uranium, plutonium			15. NUMBER OF PAGES 111
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UU

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

IRAN: THE NEXT NUCLEAR THRESHOLD STATE?

Christopher L. Maurer
Lieutenant Commander, United States Navy
B.A., Mount Saint Mary's College, 2001

Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF ARTS IN SECURITY STUDIES
(MIDDLE EAST, SOUTH ASIA, SUB-SAHARAN AFRICA)**

from the

**NAVAL POSTGRADUATE SCHOOL
September 2014**

Author: Christopher L. Maurer

Approved by: James Russell
Thesis Advisor

James Clay Moltz
Second Reader

Mohammed Hafez
Chair, Department of National Security Affairs

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

A nuclear threshold state is one that could quickly operationalize its “peaceful” nuclear program into one capable of producing a nuclear weapon. This thesis compares two known threshold states, Japan and Brazil, with Iran to determine if the Islamic Republic could also be labeled a threshold state. Furthermore, it highlights the implications such a status could have on U.S. nonproliferation policy. Although Iran’s nuclear program is mired in controversy, it relates to those of Japan and Brazil. While not maintaining as robust of a program and often conflicting with the international community, Iran has the capabilities to produce weapons grade material and could be considered a nuclear threshold state. Dozens of countries in the world have similar nuclear capabilities and maintain the Nuclear Non-Proliferation Treaty rights to advance their nuclear programs so long as they are peacefully applied. Unfortunately for nonproliferation advocates, these capabilities make fuel for both energy and weapons. To prevent proliferation and eliminate the world’s nuclear weapons arsenal, the United States will need to alter its policy and convince the world that nuclear weapons should be abolished. Although this task includes a multitude of variables, incremental steps can be taken toward the administration’s final goal.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I.	INTRODUCTION.....	1
	A. RESEARCH QUESTION	1
	B. IMPORTANCE.....	1
	C. HYPOTHESES	3
	D. THESIS OVERVIEW	6
II.	THRESHOLD DEFINED	9
	A. DUAL-USE MATERIAL AND CAPABILITIES.....	12
	B. INTENTIONS	16
III.	JAPAN	19
	A. INTRODUCTION.....	19
	B. HISTORY	19
	C. POST-WAR	22
	D. THE OPTION	23
	E. CIVILIAN NUCLEAR POWER.....	27
	F. NON-PROLIFERATION COMMITMENTS.....	31
	G. KEEPING THE OPTION OPEN.....	33
	H. CONCLUSION	33
IV.	BRAZIL	35
	A. INTRODUCTION.....	35
	B. HISTORY	35
	C. PARALLEL PROGRAM AND RIVALRY WITH ARGENTINA	37
	D. WHY A NUCLEAR SUBMARINE?	40
	E. NUCLEAR SUBMARINES AND THE THRESHOLD.....	42
	F. RELATIONSHIP WITH THE NPT AND IAEA	43
	G. CURRENT CAPABILITIES	46
	H. CONCLUSION	47
V.	IRAN	49
	A. INTRODUCTION.....	49
	B. HISTORY	50
	C. CURRENT CAPABILITIES	54
	D. JOINT PLAN OF ACTION.....	57
	E. POLITICS	60
	F. CONCLUSION	64
VI.	CONCLUSION	67
	A. THRESHOLD STATUS.....	67
	B. IMPLICATIONS FOR NONPROLIFERATION	71
	LIST OF REFERENCES	81
	INITIAL DISTRIBUTION LIST	97

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

ABACC	Brazilian-Argentine Agency for Accounting and Control of Nuclear Material
AEC	Atomic Energy Commission
AQ	Abdul Qadeer
BRIC	Brazil, Russia, India, China
CNEN	Brazilian National Nuclear Energy Commission
CTBT	Comprehensive Nuclear Test Ban Treaty
FEP	fuel enrichment plant
FFEP	Fordow Fuel Enrichment Plant
Gen IV	Generation IV nuclear reactors
GNEP	Global Nuclear Energy Partnership
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
IGRC	Islamic Revolutionary Guard Corps
INB	Brazilian Nuclear Industries
INPRO	International Project on Innovative Nuclear Reactors and Fuel Cycles
IPEN	Brazilian Institute of Technological Research
IRGC	Islamic Revolutionary Guard Corps
ISIS	Institute of Science and International Security
JPA	Joint Plan of Action
LEU	low enriched uranium
MEK	Mujahedin-e Khalq
MOX	mixed oxide
NAC	New Agenda Coalition
NAM	Non-Aligned Movement
NNWS	non-nuclear weapon states
NPR	nuclear propulsion reactors
NPT	Nuclear Non-Proliferation Treaty
NTI	Nuclear Threat Initiative

NWS	nuclear weapon states
OPCW	Organization for the Prohibition of Chemical Weapons
PATN	Brazilian Autonomous Program of Nuclear Technology
PFEP	Pilot Fuel Enrichment Plant
PNE	peaceful nuclear explosions
PTBT	Partial Test Ban Treaty
Pu	plutonium
START	New Strategic Arms Reduction Treaty
TRR	Tehran Research Reactor
U	uranium
UF6	uranium hexafluoride
WGU	weapons grade uranium

ACKNOWLEDGMENTS

I would like to thank Professor James Russell for his advice and helping me maintain my focus. Additionally, I thank Professor James Clay Moltz for his straightforwardness and for motivating me throughout the writing process.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. RESEARCH QUESTION

This thesis investigates the objective of Iran’s nuclear program and its effect on U.S. nonproliferation policy. Specifically, it seeks to determine whether and/or how Iran is attempting to become a nuclear threshold state—a state that could quickly operationalize its “peaceful” nuclear program into one capable of producing a nuclear weapon. To investigate this question, the thesis will compare Iran’s nuclear program with those of Brazil and Japan, both of which are considered threshold states, to determine if differences and similarities define Iranian intentions.¹ Given Iran’s past practices and behavior, it is difficult to ascertain its true motives. Although Iran refrains from publically committing to nuclear weapons, remains within the Nuclear Non-Proliferation Treaty (NPT), and has recently become less bellicose in its rhetoric, it has often times challenged the International Atomic Energy Agency (IAEA) and international nonproliferation principles, remaining steadfastly committed to its perceived right to the full nuclear fuel cycle.

This thesis will also consider the implications of this case study and analysis for U.S. nonproliferation policy more generally in regard to the problem of nuclear threshold states. In particular, research will focus on how the United States has approached Iran’s program and what amendments should be instituted in order to prevent proliferation among the growing number of states that are likely to use nuclear power in the future.

B. IMPORTANCE

Pursued by a growing number of states, nuclear energy programs are being seriously considered by at least 45 countries.² Regardless of these programs’ motives,

¹ Maria Rost Rublee, “The Nuclear Threshold States: Challenges and Opportunities Posed by Brazil and Japan,” *Nonproliferation Review* 17, no. 1 (March 2010), http://cns.miis.edu/npr/pdfs/npr_171_rost_rublee.pdf.

² World Nuclear Association (WNA), “Emerging Nuclear Energy Countries,” last modified February 28, 2014, <http://www.world-nuclear.org/info/Country-Profiles/Others/Emerging-Nuclear-Energy-Countries/>.

each contributes to an increased potential for nuclear weapons proliferation. George Quester explains that there are numerous approaches to proliferation, and that it is impossible to know for sure which countries that have the capability to cross the threshold will cross it.³ Furthermore, while certain specialty technologies are required to construct a bomb, much of the same equipment and materials used in peaceful nuclear programs are used in the production of nuclear weapons.

Within the framework of the Treaty on the Non-Proliferation of Nuclear Weapons, non-nuclear weapon states (NNWS) under Article IV have the “inalienable right” to research, produce, exchange, and use nuclear equipment and energy as long as it remains peaceful in nature or involves a non-proscribed military use, such as naval propulsion.⁴ Article IV also allows NPT non-nuclear nations to explore and achieve nuclear fuel-cycle mastery. As long as a nation adheres to the NPT, it can legally reach the threshold.

Due to the manner in which nuclear weapons grade material can be produced, it is curious why so many countries have not stepped over the threshold and joined the nuclear weapons club. Although maintaining and improving on their robust nuclear programs, Brazil and Japan have remained on the brink for different reasons. Although many argue that security is the primary driver of proliferation, domestic factors often maintain a significant and influential role in directing official decisions. International constraints both within and outside the NPT also affect proliferation decisions. The success or failure of international efforts to influence these decisions remains vital to the survival of the NPT. If Tehran does acquire nuclear weapons, it could become a model for other developing countries that might exploit their NPT rights to acquire their own weapons capabilities and then leave the regime.

³ George H. Quester, “Conceptions of Nuclear Threshold Status,” in *Security with Nuclear Weapons?: Different Perspectives on National Security*, ed. Regina Cowen Karp (New York: Oxford University Press, 1991), 212.

⁴ International Atomic Energy Agency (IAEA), *Treaty of the Non-Proliferation of Nuclear Power* (Vienna: IAEA, 1970), 3, <http://www.iaea.org/Publications/Documents/Infocircs/Others/infocirc140.pdf>; James Clay Moltz, “Closing the NPT Loophole on Exports of Naval Propulsion,” *The Nonproliferation Review* 6, no. 1 (1998), 108–09, <http://cns.miis.edu/npr/pdfs/cmoltz61.pdf>.

Iran is particularly important because it signed and ratified the NPT prior to developing an advanced program, similar to the position of many current non-weapon states. The process by which Iran has advanced its nuclear program and the precedent set for other emergent nuclear powers poses a threat to the future of nonproliferation efforts. Although U.S. nonproliferation policy utilizes the NPT and international norms, it may have over-relied on unilateral leverage and denial of technology to contain and reduce the threat of proliferation.⁵ Recently, the Obama administration and international community have diplomatically engaged the Iranian regime and appear to be making headway on their objective of preventing Iran from acquiring nuclear weapons. Having been exposed to diverse methods of prevention including isolation, sanctions, threats of military attack, and diplomacy, Iran offers lessons on how the United States should proceed with its nonproliferation policy to prevent others from being able to exploit loopholes within the nonproliferation regime.

C. HYPOTHESES

Two possible outcomes developed by comparing Iran's nuclear program with those of Brazil and Japan include a continued effort to advance its program, ultimately defying the NPT and other nonproliferation regime elements such as export controls, IAEA and international safeguards, and United Nations Security Council Resolutions, and unveil a nuclear weapon. Conversely, Iran could continue on its current path, but stop short of nuclear weapons by remaining at the brink of proliferation. Regardless of Iran's final position within the proliferation continuum, U.S. policy will have to change not only in regards to Iran, but in its approach to prevent future threshold and proliferator states.

Under Secretary for Political Affairs, Wendy Sherman averred in a written statement before the Senate Foreign Relations Committee that U.S. nonproliferation policy towards Iran needs to be carried out multilaterally.⁶ Multilateral consensus

⁵ Gerard C. Smith and George W. Rathjens, "Reassessing Nuclear Nonproliferation Policy." *Foreign Affairs* 59, no. 4 (1981), 886–87, <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/20040826.pdf?acceptTC=true&acceptTC=true&jpdConfirm=true>.

⁶ *U.S. Policy Toward Iran, Written Statement Before the Senate Foreign Relations Committee*, 113th Cong. (2013) (statement of Wendy Sherman, Under Secretary of State for Political Affairs), <http://www.state.gov/p/us/rm/2013/202684.htm>.

validates nonproliferation efforts. In addition, the United States uses a dual-tracked strategy that consists of sanctions and diplomacy with the possibility of sanction relief through compromise. Although some believe that Iran committed to negotiations because of sanctions, Kenneth Katzman states that sanctions have not had the desired effect of slowing Iranian progress. He explains that Iran has developed more sophisticated centrifuges, advanced its enrichment program, and improved its ballistic missile and other weapons systems.⁷ In addition, Kayhan Barzegar explains that sanctions “degrade Iran’s political equality” and makes them skeptical of the usefulness of negotiations.⁸ Etel Solingen adds that broad sanctions miss their intended targets and strengthen hardliner resolve.⁹

Regarding nonproliferation efforts for future nuclear powers, each of the 45 countries interested in nuclear power represent proliferation threats. As these countries invest in their nuclear infrastructure, they will inevitably acquire dual-use material. While acquisition of dual-use material does not guarantee nuclear weapons generation, as additional technologies, expertise, facilities, and systems are required, they do present a nuclear foundation from which to expand. To prevent future Irans, a panel of nonproliferation experts hosted by Henry Sokolski discussed the need for congressional approval for future nuclear cooperation agreements and that rules for cooperation must be universal and indiscriminate. Congressman Brad Sherman, Ranking Member, Subcommittee on Terrorism, Nonproliferation and Trade, explained that NPT enforcement needs to be “immediate and severe” and that future cooperation should abide by the established “UAE standard” that restricts enrichment and reprocessing capabilities.¹⁰

⁷ Kenneth Katzman, *Iran Sanctions* (CRS Report No. RS20871) (Washington, DC: Congressional Research Service, 2014), 49–50, <https://www.fas.org/sgp/crs/mideast/RS20871.pdf>.

⁸ Kayhan Barzegar, “Sanctions Won’t End Iran’s Nuclear Program,” in *Iran and the Bomb: Solving the Persian Puzzle*, ed. Gideon Rose and Jonathan Tepperman (New York: Council on Foreign Relations, 2012), 160.

⁹ Etel Solingen, *Nuclear Logics: Contrasting Paths in East Asia and the Middle East* (Princeton, NJ: Princeton University Press, 2007), 295.

¹⁰ Henry Sokolski, “Avoiding Future Irans: A New Course for U.S. Nonproliferation Policy,” Nonproliferation Policy Education Center, December 11, 2013, <http://www.npolicy.org/article.php?aid=1239&rtid=9>.

Although Iran's, Brazil's, and Japan's nuclear programs have demonstrated different trajectories, none of them currently possess nuclear weapons. Despite Iran's denouncement of nuclear weapons, its deviant behavior including covert facilities and activities may suggest an ambitious pursuit of weapons. In the first hypothesis, Iran would not only withdraw from the NPT, but also deviate from the desires of its population. While Iranians encourage their government to pursue nuclear energy, they have demonstrated less enthusiasm about nuclear weapons. In 2004, Karim Sadjadpour explained that while few Iranians opposed nuclear energy development, a majority expressed fear that a nuclear weapon would expose Iran's vulnerability and increase hardliner power.¹¹ Michael Herzog of the Washington Institute for Near East Policy conducted a similar analysis in 2006, in which he stated that anxiety caused by nuclear weapons increased from 34 percent in older adults to more than 50 percent among 16–24 year olds.¹² A November 2013 Gallup poll showed that 68 percent of Iranians favored the continuation of their nuclear program, while only 34 percent approved nuclear power for military applications.¹³

While the histories of all three countries' programs differ, commonalities exist. First, all three are non-nuclear weapon states that signed and ratified the NPT. All continue to expand their programs and capabilities. All three are sensitive to their domestic populations and political climates and not driven solely by security concerns.¹⁴ Furthermore, all three claim that the NPT is discriminatory towards non-nuclear weapon

¹¹ Karim Sadjadpour, "Iranians Don't Want to Go Nuclear," *The Washington Post*, February 3, 2004, <http://www.crisisgroup.org/en/regions/middle-east-north-africa/iraq-iran-gulf/iran/iranians-dont-want-to-go-nuclear.aspx>.

¹² Michael Herzog, *Iranian Public Opinion on the Nuclear Program: A Potential Asset for the International Community* (Washington, DC: Washington Institute for Near East Policy, 2006), 3–4, <http://www.washingtoninstitute.org/uploads/Documents/pubs/PolicyFocus56.pdf>.

¹³ Jay Loschky, "Most Iranians Say Sanctions Hurting Their Livelihoods," Gallup World, November 6, 2013, http://www.gallup.com/poll/165743/iranians-say-sanctions-hurting-livelihoods.aspx?utm_source=alert&utm_medium=email&utm_campaign=syndication&utm_content=morelink&utm_term=All%20Gallup%20Headlines.

¹⁴ Rublee, "Nuclear Threshold States," 54, 58; Sadjadpour, "Iranians Don't Want."

states, and the nuclear weapon states perform too little in terms of disarmament.¹⁵ Finally, they view that achieving and maintaining the option is a bargaining chip for interests beyond their nuclear programs.

Brazil and Iran are often times compared to the Japanese “threshold state” model. More recently, Iran’s path has the potential to become an inspiration for many in the developing world. This could pose a significant counterweight to the Japanese model, which is associated with strong adherence to the NPT and nonproliferation norms. While Iran challenges the NPT and international community, it fights for its rights and progressing in the face of severe sanctions and military threats.

For U.S. nonproliferation efforts, the Iran path poses a peculiar challenge in that some states may emulate its approach to nuclear independence. With the constant focus on rights under the NPT, some may believe that mastery of the nuclear fuel cycle should be pursued. The main problem for the United States and international community would be a future in which many nations conduct nuclear programs similar to that of Iran. How would the United States and the rest of the world cope? Although each case is unique, the United States should lead global nonproliferation efforts that consider multilateral engagement, places developing countries such as South Africa, Kazakhstan, Argentina, or Brazil in lead dialogue roles, promotes common interests, and understands that external factors often shape domestic sentiment but are often not the sole or primary drivers that influence decision makers.

D. THESIS OVERVIEW

The next section of this thesis will provide general information on what it means to be a nuclear threshold state and relate the importance of dual-use materials and capabilities and intentions. The next three sections will focus on the nuclear programs of Japan, Brazil, and Iran. Each section will describe the individual nuclear histories of the country’s program, current capabilities, and internal and external factors that have influenced decision makers. The Japan and Brazil sections will demonstrate that they are

¹⁵ Rublee, “Nuclear Threshold States,” 64; Shahram Chubin, “The Politics of Iran’s Nuclear Program,” *The Iran Primer*, United States Institute of Peace, 2010, <http://iranprimer.usip.org/resource/politics-irans-nuclear-program>.

threshold states, while the Iran section will be compared to these two in order to determine if it will likely follow Brazilian or Japanese nuclear postures. The final section will focus on Iran's program and the implications for U.S. nonproliferation policy. In addition to explaining U.S. nuclear weapons nonproliferation policy, this section will offer policy recommendations for the United States to effectively counter would be proliferation efforts by future threshold states.

THIS PAGE INTENTIONALLY LEFT BLANK

II. THRESHOLD DEFINED

Various definitions and concepts are used to describe nuclear threshold states. Avner Cohen and Benjamin Frankel describe them as opaque, ambiguous, and latent;¹⁶ Etel Solingen terms nations at the threshold as fence-sitters;¹⁷ George Quester uses “bomb in the basement;”¹⁸ Michel Fortmann uses the terms “impulsive, muddling through,” “nuclear captives,” and “pariah states” to describe the different approaches toward the threshold;¹⁹ and Maria Rost Rublee defines nuclear threshold states as “those that have chosen nuclear restraint despite having significant nuclear capabilities.”²⁰ This thesis combines aspects from various definitions and determines a threshold state to be one that could quickly operationalize its “peaceful” nuclear program into one capable of producing a nuclear weapon.

Cohen and Frankel use the term opaque to describe “second generation nuclear proliferators.”²¹ These countries not only suppress information and knowledge about their programs, but also conduct proliferation efforts “underground” while professing loyalty to nonproliferation efforts.²² Similar to others, Cohen and Frankel label programs as ambiguous because of the unavailability of information, or the indecisive nature of a nation’s leadership. They believe that ambiguity most accurately describes a situation in which “an openly non-nuclear weapon country is known to possess a substantial nuclear infrastructure, including reprocessing and enrichment capabilities, while there is reason to

¹⁶ Avner Cohen and Benjamin Frankel, “Opaque Nuclear Proliferation,” *Journal of Strategic Studies* 13, no.3 (1990), 18–23, <http://www.tandfonline.com/doi/pdf/10.1080/01402399008437417>.

¹⁷ Etel Solingen, *The Domestic Sources of Nuclear Postures: Influencing ‘Fence-Sitters’ in the Post-Cold War Era* (IGCC Policy Paper 8) (Irvine, CA: Institute on Global Conflict and Cooperation, October, 1994), <http://igcc.ucsd.edu/assets/001/501216.pdf>.

¹⁸ Quester, “Conceptions of Nuclear Threshold,” 212–213.

¹⁹ Michel Fortmann, “The Other Side of Midnight: Opaque Proliferation Revisited.” *International Journal* 48, no. 1 (1992/1993), 151–75. <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/40202824.pdf?acceptTC=true&acceptTC=true&jpdConfirm=true>.

²⁰ Rublee, “Nuclear Threshold States,” 50.

²¹ Cohen and Frankel, “Opaque Nuclear Proliferation,” 14.

²² *Ibid.*, 17.

suspect this capability has weapon implication.”²³ Likewise, Quester explains that the growing availability of nuclear knowledge, expertise, and accumulation of nuclear technology offers options to decision makers. Furthermore, he asserts that the ambiguous nature, in which some states pursue the threshold, is a means to an end rather than an end in itself.²⁴

The third term Cohen and Frankel use to describe threshold programs is latency. In this case, a country, consciously or unconsciously, has progressed closer to nuclear weapons than it would have with no nuclear program at all. Although a nuclear program may have begun without the intention of weapons, its progress offers such an option.²⁵ Among many others, the Council on Foreign Relations explains that Japan and Brazil, non-nuclear weapon states, possess a latent nuclear weapons capability. Due to its enrichment and reprocessing capabilities, Japan is considered to have the most robust nuclear program. Yet the country dismisses prospects of proliferation due to its commitment to nonproliferation and opposition to nuclear weapons.²⁶ Although the Council on Foreign Relations cites Brazil as the maintainer of the most advanced nuclear program in Latin America and a strong proponent of nonproliferation efforts, it shows concern in the country’s support for Iran and Brazil’s denial of International Atomic Energy Agency inspection of its centrifuges.²⁷ The Council on Foreign Relations also suggested that Iran’s uranium enrichment capability could be used for weapons production.²⁸

Etel Solingen labels fence-sitters as states that simultaneously remain uncommitted to the nonproliferation regime and nuclear weapons production. This dichotomy also extends to the expectations from the fence-sitter and international community. Where the fence-sitter expects to be included in global concerns, the

²³ Cohen and Frankel, “Opaque Nuclear Proliferation,” 19.

²⁴ Quester, “Conceptions of Nuclear Threshold,” 209.

²⁵ Cohen and Frankel, “Opaque Nuclear Proliferation,” 19–20.

²⁶ Toni Johnson, “Fifteen Nuclear Agendas to Watch,” Council on Foreign Relations, May 27, 2010, <http://www.cfr.org/proliferation/fifteen-nuclear-agendas-watch/p22023#p8>.

²⁷ Ibid.

²⁸ Ibid.

international community expects the fence-sitter to adhere to the NPT and any other nonproliferation obligations. She explains that these types of states, which maintain varied levels of capabilities, delay making final decisions regarding an end state of their nuclear program.²⁹ She contends that domestic politics, rather than external pressures, have a greater influence on nuclear decisions. This occurs because nuclear weapons possession has the potential to degrade, rather than enhance national security. Furthermore, a nuclear program is not only monetarily expensive, but also costly in terms of international reaction, which potentially includes sanctions, isolation, and military intervention.³⁰

Quester also adds that a country with “bombs in the basement” is considered to be on the threshold. Quester’s position holds that the components of a nuclear weapon are possessed by an individual state, but remain disassembled, untested, and absent of any formal admission that weapons exist.³¹ Describing a bomb in the basement as “possessing the material and means” to produce nuclear weapons, Robert Windrem of *NBC News* explains that because of its advanced nuclear program and large stockpiles of plutonium and enriched uranium, China considers Japan to have bombs in the basement, and that plans for further plutonium production and stockpiling is worrisome. China also concludes that Japan could produce a large arsenal within two years from the time of a decision.³² Likewise, Director of National Intelligence James Clapper testified that Iran has the “scientific, technical, and industrial capacity to eventually produce nuclear weapons,” but it is unknown if it will ever decide to build such a device.³³

Although the definitions offered by Rublee and others contain variations, there is consensus that capabilities and intentions are important in the direction of a nuclear

²⁹ Solingen, *Domestic Sources*, 9.

³⁰ *Ibid.*, 4–5.

³¹ Quester, “Conceptions of Nuclear Threshold,” 212.

³² Robert Windrem, “Japan Has Nuclear ‘Bomb in the Basement,’ and China Isn’t Happy,” *NBC News*, March 11, 2014, <http://www.nbcnews.com/storyline/fukushima-anniversary/japan-has-nuclear-bomb-basement-china-isnt-happy-n48976>.

³³ James Clapper, *Worldwide Threat Assessment of the U.S. Intelligence Community*, Statement for the Record, Senate Select Committee on Intelligence, January 29, 2014, 5–6, http://www.dni.gov/files/documents/Intelligence%20Reports/2014%20WTA%20%20SFR_SSCI_29_Jan.pdf.

program and that remaining on the threshold, similar to its crossing, serves political interests ranging from bargaining chips to security concerns. Whereas capabilities are the physical attributes of a program, intentions are the political decisions based on those capabilities.

A. DUAL-USE MATERIAL AND CAPABILITIES

A characteristic of nuclear programs that concern nonproliferation advocates is the utilization of dual-use technologies and materials. In this context, dual-use means that these elements are used in both civilian and military applications. Although possession of dual-use items used for civilian programs can be applied to a weapons program, their possession does not automatically translate into a weapons commitment. The Treaty on the Non-Proliferation of Nuclear Weapons states in Article IV that parties to the treaty “have the inalienable right... to develop research, production and use of nuclear energy for peaceful purposes.”³⁴ Moreover, certain specialty technologies are required to construct a bomb.

Two avenues to make nuclear fuel or weapons material are uranium (U) and plutonium (Pu). Uranium occurs naturally, and in order to be used in reactors, it must be mined, milled, and converted into a useable fuel. In its natural form, uranium is approximately 99.3 percent U-238 and 0.7 percent U-235. U-235 is the sought after isotope of uranium because it easily fissions, whereas U-238 has only a small probability of fission if it absorbs an additional neutron. After it is mined, uranium is milled or separated from the ore to make yellowcake. The yellowcake is converted into uranium hexafluoride gas, UF₆, which is suitable for enrichment and necessary for both reactor fuel and weapons. Enrichment concentrates the level of U-235. While nuclear reactors require low enriched uranium (LEU) situated between 0.7 percent and 20 percent, nuclear

³⁴ IAEA, *Treaty of the Non-Proliferation*, 3.

weapons require highly enriched uranium HEU in excess of 90 percent U-235. Enrichment is conducted by gaseous diffusion, gas centrifuge, or laser separation.³⁵

While all methods of enrichment separate U-238 and U-235, gas centrifuge is more efficient than gaseous diffusion and more common than laser separation.³⁶ In the gas centrifuge method, UF₆ is spun at high speeds to separate uranium isotopes. While a single unit makes small increases in the concentration of U-235, cascading or connecting units enhance the concentration of U-235 by continually extracting higher levels of the enriched uranium. The Nuclear Threat Initiative (NTI) explains that cascades dedicated to LEU production differ from cascades oriented towards HEU, in that the LEU will have fewer levels of enrichment. Although this appears to be cut and dry, the facility that houses the cascades can be designed to offer the option of converting LEU to HEU connections³⁷ Furthermore, NTI explains that “batch recycling” can be used, in which LEU connections remain constant while enriched uranium is continually fed through the system. Although this method is less efficient than an HEU dedicated cascade, weapons grade enrichment is still possible.³⁸

The other pathway to nuclear energy and weapons is the use of plutonium. Although traces of plutonium exist in nature, the vast majority of it must be produced, and Pu-239 is the most fissile plutonium isotope. When uranium is used in light water reactors and releases neutrons, U-238 atoms absorb neutrons and makes U-239, which then decays to form Pu-239.³⁹ An advantage of spent nuclear fuel is that it can be reprocessed in order to extract plutonium and uranium, which can be used separately or

³⁵ “Stages of the Nuclear Fuel Cycle,” Nuclear Regulatory Commission, last modified May 21, 2013, <http://www.nrc.gov/materials/fuel-cycle-fac/stages-fuel-cycle.html>; Charles D. Ferguson, “Proliferation Risks of Nuclear Power Programs,” Nuclear Threat Initiative, December 1, 2007, <http://www.nti.org/analysis/articles/risks-nuclear-power-programs/>.

³⁶ “Uranium Enrichment,” Nuclear Regulatory Commission, last modified February 21, 2014, <http://www.nrc.gov/materials/fuel-cycle-fac/ur-enrichment.html>.

³⁷ Ferguson, “Proliferation Risks;” “Backgrounder on Plutonium,” Nuclear Regulatory Commission, last modified January 8, 2014, <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/plutonium.html>.

³⁸ Ibid.

³⁹ Ibid.

combined to make mixed oxide (MOX) fuel. The recycling and reuse of fuel contributes to a state's energy security and cuts down on nuclear waste.⁴⁰

Plutonium can also be used in weapons in which higher concentrations of Pu-239 are preferred (reactor grade plutonium can be used in weapons). To achieve weapons grade plutonium that is roughly 94 percent Pu-239 a special reactor is used. Whereas plutonium produced in a light water reactor remains in the reactor for approximately three years, which allows additional neutrons to be absorbed and higher than Pu-239 isotopes to develop, the special reactors produce Pu-239 by burning uranium for a short period of time, often two to three months.⁴¹ Furthermore, plutonium can be produced in a breeder reactor, which produces more plutonium than it consumes. Thus creating stockpiles from which the nuclear material could be diverted to a weapon.

In addition to creating power and making nuclear weapons, these two elements have further uses. Used in many applications for space exploration, plutonium acts as a power and heat source for space shuttles, satellites, and planetary rovers. Plutonium was also used to power heart pacemakers.⁴² Similarly, uranium is used in inertial navigation systems, aircraft control surfaces, and armor plating. Uranium was also used in more pedestrian matters such as staining glass, coloring ceramics, and developing photographs.⁴³ An additional use of uranium, which presents a proliferation concern, is its use in naval propulsion.

Currently, the United States, Russia, China, Great Britain, France, and India, a non-member state to the NPT, are the only countries with nuclear powered naval vessels, which include ships or submarines. Although India recently introduced a nuclear submarine, and Brazil aspires to develop the same, serious concern developed when Iran

⁴⁰ "Processing of Used Nuclear Fuel," World Nuclear Association, last modified September 2013, <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Fuel-Recycling/Processing-of-Used-Nuclear-Fuel/>.

⁴¹ "Plutonium," World Nuclear Association, last modified March 2012, <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Fuel-Recycling/Plutonium/>.

⁴² "Facts About Plutonium," Live Science, September 23, 2013, <http://www.livescience.com/39871-facts-about-plutonium.html>.

⁴³ "Facts About Uranium," Live Science, September 18, 2013, <http://www.livescience.com/39773-facts-about-uranium.html>.

announced, in 2012, that it too desired a nuclear sub. Although these types of submarines enhance tactical and strategic military advantage, their proliferation concern stems from a loophole within the NPT that does not forbid states from generating HEU for naval propulsion.⁴⁴

Until recently, naval propulsion reactors received little attention in regards to proliferation concerns because high costs, cheaper and safer alternatives, and limited resources constrained the possession of nuclear powered naval vessels to the nuclear weapon states. The major concerns include uranium enrichment under the guise of naval propulsion. This could be intended for other military uses and the possible exportation of this technology to non-weapon states and non-NPT signatories. Without banning naval propulsion reactors, NPT safeguards do not apply to either the equipment or fuel during its “non-explosive military use.”⁴⁵

Although dual-use materials and nuclear powered submarines legally provide states elements of nuclear weapons, it does not dictate that a state will pursue such devices. First, to go from energy production to arms production is difficult. Second, there are perceived advantages and disadvantages of acquiring nuclear weapons, and third, a decision has to be made to develop a weapons program. Although dual-use materials such as plutonium, uranium, centrifuges, and reprocessing plants are used in civilian nuclear programs, additional equipment, testing, and procedures are required for weapons construction. Some of these include the research and development of plutonium and uranium metallurgy; development of chemical and high explosive programs; the use of special high speed cameras or pulsed x-ray generators to conduct and analyze hydrodynamic testing; the presence or use of thousands of pounds of natural uranium and tungsten, or hundreds of pounds of beryllium, which are used to reflect neutrons and tamp the nuclear explosion; criticality tests to understand weapon fabrication; the use of neutron generators and associate electronics to measure effectiveness; the use of

⁴⁴ Greg Thielmann and Wyatt Hoffman, “Submarine Nuclear Reactors: A Worsening Proliferation Challenge,” The Arms Control Association, July 26, 2012, http://www.armscontrol.org/files/TAB_Submarine_Nuclear_Reactors.pdf.

⁴⁵ Moltz, “Closing the NPT.”

computational physics models that use special coding and computing systems; the training of personnel in diversified areas of physics, chemistry, and engineering; and the research and development of a delivery vehicle.⁴⁶

B. INTENTIONS

Prior to establishing a civilian nuclear program or a nuclear weapons program, the political will or intent to pursue such an endeavor will presage development. Decision makers must weigh their options carefully and determine, based on their perceptions, how the advantages and disadvantages of becoming a nuclear power or remaining weapons free will affect their individual political lives or state's future. Reasons to pursue a civilian nuclear program revolve around development, scientific achievement, international prestige and recognition, economic and energy independence, and climate concerns.

Classical realists argue that the primary motivators for acquiring or refraining from nuclear weapons are based on the likelihood of advancing a nation's power and security. Although security concerns and other external factors remain important, Tanya Ogilvie-White argues that the realist perspective tends to discount internal pressures. She states that realist theories "overlook the point that states have multiple goals, both domestic and international, and that these goals are interlinked."⁴⁷ Japan, Brazil, and Iran all desire security and regional if not global influence, but nuclear weapons may not be in their best interest to acquire these pursuits. Although nuclear weapons would give each a perceived sense of security, nuclear armament could also bring multilateral pressure, sanctions, and isolation, which could disrupt their other desires of global inclusion and international respect. To be accepted as a legitimate member of the international community, non-nuclear weapon states, like nuclear weapon states, are expected to abide

⁴⁶ Richard R. Paternoster, *Nuclear Weapon Proliferation Indicators and Observables* (Los Alamos, NM: Los Alamos National Laboratory, 1992), 10–20, <http://www.fas.org/sgp/othergov/doe/lanl/la-12430-ms.pdf>; U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction* (OTA-BP-ISC-115) (Washington DC: U.S. Government Printing Office, 1993), 120–22, 190–95.

⁴⁷ Tanya Ogilvie-White, "Is There a Theory of Nuclear Proliferation?: An Analysis of the Contemporary Debate," *The Nonproliferation Review* 4, no. 1 (1996), 48, <http://cns.miis.edu/npr/pdfs/ogilvi41.pdf>.

by regulations set forth by other signed and agreed to treaties such as the NPT. Furthermore, Solingen explains that the questionable utility of nuclear weapons, requirements for industrialization, involvement in the international economy, and the reduction of Cold War patron/client relations opened discussions between opposing contingents in terms of domestic and foreign policy.⁴⁸

Rather than pursuing nuclear weapons, a threshold posture could serve state interests not only in areas of energy dependence and prestige, but also security matters. Michel Fortmann relates the relationship between Brazil and Argentina, in which nuclear cooperation led not only to development and esteem, but also an assurance of restraint underlined by a notion of seriousness.⁴⁹ Similarly, Quester suggests that the threshold offers the possibility of deterrence and a decisive advantage, but that crossing the line could spur preemptive military action and political isolation. He describes that a general understanding exists, which indicates that if a nation pursues nuclear weapons, its ambitions will be responded to.⁵⁰ Furthermore, remaining at the threshold could also be used as a bargaining chip to achieve national goals, or at least create a negotiation environment in which the threshold state enters with a perceived advantage.

Although there is benefit to remaining at the threshold, the ambiguity of the position could create confusion, hinder international relations, and cause instability. Misunderstanding intentions and capabilities, outside nations may perceive threshold states as deviant actors seeking to proliferate. While the threshold state seeks independence and authority in the international community, it may receive negative attention in the form of sanctions or military action and be viewed as untrustworthy. In the end, a threshold status could bring the same negative reactions as introducing nuclear weapons.

⁴⁸ Solingen, *Domestic Sources*, 4–6.

⁴⁹ Fortmann, “The Other Side,” 157.

⁵⁰ Quester, “Conceptions of Nuclear Threshold,” 222–25.

THIS PAGE INTENTIONALLY LEFT BLANK

III. JAPAN

A. INTRODUCTION

As a nuclear threshold state, Japan provides a potential model for all non-nuclear weapon states. During World War II, it initiated a weapons program, but has since renounced weapons production or possession. Currently, Japan maintains a top-of-the-line civilian nuclear program that includes enrichment and reprocessing capabilities. Japan possesses few energy resources. Before the Fukushima nuclear disaster, it relied on nuclear energy to generate 30 percent of its electricity.⁵¹ Due to its reliance on foreigners for uranium, it justifies its reprocessing capability by citing concerns over resource and energy security.⁵² Furthermore, Japan is a leader of international nonproliferation efforts, and although it has neighbors with nuclear weapons, it remains committed to its Three Non-Nuclear Principles. Japan demonstrates to Iran and other non-nuclear weapons states with major security concerns the possibility to remain within the confines of the NPT and simultaneously stockpile nuclear material, knowledge, and technology nearly sufficient for nuclear weapons.

B. HISTORY

As the only nation to have nuclear weapons used against it, Japan maintains an aversion to nuclear weapons. But this was not always the case. During World War II, Japan researched and developed a nuclear weapons program that manufactured nuclear components at different locations throughout the country. Initially envisioned as an element of defense, nuclear weapons would supplement kamikaze attacks on Allied

⁵¹ Maria Rost Rublee, "Future of Japanese Nuclear Policy," *Strategic Insights* 8, no. 2 (2009): 6, <http://calhoun.nps.edu/public/bitstream/handle/10945/11379/rubleeApr09.pdf?sequence=1>.

⁵² *Ibid.*

forces.⁵³ Japanese interest in nuclear weapons began in 1940 when the country's leading physicist, Yoshio Nishina presented the idea to the military and began to research uranium's fissile qualities.⁵⁴

While the Army and Navy separately investigated nuclear weapons, Japan's top scientists discussed the probability of constructing a weapon. In March 1943, they determined that a bomb was not feasible during WWII for either the Japanese or the Americans.⁵⁵ Although post-war comments suggest that many scientists were against construction, the program continued. Throughout the remainder of the war, the Army focused on nuclear weapons, while the Navy, which initially expressed interest in nuclear propulsion, was ordered to research weapons after Japan's defeat at Midway. Concerned over Japan's lack of petroleum resources and an understanding that the United States already researched nuclear propulsion, Japanese naval leaders reported that Japan would be "well advised to do the same."⁵⁶ Despite this plea, Admiral Isoroku Yamamoto, Commander of the Combined Fleet, forced the navy to research the feasibility of nuclear weapons production.⁵⁷

Despite great sacrifice and effort, resources and coordination between the military branches were scarce. While the Army and Navy pursued separate programs, scientists with uranium enrichment expertise were unavailable due to university affiliation or exclusion from the program.⁵⁸ Rather than calling on those with experience, Nishina requested Masa Takeuchi, who became responsible for the U-235 separation program.

⁵³ Robert K. Wilcox, *Japan's Secret War: Japan's Race against Time to Build Its Own Atomic Bomb* (New York: Marlowe), 1995, 25.

⁵⁴ Deborah Shapley, "Nuclear Weapons History: Japan's Wartime Bomb Projects Revealed." *Science* 199, no. 4325 (1978), 153. <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/1745136.pdf?acceptTC=true&jpdConfirm=true>.

⁵⁵ Barry R. Schneider, *Radical Responses to Radical Regimes: Evaluating Preemptive Counter-Proliferation* (Washington, DC: National Defense University, 1995), 11.

⁵⁶ Walter E. Grunden, Mark Walker, and Masakatsu Yamazaki, "Wartime Nuclear Weapons Research in Germany and Japan," *Osiris* 20 (2005), 116, <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/3655253.pdf?acceptTC=true&jpdConfirm=true>.

⁵⁷ *Ibid.*, 116.

⁵⁸ Shapley, "Nuclear Weapons History," 155.

Despite being an accomplished chemist, Takeuchi had never worked in this area before.⁵⁹ Furthermore, competition between the services was intense, and despite the occasional collaboration, it was difficult to determine how much duplication of effort occurred.⁶⁰

In order to separate U-235 from U-238, Japanese scientists, like Americans who completed the task earlier, discussed the option of converting their cyclotrons into mass spectrographs. Japanese officials discarded this idea because their single functioning cyclotron conducted experiments geared toward nuclear energy. Concluding that centrifuge and gaseous diffusion separation methods would need large facilities, Nishina and others finally settled on thermal diffusion. This method not only required a simpler design, but was developed in Germany, which presented Japan the opportunity to acquire equipment and expertise.⁶¹

By 1943, Premier Hideki Tojo ordered the military to increase its efforts. In addition to Nishina's program being designated as NI, it received an additional 200,000 yen than the year before.⁶² After many experiments and configurations, Nishina's group assembled a functioning separator in March 1944. Before the Army could benefit from any substantial gains, the facility containing the separators came under U.S. attack and was destroyed in April 1945.

Similar to the Army, the Navy viewed each defeat in battle as an increased necessity for a new and decisive weapon. The Navy allocated additional funds for the program and designated it as F-go. Rather than using thermal diffusion like the Army, the Navy decided to use ultracentrifuges. Furthermore, as the war continued, the Navy's ability to gather resources throughout the empire dramatically decreased. The lack of resources and the threat of direct attacks against Japan proper forced the Army and Navy to cooperate and for the Japanese to seek new sources of uranium. Their search led them to Korea, which had known deposits of uranium and other elements.⁶³

⁵⁹ Wilcox, *Japan's Secret War*, 91.

⁶⁰ *Ibid.*, 90.

⁶¹ Grunden, Walker, and Yamazaki, "Wartime Nuclear Weapons," 119.

⁶² Wilcox, *Japan's Secret War*, 97.

⁶³ Grunden, Walker, and Yamazaki, "Wartime Nuclear Weapons," 121–122.

Although the Japanese atomic program continued, it never proceeded much further than the separation stage. Even after the bombings of Hiroshima and Nagasaki, interest remained in nuclear weapons and Nishina was asked if it was still possible to build a device.⁶⁴ Although his answer remains a mystery, the desperate situation Japan faced during the final stages of WWII, coupled with the military and scientific collaboration toward nuclear weapons suggests that if Japan produced a weapon, it would have most likely used it.⁶⁵

C. POST-WAR

Despite its pursuit during the war, Japan's post-war rebuilding and public opinion focused its attention away from nuclear weapons. First, the United States occupied Japan after WWII and developed a constitution that forbade Japan from maintaining any offensive or war-making capabilities. Although typically considered offensive, nuclear weapons were not mentioned in the constitution. This omission has left the constitution open to interpretation and debate.⁶⁶

Although it has opened slightly in recent years, public debate in the aftermath of WWII was quieted by both the Japanese public and the United States, as neither wanted Japan to gain an independent nuclear capability. The small amount of discussion of nuclear weapons that existed took place behind closed doors. While Prime Minister Nobusuke Kishi publically commented in 1957, that the constitution did not specifically deny Japan nuclear weapons, the protestation that followed forced him and his cabinet to resign.⁶⁷ In addition, the 1952 Mutual Security Assistance Pact and the 1960 Treaty of Mutual Cooperation and Security signed with the United States stipulated that both countries would come to the assistance of the other in terms of defending common

⁶⁴ Shapley, "Nuclear Weapons History," 154.

⁶⁵ Ibid., 157; Wilcox, *Japan's Secret War*, 242.

⁶⁶ Kurt M. Campbell and Tsuyoshi Sunohara, "Japan: Thinking the Unthinkable," in *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*, ed. Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss (Washington, DC: The Brookings Institution, 2004), 220.

⁶⁷ Ibid., 220–21.

interests. Furthermore, in return for its extended deterrence services, Japan granted the United States basing rights, but forbade nuclear weapons and even nuclear-powered ships.⁶⁸

D. THE OPTION

In the years following WWII, Japan's nonproliferation commitment has been challenged. Upon President Eisenhower's encouragement to prepare for nuclear war, Japan studied protection measures and U.S. battlefield nuclear doctrine. In 1955, Prime Minister Ichiro Hatoyama explained that U.S. nukes in Japan were justified because their presence preserved peace. Furthermore, Hatoyama's successor, Shinsuke Kishi acknowledged that Japan's constitution did not forbid defensive nuclear weapons. Throughout the 1950s, high ranking officials occasionally voiced support for weapons and future applications, but the nuclear allergy intensified due to the Daigo Fukuryūmaru (Lucky Dragon) incident in the vicinity of the Marshall Islands in 1954. This involved a Japanese fishing crew that was exposed to radiation from U.S. nuclear tests.⁶⁹

In 1964, Eisaku Sato, known to be interested in nuclear weapons, was Japan's prime minister when China tested its first nuclear device. This event spurred some politicians, including the powerful and popular Yasuhiro Nakasone and Shintaro Ishihara to question Japan's aversion to nuclear weapons.⁷⁰ Furthermore, Japan feared that increased U.S. involvement in Vietnam would detract from its own security concerns, especially on the heels of China's test and the possibility of China holding Japan as a "nuclear hostage."⁷¹ During a private meeting between Sato and U.S. president Lyndon Johnson, the prime minister suggested that if the Chinese got a bomb, Japan should also

⁶⁸ Emma Chanlett-Avery and Mary Beth Nikitin, *Japan's Nuclear Future: Policy Debate, Prospects, and U.S. Interests* (CRS Report No. RL34487) (Washington, DC: Congressional Research Service, 2009), 2, <https://www.fas.org/sgp/crs/nuke/RL34487.pdf>.

⁶⁹ Katsuhisa Furukawa, "Japan's Nuclear Option," in *Over the Horizon Proliferation Threats*, ed. James J. Wirtz and Peter R. Lavoy (Stanford, CA: Stanford University Press, 2012), 13–15.

⁷⁰ Campbell and Sunohara, "Japan: Thinking the Unthinkable," 221.

⁷¹ *Ibid.*, 221–22.

have one.⁷² While leaders privately justified it as a defensive weapon and within the confines of the constitution, their argument was limited due to fear of international reaction, instability, and outbreak of war.⁷³

Sato had to balance his desire for nuclear weapons with the desires of his population and those of the United States. As a campaign promise, Sato pledged to receive Okinawa back from the United States, which occurred in 1972. Although U.S. occupation of the island offered protection in the form of nuclear weapons stationed there, which Sato liked, the public would not accept Japanese accommodation of the weapons after the island's return. The 1,300 weapons stationed there were returned to the United States in June 1972.⁷⁴ Fearful of Sato's discussion about nuclear weapons, the Johnson administration began pushing Japan to sign the NPT. In an effort to appease both sides, Sato promoted U.S. policies during the Vietnam War, secretly hosted U.S. nuclear-powered aircraft carriers and announced in 1967 and 1968, Japan's "Three Non-Nuclear Principles" and "Four Nuclear Policies." Although not law, the principles hold that Japan will not manufacture, possess, or allow nuclear weapons into Japan. The four policies commit Japan to peaceful uses of nuclear energy, efforts toward global disarmament, reliance on U.S. extended deterrence, and support for the Three Non-Nuclear Principles as long as national security is assured.⁷⁵

Although Sato publically denounced nuclear weapons, he secretly ordered the "Study Group on Democracy" to investigate if building a nuclear weapons capability was in Japan's best interest. The study's conclusion in the 1968/70 internal report explained that technically and economically such a project could be conceived, but political and security concerns limited the weapon's acceptability. The study highlighted that the U.S. nuclear umbrella sufficiently guaranteed Japan's security, while developing an indigenous program, especially a small one, would make the nation more vulnerable with

⁷² Ibid., 222.

⁷³ Campbell and Sunohara, "Japan: Thinking the Unthinkable," 222.

⁷⁴ Furukawa, "Japan's Nuclear Option," 18.

⁷⁵ Campbell and Sunohara, "Japan: Thinking the Unthinkable," 223.

Japan's population density representing a defenseless target.⁷⁶ The study also suggested that nuclear weapons would isolate Japan from allies and the rest of the world, two elements that it relied on for security and economic prosperity. Finally, the report averred that the benefits from such an endeavor would be less reliance on the United States, avoidance of entanglement with U.S. interests, and national pride.⁷⁷

An additional study in the late 1960s by the Research Commission on National Security suggested that plutonium weapons could be produced at a rate of 20 per year and most effectively delivered by submarine. Research conducted in 1969 by the Ministry of Foreign Affairs concluded that although Japan should maintain its nuclear abstinence, it would behoove itself to achieve a latent capability. This was intended to give Japan the option to produce weapons relatively quick and also a reminder to the United States of its potential. Furthermore, it suggested that Japan should educate its population that nuclear policy is based on developments in the international environment. Defense Minister Yasuhiro Nakasone initiated an additional study in 1970, which provided similar analysis to prior reports.⁷⁸

Additional threats to Japanese security in the early 1990s surfaced when U.S. intelligence revealed that North Korea had developed a secret nuclear weapons program and that China continued to improve its arsenal. This took place in the aftermath of the Gulf War and during tense periods between China and Taiwan, and Pakistan and India.⁷⁹ In addition to a North Korean threat of a weapons program and its insistence of withdrawing from the NPT, the push for indefinite extension of the NPT in 1995 provoked additional debate and research.⁸⁰ Despite concerns over an extension's effect of denying Japan weapons forever and the inevitable lack of effort towards disarmament, the new government accepted the extension. This stance was confirmed by a Japanese

⁷⁶ Etel Solingen, "The Perils of Prediction: Japan's Once and Future Nuclear Status," in *Forecasting Nuclear Proliferation in the 21st Century: A Comparative Perspective*, vol. 2, ed. William C. Potter and Gaukhar Mukhatzhanova, 131–157 (Stanford, CA: Stanford University Press, 2010), 133.

⁷⁷ Rublee, "Future of Japanese," 1–2.

⁷⁸ Furukawa, "Japan's Nuclear Option," 18–20.

⁷⁹ Campbell and Sunohara, "Japan: Thinking the Unthinkable," 226–27.

⁸⁰ Solingen, "Perils of Prediction," 143–145.

Defense Agency study, which declared that nuclear weapons would destroy the balance of power in the region, cause an arms race, destroy the nonproliferation regime, and negatively affect the U.S. nuclear umbrella. The study also averred that such a program would portray Japan as distrustful and cost too much.⁸¹

In 1998, Japan's non-proliferation resolve was challenged again when India and Pakistan both conducted successful nuclear tests. The perceived casual response from the international community frightened Japan as it expected NPT violators to be severely punished.⁸² Later that year, North Korea launched a Taepo-Dong missile over Japan. This threat sparked discussion of remilitarization, nuclear weapons, and pre-emptive strikes on North Korea. Despite the public's continued aversion to nuclear weapons, events such as these give conservative arguments more credence. Although Vice Defense Minister Shingo Nishimura was forced to resign after he stated in 1999 that Japan would benefit from nuclear weapons, then Deputy Chief Cabinet Secretary Shinzo Abe explained that weapons would not violate the constitution.⁸³

The year 2002 represented another year in which North Korea challenged Japan's nonproliferation stance. It was confirmed that North Korea maintained a secret enrichment program, abducted Japanese citizens, and stated that "arms" more effectively dealt with Japan than "words."⁸⁴ After North Korea's first nuclear test in 2006, Japan revealed the results of another secret study, "On the Possibility of Developing Nuclear Weapons Domestically," which supported the conclusions of earlier studies.⁸⁵ Although these studies reaffirm Japan's nonproliferation commitments, each one represents a sector of government that remains open to nuclear weapons. Maria Rost Rublee suggests that although some, particularly in the Liberal Democratic Party, favor nuclear weapons, the

⁸¹ Rublee, "Future of Japanese," 2–3.

⁸² Campbell and Sunohara "Japan: Thinking the Unthinkable," 228.

⁸³ *Ibid.*, 229.

⁸⁴ Rublee, "Future of Japanese," 3.

⁸⁵ *Ibid.*

point of their raising the issue was directed less at an actual program, and aimed more at publicizing the debate and testing the population's tolerance for nuclear discussion.⁸⁶

E. CIVILIAN NUCLEAR POWER

Japan began its nuclear energy program in 1954 when it allocated funds for nuclear research and development. In 1955, the Atomic Energy Basic Law was passed, which created the Japanese Atomic Energy Commission and other organizations to pursue peaceful nuclear energy. The Japan Power Demonstration Reactor was the country's first power producing reactor and ran from 1963 to 1976. Japan imported its first commercial reactor from the United Kingdom and began operations in 1966. In 1955, the United States and Japan signed the Agreement for Cooperation Between the Government of the United States of America and the Government of Japan Concerning Civil Uses of Atomic Energy, which allowed for the exchange of nuclear material and equipment, including enriched uranium and reactors.⁸⁷

U.S. companies such as General Electric and Westinghouse partnered with Japanese companies to provide the island country with not only nuclear reactors and equipment, but also the training and expertise that allowed Japan to construct its own. While Japan was a key importer of U.S. nuclear technology and material during the 1960s, 70s, and 80s, it purchased more than 60 percent of all U.S. nuclear exports during the 14 years from 1994 to 2008. In 2009, Japan imported more than \$300 million worth of U.S. enriched uranium.⁸⁸

Since 1970, Japan brought 54 reactors into operation and continues, despite setbacks, to develop plans for its fast breeder reactor program. Before shutting down its reactors due to the Fukushima disaster, Japan relied on nuclear power to produce

⁸⁶ Ibid., 3–4.

⁸⁷ Jane Nakano, "Civilian Nuclear Energy Cooperation Between the United States and Japan," in *The New Nuclear Agenda: Prospects for US-Japan Cooperation*, ed. Yuki Tatsumi (Washington, DC: Henry L. Stimson Center, 2012), 44–45, http://www.stimson.org/images/uploads/research-pdfs/New_Nuclear_Agenda_FINAL_3_15_12.pdf.

⁸⁸ Paul K. Kerr, Mark Holt, and Mary Beth Nikitin, *Nuclear Energy Cooperation with Foreign Countries: Issues for Congress* (CRS Report No. R41910) (Washington, DC: Congressional Research Service, July 11, 2011), 4–5, <http://fas.org/sgp/crs/nuke/R41910.pdf>.

approximately 30 percent of its electricity.⁸⁹ Furthermore, Japan imports more than 80 percent of its energy resources, making nuclear self-sufficiency a priority.⁹⁰ In April 2014, Kazuo Ishikawa, former Trade Ministry official stated “Japan must continue to work on the nuclear fuel cycle. Japan’s energy security depends on it.”⁹¹

Although Japan imports all of its natural uranium and most of its enriched uranium from the United States, France, the United Kingdom, China, Canada, and Australia, it has developed a substantial front end fuel cycle. Japan Nuclear Fuel Ltd. operates a commercial enrichment plant at Rokkasho with another plant being planned by Toshiba and the Russian nuclear corporation Rosatom. Fuel fabrication is accomplished at three facilities operated by Mitsubishi Nuclear Fuel Co. Ltd. and Japan’s Nuclear Fuel Industries. The three facilities are capable of fabricating a combined 900 tons of uranium fuel per year.⁹²

In order to make the most of its imported uranium, Japan has invested heavily in the back end of its fuel cycle to reprocess spent fuel and extract the unused uranium and plutonium. While Japan relied on British and French companies to reprocess more than 7,000 tons of spent fuel, the Tokai reprocessing facility has been in operation since 1977 and is capable of reprocessing spent fuel into 40 tons of MOX per year. In addition, the Rokkasho nuclear facility has the capacity of reprocessing 800 tons of spent fuel per year, but has yet to operate at full capacity and is under full IAEA safeguards.⁹³ The importance of reprocessing is that plutonium in spent fuel is not weapons-usable, but after it is separated out through reprocessing it is possible to use in nuclear weapons.⁹⁴

⁸⁹ “Nuclear Power in Japan,” World Nuclear Association (WNA), last modified February 26, 2014, <http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Japan/>.

⁹⁰ WNA, “Nuclear Power in Japan.”

⁹¹ Hiroko Tabuchi, “Japan Pushes Plan to Stockpile Plutonium, Despite Proliferation Risks,” *The New York Times*, April 9, 2014, http://www.nytimes.com/2014/04/10/world/asia/japan-pushes-plan-to-stockpile-plutonium-despite-proliferation-risks.html?_r=0.

⁹² WNA, “Nuclear Power in Japan.”

⁹³ *Ibid.*

⁹⁴ Chanlett-Avery and Nikitin, *Japan’s Nuclear Future*, 4.

Japan has also invested heavily into its fast breeder reactor program, but due to construction delays and continuous problems, it has sidelined breeder reactors as the mainstay to its nuclear energy security. Proclaimed to guarantee Japan nuclear energy security, fast reactors have been the center of Japan nuclear energy policy since the 1950s and were expected to be the primary reactors in Japan by 2050. Japan's first fast reactor, Joyo operated approximately 30 percent of the time from 1977 to 2007. Japan's other fast reactor Monju has operated for approximately two years since 1994 and is currently offline due to mechanical failures that included a sodium leak in 1995 and additional faulty reactor components in 2010.⁹⁵

Although the fast reactor program maintains a reduced status, Japan's capabilities and accumulation of plutonium concern nonproliferation advocates. Currently, Japan possesses approximately 45 tons of civil plutonium, of which 10 tons are stored in Japan. Frank N. von Hippel and Masafumi Takubo explain that although Japan's plutonium stockpile is reactor-grade, it can be used to make more than 1,000 nuclear explosives.⁹⁶

Furthermore, after the Fukushima disaster, Japan shut down its reactors, but continues work on the Rakkasho reprocessing. According to Steven Fetter, the former Assistant Director of the White House Office of Science and Technology Policy, the continuation of such a facility, without plans to put forth its product for energy uses, has led many to believe that Japan seeks a latent deterrent. Fetter also suggests that this capability could possibly force others to reconsider their nonproliferation commitments.⁹⁷

⁹⁵ Tatsujiro Suzuki, "Japan's Plutonium Breeder Reactor and its Fuel Cycle," in *Fast Breeder Reactor Programs: History and Status* (Princeton, NJ: International Panel on Fissile Materials, February 2010), 53–55, <http://fissilematerials.org/library/rr08.pdf>; "Japan to Drop Troubled Fast Breeder Reactor from Energy Plan," *Nikkei Asian Review*, February 7, 2014, <http://asia.nikkei.com/Politics-Economy/Policy-Politics/Japan-to-drop-troubled-fast-breeder-reactor-from-energy-plan>.

⁹⁶ Masafumi Takubo and Frank N. von Hippel, *Ending Reprocessing in Japan: An Alternative Approach to Managing Japan's Spent Nuclear Fuel and Separated Plutonium* (Princeton, NJ: International Panel of Fissile Materials, 2013), 15, <http://fissilematerials.org/library/rr12.pdf>.

⁹⁷ Shannon Tiezzi, "Japan's Plutonium Problem," *The Diplomat*, February 19, 2014. <http://thediplomat.com/2014/02/japans-plutonium-problem/>.

Despite these concerns and mounting costs of the reprocessing program, in which the Rakkasho facility has accrued a \$22 billion bill, Japan remains committed to closing the fuel cycle and securing energy independence.⁹⁸

Although Japan stockpiles plutonium, Japanese nuclear policy expert Katsuhisa Furukawa explains that not only is the plutonium under IAEA safeguards, but that it would likely take between three to five years to produce a device. He attributes this to Japan's limited domestic stock of uranium, its vulnerability to nuclear fuel embargoes, its pacifist society, its lack of experience and nuclear doctrine, and the absence of a command and control, intelligence, and operation security systems.⁹⁹

An additional aspect of Japan's civilian nuclear program that gives credence to the country's innovation is its past interest in nuclear propulsion. Prior to and during WWII, Japan's naval officials grew concerned over its oil reserves and researched the utility of nuclear powered vessels. Although the war limited the military program, a nuclear powered merchant ship, Mutsu, was put into service in 1970.¹⁰⁰ Believed by many Japanese officials to be the first in a fleet of nuclear powered merchant ships, Mutsu suffered technical and political problems.

Its first sea trial was delayed due to the local fishing industry's concern of radioactive contamination. Only after Japanese officials agreed to tow the ship to the open ocean was the Mutsu released from her berth in 1974.¹⁰¹ When the ship's reactor achieved criticality a safety alarm alerted the crew that a radiation leak was present and the reactor was subsequently shutdown. Another controversy developed when fishermen blocked the Mutsu's return to the port of Mutsu for 45 days.¹⁰² After its return, Mutsu's

⁹⁸ Hiroko Tabuchi, "Japan Pushes Plan to Stockpile Plutonium, Despite Proliferation Risks," *The New York Times*, April 9, 2014, <http://thediplomat.com/2014/02/japans-plutonium-problem/>.

⁹⁹ Furukawa, "Japan's Nuclear Option," 25–26.

¹⁰⁰ "Nuclear-Powered Ships," World Nuclear Association (WNA), last modified April 2014, <http://www.world-nuclear.org/info/non-power-nuclear-applications/transport/nuclear-powered-ships/>.

¹⁰¹ "Nuclear Ship Mutsu - Development," GlobalSecurity.org, last modified July 16, 2012, <http://www.globalsecurity.org/military/world/japan/ns-mutsu-dev.htm>.

¹⁰² Ronald E. Yates, "Setbacks Submerge Japan's Nuclear Ship," *Chicago Tribune*, September 2, 1990, http://articles.chicagotribune.com/1990-09-02/news/9003130692_1_reactor-radiation-ship.

reactor underwent extensive overhaul and was retested in 1991. After four successful sea trials, the Japanese gained experience in design, construction, and operation of nuclear vessels.¹⁰³ One year later, the ship was decommissioned.

While Mutsu experienced technical and political difficulties, Japan continued its marine reactor research and development. In 1996 and 1997, Japan produced safer and more reliable prototype reactors known as the Marine Reactor X and Deep-Sea Reactor X.¹⁰⁴ Japan does not currently have a nuclear powered ship, but the two reactors were developed for future use.

The continuation of this program demonstrates Japan's pursuit of alternate fuel sources for its commercial vessels. Although not intended to be devious, marine nuclear propulsion provides an additional avenue to weapons-grade material. Although Mutsu used LEU of four percent,¹⁰⁵ the NPT does not limit enrichment levels of naval propulsion reactors.¹⁰⁶

F. NON-PROLIFERATION COMMITMENTS

In addition to bilateral pacts with the United States, Japan made other moves to solidify its commitment to nonproliferation and disarmament. On December 19, 1955, the Diet adopted Japan's Atomic Energy Basic Law, which states that Japan would only seek peaceful nuclear pursuits. Furthermore, Japan joined the IAEA in 1957. Comfortable with his country's security environment, Prime Minister Hayato Ikeda focused national efforts to revitalize Japan's economy and make it a world leader by the end of the 1960s.¹⁰⁷

While the Lyndon Johnson administration pressured Japan to sign the NPT in 1968, Japan's leaders debated the treaty's advantages. Although deliberations were tense, both sides agreed that the NPT unfairly treated non-weapon states by banning them from

¹⁰³ "Nuclear Ship Mutsu—Operations," GlobalSecurity, last modified July 16, 2012, <http://www.globalsecurity.org/military/world/japan/ns-mutsu-ops.htm>.

¹⁰⁴ "MRX (Marine Reactor X)," GlobalSecurity, Last modified July 16, 2012, <http://www.globalsecurity.org/military/world/japan/ns-mrx.htm>.

¹⁰⁵ WNA, "Nuclear-Powered Ships."

¹⁰⁶ Moltz, "Closing the NPT," 108.

¹⁰⁷ Solingen, *Nuclear Logics*, 70.

ever acquiring nuclear weapons, while it did too little to address nuclear weapons states' commitments to disarmament. Furthermore, Japan's Foreign Ministry conducted a policy study. This study claimed that if Japan signed the NPT it should keep the economic and technical ability to develop weapons, for the future might necessitate their availability. Although Japan signed the NPT in 1970, it took until 1976 to ratify the treaty on the preconditions that West Germany would sign and ratify, and a U.S. guarantee that it would not interfere with Japan's civilian reprocessing activities.¹⁰⁸ The debate surrounding ratification was intense because Japan viewed the treaty as a "commitment they would unlikely break," but understood that any further delay could cause greater suspicion from the international community and damage U.S.-Japan relations.¹⁰⁹

Japan is also a member of many organizations such as the United Nations, the Conference on Disarmament, the International Atomic Energy Agency, the Organization for the Prohibition of Chemical Weapons (OPCW), and the Comprehensive Test Ban Treaty Organization Preparatory Commission. In addition to the NPT, Japan is a state party to other nuclear treaties and agreements such as Comprehensive Nuclear Test Ban Treaty (CTBT), Partial Test Ban Treaty (PTBT), Joint Spent Fuel Convention, Convention on the Physical Protection of Nuclear Material, Zangger Committee, Nuclear Supplier Group, Australia Group, Missile Technology Control Regime, Wassenaar Arrangement, and has signed an IAEA Safeguards Agreement and placed in force the Additional Protocol.¹¹⁰ Japan also works with the IAEA and other multilateral efforts toward future fuel cycle technologies such as Generation IV Nuclear Reactors (Gen IV), International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), and the Global Nuclear Energy Partnership (GNEP), which researches and develops future nuclear technologies with the highest standards for safety, security, and nonproliferation.¹¹¹

¹⁰⁸ Campbell and Sunohara "Japan: Thinking the Unthinkable," 225.

¹⁰⁹ Rublee, "Future of Japanese," 2.

¹¹⁰ "Japan - Inventory of International Nonproliferation Organizations and Regimes," James Martin Center for Nonproliferation Studies, last modified May 25, 2012, <http://cns.miis.edu/inventory/pdfs/japan.pdf>.

¹¹¹ Chanlett-Avery and Nikitin, *Japan's Nuclear Future*, 6.

G. KEEPING THE OPTION OPEN

Although public discussion over nuclear weapons has somewhat opened, Japan's population remains largely anti-nuclear. Being the case, the government is unlikely to go against its citizens' desires, but views that having the option available is important. Former Prime Minister Junichiro Koizumi explained that although Japan does not have nuclear weapons, it is possible to get them. Furthermore, in 2003, Chief Cabinet Secretary Yasuo Fukuda reiterated Koizumi's sentiment, and Shinzo Abe added that nuclear weapons are permitted if they are defensive. All three agreed that although keeping the option open is important for Japan's future leaders, the country does not intend on a weapons capability for the distant future.¹¹² Furthermore, Kyoto University Professor Terumasa Nakanishi argued that Japan should attain an infrastructure that would allow the country to quickly build nuclear weapons. He described three situations in which Japan might need nuclear weapons. These include a deterioration of the U.S. commitment; China attaining a naval capability that allows it to maintain a permanent presence in the vicinity of Japan; and the international community accepting North Korea with a nuclear arsenal.¹¹³

H. CONCLUSION

Although Japan's nuclear industry has been setback by the 2011 Fukushima meltdown, it still maintains a robust nuclear infrastructure. Japan has advanced enrichment and reprocessing capabilities, which allow it to stockpile great amounts of weapons usable nuclear material. Japan has enough plutonium within its borders for more than 1,000 weapons.¹¹⁴ Japan also has the technological acumen and financial resources to build a weapon if so desired. These capabilities to build nuclear weapons were not accidents, but purposefully maintained. In 1994, a Japanese newspaper, *Mainichi Shimbun*, reported that a top secret document, "Our Nation's Foreign Policy Principles" established the criterion that Japan continues its nonproliferation stance, but keep the

¹¹² Campbell and Sunohara "Japan: Thinking the Unthinkable," 230.

¹¹³ Furukawa, "Japan's Nuclear Option," 22–23.

¹¹⁴ Tiezzi, "Japan's Plutonium Problem."

financial and technical capacity to build nuclear weapons.¹¹⁵ Furthermore, Japan is situated in a dynamic security environment, and studies suggest that it is beneficial for the country to refrain from nuclear weapons, but maintain the option for future considerations.

¹¹⁵ Norihiro Kato, "Ambiguities of Japan's Nuclear Policy," *The New York Times*, April 13, 2014, http://www.nytimes.com/2014/04/14/opinion/kato-ambiguities-of-japans-nuclear-policy.html?_r=0.

IV. BRAZIL

A. INTRODUCTION

Brazil's nuclear history began in the 1950s and was founded on aspirations of prestige, power, energy independence, scientific achievement, economic prosperity, and global integration. Although it began and is currently under civilian control, Brazil's nuclear program advanced rapidly under the tutelage of its military. It not only began a nuclear weapons program, which it later renounced, but also successfully enriched uranium and began a nuclear submarine program. Furthermore, Brazil has experienced setbacks from the international community, which it views as the result of the imbalance between the nuclear weapon states and non-nuclear weapon states. Although Brazil is a member, or state party, to many nuclear organizations and agreements that dedicate the country to nonproliferation and disarmament, it continues to have a tense relationship with the international nonproliferation regime. Among other elements of its nuclear program, Brazil stresses its need to domestically produce nuclear energy and its rights as a NNWS under the NPT. Although Brazil is constrained by regional and international commitments, its refusal to sign the IAEA Additional Protocol and its pursuit of nuclear submarines not only questions its intentions, but allows the country to close the gap between its current capabilities and the nuclear weapons threshold.

B. HISTORY

In 1951, Brazil established the National Research Council, later renamed the National Council for Scientific and Technological Development to lead Brazil's nuclear efforts. Similar to other nuclear aspirants, Brazil sought foreign assistance for nuclear know-how and material. In 1953–1954, Brazil attempted to acquire nuclear technology from West Germany and France, but U.S. concerns of proliferation blocked the transfer of ultracentrifuges from Germany, and internal political turmoil in Brazil prevented a deal with France. Undeterred, Brazil opted to take advantage of the U.S. Atoms for Peace

program and signed a deal with the United States that built a research reactor for Brazil in exchange for a pledge to engage only in peaceful uses.¹¹⁶

Maintaining the commitment toward its “brilliant future,”¹¹⁷ Brazil’s military government, led by President Marshal Artur da Costa e Silva, decided to pursue the full nuclear fuel cycle. In 1971, Brazil’s National Nuclear Energy Commission (CNEN) agreed with Westinghouse and the U.S. Atomic Energy Commission to build and supply the fuel for Angra 1, Brazil’s first nuclear power plant.¹¹⁸ In 1973, Brazil attempted to renew its contract with Westinghouse with the added provision that the supplier provide Brazil with enrichment capability. Westinghouse agreed to build more reactors, but refused to provide enrichment resources as Brazil was still outside the NPT.¹¹⁹

Another setback to Brazil’s full cycle came shortly after India’s test of a nuclear device in 1974. Concerned over proliferation, the United States strengthened its control over exporting nuclear technology. The Atomic Energy Commission (AEC) required countries to purchase enriched uranium by certain dates. This new requirement caused an “inflated demand” that the AEC was unsure it could fulfill.¹²⁰ To solve this problem, the AEC limited the supply and turned permanent contracts into conditional ones. For Brazil, this meant that its fuel supply and Westinghouse contract were in jeopardy. From this, Brazil realized the importance of a domestic capability and no longer viewed the United States as a “reliable nuclear trading partner.”¹²¹

In 1975, Brazil turned to West Germany to construct eight reactors and provide full nuclear fuel cycle technology. Originally covering mining, enrichment, fuel

¹¹⁶ Togzhan Kassenova, *Brazil’s Nuclear Kaleidoscope* (Washington, DC: Carnegie Endowment for International Peace, March 12, 2014), 17–18.

¹¹⁷ Virginia Gamba-Stonehouse, “Argentina and Brazil,” in *Security with Nuclear Weapons?: Different Perspectives on National Security*, ed. Regina Cowen Karp (New York: Oxford University Press, 1991), 232.

¹¹⁸ Diego Santos Vieira de Jesus, “The Brazilian Way: Negotiation and Symmetry in Brazil’s Nuclear Policy,” *The Nonproliferation Review* 17, no. 3 (2010), 553, <http://www.tandfonline.com/doi/pdf/10.1080/10736700.2010.517003>.

¹¹⁹ Kassenova, *Brazil’s Nuclear Kaleidoscope*, 18.

¹²⁰ *Ibid.*, 19.

¹²¹ Michael Barletta, *The Military Nuclear Program of Brazil*, Working Paper (Stanford, CA: Center for International Security and Arms Control, 1997), 14, <http://iis-db.stanford.edu/pubs/10340/barletta.pdf>.

fabrication, reprocessing, and power plant construction, the deal was criticized by the United States. This led West Germany to provide Brazil with the less efficient jet-nozzle method of enrichment and place all Brazilian facilities under safeguards.¹²² In 1978, under President Carter, the United States passed the U.S. Nuclear Non-Proliferation Act that required nuclear safeguards on imported material and equipment. Viewing this as another hindrance to autonomy, Brazil's Ministry of Mines and Energy stated, "our nuclear program will continue...we do not want the atomic bomb. We want to be independent, to construct for our future, and to prevent the effect of any future world petroleum and energy crisis."¹²³ In response to the barriers placed on its nuclear program, the military proposed a parallel program that promoted independence, self-sufficiency, and technical achievement.

C. PARALLEL PROGRAM AND RIVALRY WITH ARGENTINA

Officially titled the Brazilian Autonomous Program of Nuclear Technology (PATN), Brazil's secret military nuclear program included all three services. The Air Force studied laser enrichment and the Army researched graphite reactors. The Navy focused on both enrichment and nuclear submarines.¹²⁴ Working with the Institute of Technological Research (IPEN), the Navy program evolved the quickest and survived the longest. By 1981 the Navy built two centrifuges and a cascade of nine by 1984.¹²⁵ In 1986 it had mastered the enrichment process, but to ensure the program continued to receive material and equipment, its success was not announced until September 1987.¹²⁶

Although a majority of the technologies were domestically produced, the parallel program benefited from foreign assistance. Many scientists and engineers received education in the United States and advanced training in West Germany, particularly in

¹²² Barletta, *Military Nuclear Program*, 4–5.

¹²³ Kassenova, *Brazil's Nuclear Kaleidoscope*, 20.

¹²⁴ *Ibid.*, 23.

¹²⁵ *Ibid.*

¹²⁶ Barletta, *Military Nuclear Program*, 6.

areas of nuclear safety and material management. Brazil also clandestinely received 200 kilograms of uranium hexafluoride from China and special instrumentation to construct ultracentrifuges from West Germany.¹²⁷

Furthermore, the program was in competition with Argentina's own secret program. Similar to Brazil, Argentina initiated its nuclear program in the 1950s, relied on the United States and West Germany for material and expertise, and suffered similar setbacks due to supply controls. In the 1970s, Argentina led South America in the nuclear field and produced power in 1974 with plans to build a reprocessing plant and enrichment facility by 1978. While neither country viewed the other as a threat,¹²⁸ Brazil urgently believed that it needed the capability to make a bomb. Not to construct and unveil a bomb, but to have the option of developing one. "The mere capacity to match a potential Argentine bomb was presumed sufficient to deter its construction."¹²⁹ This assessment matched a 1983 National Intelligence Estimate, which asserted that because Brazil refrained from signing the NPT and believed that peaceful nuclear explosions (PNE) were a right, the country at the very least sought the option.¹³⁰

Rather than starting an arms race, the neighboring countries supported each other's programs. By the mid-1980s the two revealed their secret programs and began cooperating. Politics, economics, civilian leadership, presidential leadership, external suspicion, and frustration with nuclear suppliers enhanced cooperation between the two. This cooperation not only advanced nuclear development, but as Virginia Gamba-Stonehouse suggests, it also advanced security and stability.¹³¹ In 1985, Argentine President Raul Alfonsin and Brazilian President Jose Sarney signed the Joint Declaration on Nuclear Policy, which declared cooperation between the two and any other Latin

¹²⁷ Ibid., 13.

¹²⁸ Kassenova, *Brazil's Nuclear Kaleidoscope*, 22.

¹²⁹ Barletta, *Military Nuclear Program*, 15.

¹³⁰ Director of Central Intelligence, *Brazil's Changing Nuclear Goals: Motives and Constraints* (Special National Intelligence Estimate, October 21, 1983), 2, http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000787519.pdf.

¹³¹ Gamba-Stonehouse, "Argentina and Brazil," 236.

American country seeking nuclear energy for peaceful purposes. This expanded the Cooperation Agreement for the Development and Application of the Peaceful Uses of Nuclear Energy signed in 1980.

While many other agreements between Brazil and Argentina were signed, the bilateral agency, Brazilian-Argentine Agency for Accounting and Control of Nuclear Material (ABACC) was formed in 1991. This entity ensured the peaceful uses of nuclear energy, informed each side on the other's activities, and permitted access to one another's military installations for verification purposes. Established before either signed the NPT, and viewed as less strict than the IAEA Additional Protocol, its verification methods are recognized by the NSG and allow Brazil and Argentina to participate in the trade of enrichment and reprocessing technology.¹³² Furthermore, the ABACC, Brazil, Argentina, and the IAEA formed the Quadripartite Agreement, which extended safeguards established in the ABACC and allowed the IAEA to conduct its own verification processes.¹³³

Although organizations and agreements such as these promote cooperation and understanding, tensions still arise. Argentina still fears that Brazil will seek nuclear weapons when political elites publically discuss the possibility of nuclear devices. In 2009, Brazil's Jose Alencar, then vice president and former defense minister, stated that nuclear weapons could provide a deterrent capability and boost international recognition.¹³⁴ While most believe that Brazil should adhere to its constitution and nuclear commitments, others view India as an example of how nuclear weapons can still benefit a nation.¹³⁵

¹³² Kassenova, *Brazil's Nuclear Kaleidoscope*, 63.

¹³³ Etel Solingen, "Hindsight and Foresight in South American Nonproliferation Trends in Argentina, Brazil, and Venezuela," in *Over the Horizon Proliferation Threats*, ed. James J. Wirtz and Peter R. Lavoy (Stanford, CA: Stanford University Press, 2012), 142–143.

¹³⁴ *Ibid.*, 146.

¹³⁵ Irma Arguello, "The Position of an Emerging Global Power: Brazilian Responses to the 2010 U.S. Nuclear Posture Review," *The Nonproliferation Review* 18, no. 1 (2011), 193, <http://www.tandfonline.com/doi/pdf/10.1080/10736700.2011.549180>.

Another area that causes concern not only for Argentines, but also the rest of the world, is Brazil's nuclear submarine program. Even after a civilian government took over from the military in 1985, the Navy program continued to proceed and receive government support. Shutting the parallel program down, President Fernando Collor de Mello and his successors Itamar Franco and Fernando Cardoso cut the submarine program's budget, but did not cancel it altogether.¹³⁶ Despite this trend, the Cardoso government contracted with the Navy in 2000 to construct a uranium enrichment facility at Resende. Construction and testing were completed in 2004 and the first of four cascade modules became operational in 2005.¹³⁷ In 2003, newly elected President Luiz Inacio Lula da Silva supported the submarine program and for the first time, civilians rather than solely the military promoted the nuclear submarine program.¹³⁸

D. WHY A NUCLEAR SUBMARINE?

When the parallel program began, Brazil's Navy worked for an enrichment capability to fuel a nuclear submarine. Although regional and global circumstances have changed since the program's inception, the reasoning for building a nuclear powered submarine has remained constant. To support the objectives of sea denial, sea control, and power projection, Brazil's National Strategy of Defense explained the utility of nuclear submarines.¹³⁹

Since the 1960s, Brazil considered power projection to be attained through the "maritime security area," which pertained to the South Atlantic, but has since expanded globally.¹⁴⁰ Beginning with waters closer to home, Brazil's priority is the protection of its 5,000 mile coastline, the 70 percent of its population living within 200 miles of the sea, the large amount of economic activity that takes place on the coast, and its offshore

¹³⁶ Kassenova, *Brazil's Nuclear Kaleidoscope*, 27.

¹³⁷ Santos Vieira de Jesus, "Brazilian Way," 558.

¹³⁸ Kassenova, *Brazil's Nuclear Kaleidoscope*, 28.

¹³⁹ Brazil, Ministry of Defense, *National Strategy of Defense* (Brazil: December 18, 2008) http://www.defesa.gov.br/projetosweb/estrategia/arquivos/estrategia_defesa_nacional_ingles.pdf.

¹⁴⁰ Gamba-Stonehouse, "Argentina and Brazil," 240.

natural resources.¹⁴¹ Although Taylor explains that nuclear submarines are ill suited to protect oil platforms as they do not present a visual deterrent, like patrol craft, former Vice President Alencar justified nuclear submarines by explaining that Brazil needs one to protect and deter aggressors from encroaching on its four million miles of economic exclusion zone and its recently discovered oil and natural gas fields.¹⁴²

In addition, Brazil fears foreign presence in its maritime domain. The potential effectiveness of submarines conjures up memories of the 1982 Falkland/Malvinas War, in which a British sub not only sank the Argentine *General Belgrano*, but also marginalized the rest of its navy.¹⁴³ The 2008 reestablishment of the U.S. Fourth Fleet concerns Brazil because its responsibilities include the waters surrounding South America.¹⁴⁴

Brazil maintains that technological development spurs industrial advancement. This was evident in the late 1960s when Embraer Aeronautics developed a number of aircraft for the military that were later converted to civilian use and subsequently exported. Similarly, former President Lula da Silva views the submarine project as not only a path to Brazilian technological achievement and independence, but also a benefit to the economy. The submarine program alone is expected to include 30 companies, employing 8,000 Brazilians, and supplying more than 36,000 parts and supplies. This does not include the construction of the shipyard and base for future subs.¹⁴⁵ Like Embraer, Brazil plans to export nuclear sub technology.¹⁴⁶

Brazil also views nuclear submarines as an avenue to modernity and political prestige. As one of the top ten economies in the world, Brazil has no affiliation with nuclear weapons, but is the first NNWS to pursue a nuclear submarine. In addition, Brazil

¹⁴¹ Kassenova, *Brazil's Nuclear Kaleidoscope*, 31.

¹⁴² Paul D. Taylor, "Why Does Brazil Need Nuclear Submarines?" *Proceedings* 135, no. 6 (June 2009), <http://www.usni.org/magazines/proceedings/2009-06/why-does-brazil-need-nuclear-submarines>.

¹⁴³ Barletta, *Military Nuclear Program*, 9.

¹⁴⁴ Taylor, "Why Does Brazil?"

¹⁴⁵ Sarah Diehl and Eduardo Fujii, "Brazil's New National Defense Strategy Calls for Strategic Nuclear Developments," Nuclear Threat Initiative, October 30, 2009, <http://www.nti.org/analysis/articles/brazils-new-defense-strategy/>.

¹⁴⁶ Taylor, "Why Does Brazil?"

is the only BRIC (Brazil, Russia, India, China) country without a nuclear sub. To become a global player, Brazil believes that a nuclear submarine would make a strong case for such a role.¹⁴⁷

E. NUCLEAR SUBMARINES AND THE THRESHOLD

Nuclear submarines allow NNWS to legally approach the nuclear weapons threshold because the NPT makes no mention of nuclear propulsion reactors (NPR). This omission allows NNWS to utilize HEU, or weapons grade uranium, for its naval propulsion needs. While this fuel is being used in a “non-explosive” manner, it is withdrawn from safeguards and offers an opportunity for diversion.¹⁴⁸ Furthermore, stockpiles of HEU can be claimed to be stored for this and other military purposes allowing states the ability to “rapidly break out of the NPT.”¹⁴⁹

Although the United States and United Kingdom navies reportedly use HEU in excess of weapons grade for their NPRs, reports indicate that Brazilian naval reactors will use less than 20 percent enriched uranium. While the Nuclear Threat Initiative estimates that Brazil will use between seven and 10 percent enriched uranium,¹⁵⁰ Togzhan Kassenova explains that Brazil is likely to use 18-19 percent enriched uranium, but in coordination with ABACC and the IAEA, it could use uranium enriched beyond the 20 percent mark. The importance of the 20 percent mark is that “most of the isotope separative work needed to reach 90 percent enrichment is done.”¹⁵¹

In addition to having the legal capacity to enrich uranium beyond 90 percent and withdrawing the material from safeguards, Brazil contracted with the French company DCNS in 2008 to build its nuclear submarines, which agreed to provide training,

¹⁴⁷ Kassenova, *Brazil's Nuclear Kaleidoscope*, 37.

¹⁴⁸ Moltz, “Closing the NPT,” 109.

¹⁴⁹ Thielmann and Hoffman, “Submarine Nuclear Reactors,” 3–4.

¹⁵⁰ “Brazil Submarine Import and Export Behavior,” Nuclear Threat Initiative, July 18, 2013, <http://www.nti.org/analysis/articles/brazil-submarine-import-and-export-behavior/>.

¹⁵¹ Kassenova, *Brazil's Nuclear Kaleidoscope*, 29.

technology, and knowledge.¹⁵² Although Brazil is relatively inexperienced in nuclear submarine construction, over time it will gain experience and expertise to go along with its material production.

Despite its ability to close the threshold within a legal framework, Brazil negotiates with the ABACC and the IAEA to determine sufficient verification methods. As the first NNWS under the NPT to develop a nuclear submarine, it is important for Brazil to work with the IAEA and put safeguards on its NPR fuel to not only reassure the world that it will be used for peaceful purposes, but also to set a precedent for future submarine builders.¹⁵³

F. RELATIONSHIP WITH THE NPT AND IAEA

Although Brazil renounced nuclear weapons in its 1988 constitution, signed the NPT in 1998, and maintains a role in nonproliferation and disarmament efforts, it continues to have an uneasy relationship with the international nonproliferation regime. In response to its past military governments and weapons program, Brazil's 1988 Constitution states in Article XXI that "all nuclear activity within the national territory shall only be admitted for peaceful purposes and subject to approval by the National Congress."¹⁵⁴

Prior to its current constitution, Brazil laid the ground work for peaceful uses of nuclear energy. Upon its formation in 1967, Brazil signed the Treaty of Tlatelolco, which created a nuclear weapons free zone in Latin America and the Caribbean. Despite its signature, Brazil, like Argentina, did not accede to the treaty until 1994, but both abided by it. In 1984, Brazilian Air Force officials proposed the idea of conducting a PNE, but

¹⁵² Taylor, "Why Does Brazil?"

¹⁵³ Kassenova, *Brazil's Nuclear Kaleidoscope*, 38.

¹⁵⁴ Brazil, Chamber of Deputies, *Constitution of the Federative Republic of Brazil*, 3rd ed. (Brasilia: Documentation and Information Center Publishing Coordination, 2010), 32, <http://english.tse.jus.br/arquivos/federal-constitution>.

President Figueiredo concluded that although PNEs are “available”¹⁵⁵ to non-nuclear weapon states, a test would undermine the spirit of the treaty and direct undesired attention to Brazil’s main objective of enriching uranium.¹⁵⁶

To further their cooperation in economic, political, and societal matters, Brazil and Argentina signed nuclear deals that brought the countries closer together. In 1980, they signed the Cooperation Agreement for the Development and Application of the Peaceful Uses of Nuclear Energy; in 1985, they signed the Joint Declaration on Nuclear Policy; in 1991 they signed the Bilateral Agreement and the Quadripartite Agreement; and the NPT in 1998.

NPT ratification was not unanimously accepted throughout Brazil. Many believed that previous agreements such as the Tlatelolco Treaty, ABACC, and its own constitution sufficed to prevent Brazil from seeking nuclear weapons. Others argue that accession to the NPT was a move that gave Brazil “neither technological nor political gains.”¹⁵⁷

Brazil views the NPT as discriminatory and disproportionately favoring the nuclear weapon states (NWS), while limiting and burdening the NNWS. From Brazil’s perspective, the treaty suggests that the NWS will protect the NNWS from nuclear attack, “which went against a fundamental need of each country to be able to defend itself.”¹⁵⁸ In addition, the treaty was largely created by the NWS with too little consultation from the NNWS. This led to the belief that NWS placed NNWS in a “permanent condition of technological disadvantage.”¹⁵⁹

Furthermore, Brazil often cites the disparity between efforts toward nonproliferation and a lack of NWS commitment to disarmament. As a leader of international nonproliferation and disarmament efforts, Brazil actively participates within the New Agenda Coalition (NAC), which focuses global attention toward NWS

¹⁵⁵ IAEA, *Treaty of the Non-Proliferation*, Article V.

¹⁵⁶ Barletta, *Military Nuclear Program*, 19.

¹⁵⁷ Kassenova, *Brazil’s Nuclear Kaleidoscope*, 53.

¹⁵⁸ *Ibid.*

¹⁵⁹ Santos Vieira de Jesus, “Brazilian Way,” 553.

responsibilities of disarmament. During the 2000 NPT Review Conference, Brazil and the NAC established the 13 Practical Steps toward global disarmament.¹⁶⁰ Brazil argues that nonproliferation and disarmament are interdependent and that NNWS will not feel the need to develop their own weapons capabilities if they are assured that NWS are not developing new weapons or systems.¹⁶¹ While Brazil argues that the NWS remain noncommittal to their NPT Article VI obligations, it views measures such as the IAEA's Additional Protocol as another example of the nuclear haves dictating rights of the nuclear have-nots.

Brazil's contention with the IAEA's Additional Protocol is similar to that of the NPT. The Additional Protocol allows the IAEA greater access to both declared and undeclared nuclear information, equipment, material, and facilities. Specifically, it grants full access to a state's nuclear fuel cycle and allows for short notice access, as little as two hours, to facilities. Furthermore, the protocol is ambiguous about its inspections, particularly its ability to inspect mines, enrichment facilities, waste sites, "as well as to any other location where nuclear material is or may be present."¹⁶²

Presently, Brazil will not sign the Additional Protocol because it refuses to take on additional responsibility until the NWS make meaningful efforts toward disarmament. Brazil views it as insulting to its nonproliferation efforts and national pride. Brazilian officials claim that the IAEA neglects to consider Brazil's renouncement of nuclear weapons and the steps it has taken towards nonproliferation,¹⁶³ and that Brazil "does not want its autonomy curtailed even further."¹⁶⁴ Officials also argue that the protocol creates additional financial costs to developing countries because of further regulations and

¹⁶⁰ Kassenova, *Brazil's Nuclear Kaleidoscope*, 53.

¹⁶¹ Santos Vieira de Jesus, "Brazilian Way," 563.

¹⁶² International Atomic Energy Agency, "IAEA Safeguards Overview: Comprehensive Safeguards Agreements and Additional Protocols," last modified September 20, 2012, http://www.iaea.org/Publications/Factsheets/English/sg_overview.html.

¹⁶³ Solingen, "Hindsight and Foresight," 145.

¹⁶⁴ Rublee, "Nuclear Threshold States," 54.

believe that these countries should not have to dedicate funds to internationally mandated requirements. Moreover, Brazil believes that increased access will make its technology vulnerable to industrial espionage.¹⁶⁵

Although Brazil is concerned about protecting the secrecy of its submarine program's location and technology,¹⁶⁶ a recent example of Brazil's concern over protecting its centrifuges took place in 2004, when it denied the IAEA from conducting full inspections on its enrichment capabilities at the Resende enrichment facility. Panels placed in front of the centrifuges and casings obstructed IAEA access. This not only raised doubts about the intentions of its nuclear program, but also set a precedent for others who wished to "blackout" some of their nuclear equipment.¹⁶⁷ According to Maria Rost Rublee, Brazil denied access not to hide unlawful activity, but to establish limits on investigations and to protect proprietary technology that Brazil claims is 25 percent more efficient than centrifuges used by other nations. Despite the friction, the two sides negotiated a deal, which allowed Brazil to keep the panels in place, but at a reduced size.¹⁶⁸

G. CURRENT CAPABILITIES

Brazil has an abundance of uranium resources, which it uses for domestic use and international trade. Since 1982, Brazil has mined uranium from three mines, which hold five percent of the world's uranium deposits, but presently mines exclusively from Lagoa Real at a rate of 340 tons per year.¹⁶⁹ Additionally, Brazil enriches uranium at its Nuclear Fuel Factory at Resende to 3.5-4.0 percent for use in the Angra 1 and Angra 2 power plants and plans to continue enrichment for the Angra 3 reactor, which has been under construction since the 1980's.¹⁷⁰ Although Brazil has an enrichment capability, it

¹⁶⁵ Santos Vieira de Jesus, "Brazilian Way," 558.

¹⁶⁶ Kassenova, *Brazil's Nuclear Kaleidoscope*, 61.

¹⁶⁷ Rublee, "Nuclear Threshold States," 55.

¹⁶⁸ *Ibid.*

¹⁶⁹ "Nuclear Power in Brazil," World Nuclear Association (WNA), last modified March 2014, <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Brazil/>.

¹⁷⁰ Rublee, "Nuclear Threshold States," 55.

continues to rely on Canada and URENCO for a portion of its industrial scale enrichment.¹⁷¹ Furthermore, Brazil had a small scale reprocessing program, but dismantled the facility in the early 2000s.¹⁷²

In addition to Brazil's resources and capabilities to enrich uranium, nonproliferation advocates remain concerned because Brazil's civilian nuclear industry works closely with its navy. The Brazilian Navy owns the centrifuges and leases them to Brazilian Nuclear Industries (INB), which runs the Resende facility. Moreover, it enriches uranium at the Aramar Experimental Center for use in its nuclear submarine program.¹⁷³ Brazil's civilian nuclear industry justifies its reliance on the military branch and promotes further nuclear usage by citing the country's over-reliance on hydroelectricity, its vulnerability to climate change, and its subjection to fluctuations in oil and gas prices.¹⁷⁴

H. CONCLUSION

From its initial interest in nuclear power, Brazil believes it has been subjugated into an inferior position in nuclear matters in relation to the nuclear weapon states. This feeling has resonated throughout its nuclear history. While efforts to advance its program have been met by obstacles and oversight of the international community, Brazil advanced its nuclear capability through its parallel program. Although it has since renounced nuclear weapons and has remained faithful to its NPT commitment, Brazil demonstrates its urge for nuclear independence and like Iran fights for non-weapon states' nuclear rights. Brazil refuses to sign the Additional Protocol because it views the agreement as an enhancement to the discriminatory nature of the NPT. Although rectifying its differences with the IAEA in 2004, Brazil raised eyebrows when it impeded full IAEA inspection of its centrifuges. Finally, the Brazilian Navy's involvement with its

¹⁷¹ Kassenova, *Brazil's Nuclear Kaleidoscope*, 46–47.

¹⁷² Santos Vieira de Jesus, "Brazilian Way," 559.

¹⁷³ Kassenova, *Brazil's Nuclear Kaleidoscope*, 47.

¹⁷⁴ *Ibid.*, 43-44; Barletta, *Military Nuclear Program*, 14.

civilian nuclear industry and its nuclear submarine program not only raises suspicion of its intentions, but also allows it to advance its program towards the nuclear weapons threshold by offering a legal avenue to HEU production.

V. IRAN

A. INTRODUCTION

Envisioned to propel Iran's global image, its nuclear program initially focused on energy production and the nuclear fuel cycle. Over the course of time, a revolution, the Iran-Iraq War, U.S. presence in the region, tension with neighbors, condemnation from the international community, and dynamic politics, shaped Iran's nuclear perceptions. Although Iranian leaders swear its program is for peaceful purposes, its actions lead many to believe that the country seeks nuclear weapons.

Iran has built a substantial nuclear infrastructure, which includes mining, milling, enrichment, and fuel fabrications facilities. Although the country studies plutonium separation and has experimented with equipment often used in nuclear weapons, it maintains the ability to enrich uranium to levels suitable for reactors or weapons. Under the current deal with the P5+1, Iran has suspended its 20 percent uranium enrichment, but unless the Joint Plan of Action (JPA) is extended a more definitive agreement is established before July 20, 2014, Iran could resume its enrichment to higher levels. Although the JPA intends to increase Iran's breakout time, estimates conclude that Iran could still manufacture enough fissile material within five months.¹⁷⁵

Iran's relation with the IAEA is at times cooperative and other times uncooperative. Despite who is president, the Supreme Leader makes all the important decisions and is influenced by a diverse set of political elements. Although Iranian intentions remain unclear, its nuclear program has historically faced periods of progress beset by episodes of disruption. Despite this progression, Iran slowly develops its program and offers its leadership options for the direction of its nuclear future.

¹⁷⁵ Wisconsin Project on Nuclear Arms Control, "Iran's Nuclear Timetable," Iran Watch, June 16, 2014, <http://www.iranwatch.org/our-publications/articles-reports/irans-nuclear-timetable>; *Defining Iranian Nuclear Programs in a Comprehensive Solution Under the Joint Plan of Action*, Institute for Science and International Security (ISIS) (Washington, DC: Author, January 15, 2014), http://www.isis-online.org/uploads/isis-reports/documents/Elements_of_a_Comprehensive_Solution_20Jan2014_1.pdf.

B. HISTORY

Iran's nuclear history began in the 1950's with Mohammad Reza Shah Pahlavi's desire to be a "third superpower" alongside the United States and the Soviet Union.¹⁷⁶ Its civilian program started in 1957 under the U.S. Atoms for Peace program, which supplied the Tehran Nuclear Research Center with a research reactor and highly enriched uranium to fuel the reactor.¹⁷⁷ During the program's initial stages, Iranians focused on energy production. The Shah wanted to conserve Iran's fossil fuels for export and viewed nuclear power as a benefit of technology.

Regarding the weapons side of the equation, he "wanted to keep open the option of developing nuclear weapons by seeking access to the full nuclear fuel cycle."¹⁷⁸ He sought uranium enrichment and plutonium reprocessing capabilities.¹⁷⁹ Although Iran signed the Treaty on the Non-Proliferation of Nuclear Weapons in July of 1968 and later ratified it in 1970, the United States rejected these desires over proliferation concerns.

The shah envisioned more than 20 operational reactors producing energy. In 1975, West Germany began construction on two units for the Bushehr power plant, France began preparations for two additional sites, and thousands of Iranian scientists received nuclear education and training in these countries as well as the United States, the United Kingdom, and India.¹⁸⁰ In the late 1970s, Iran imported uranium yellowcake from South Africa and uranium dioxide from Algeria.¹⁸¹ If Iran had conversion and enrichment capabilities at the time, it could have produced weapons-grade material.¹⁸²

¹⁷⁶ Kenneth M. Pollack, *Unthinkable: Iran, the Bomb, and American Strategy* (New York: Simon and Schuster, 2013), 34.

¹⁷⁷ Ariana Rowberry, "Sixty Years of 'Atoms for Peace' and Iran's Nuclear Program," The Brookings Institution, December 18, 2013, <http://www.brookings.edu/blogs/up-front/posts/2013/12/18-sixty-years-atoms-peace-iran-nuclear-program-rowberry>.

¹⁷⁸ David Albright and Andrea Stricker, "Iran's Nuclear Program," The Iran Primer, United States Institute for Peace, n.d., <http://iranprimer.usip.org/resource/irans-nuclear-program>.

¹⁷⁹ *Ibid.*

¹⁸⁰ Leonard S. Spector and Jacqueline R. Smith, *Nuclear Ambitions: The Spread of Nuclear Weapons, 1989–1990* (Boulder, CO: Westview, 1990), 204.

¹⁸¹ Anthony H. Cordesman, *Iran's Military Forces in Transition: Conventional Threats and Weapons of Mass Destruction* (Westport, CT: Praeger, 1999), 239.

¹⁸² Spector and Smith, *Nuclear Ambitions*, 205.

By 1979, Iran had invested \$3 billion for the two units. Just prior to the Islamic Revolution, one unit was finished while the other was half complete. The revolution halted further progress.¹⁸³

Professing that nuclear power contradicted the principles of Islam, Ayatollah Khomeini ceased further work on the Bushehr facility and forced the cancellation of contracts with the United States, United Kingdom, France, and West Germany.¹⁸⁴ Furthermore, many nuclear-trained scientists evaded the revolution and departed the country.¹⁸⁵ During the Iran-Iraq War, the Bushehr plant received heavy damage from Iraqi air attacks. Although many perceived that the effects of the revolution and war stopped all work on the nuclear program, some aspects continued.

During the war, the Islamic Revolutionary Guard Corps (IRGC) took control of the nuclear program and continued its progress in a different direction. The quest for nuclear weapons was not only an answer for Saddam Hussein's use of chemical weapons during the conflict, but also solidification of Iran's placement as the rightful hegemon in the Middle East.¹⁸⁶ Ayatollah Mohammad Beheshti, a leader of the Islamic Republic Party, summoned Dr. Fereidun Feharaki, a nuclear advisor to the shah, to build a bomb as part of his duty to preserve the revolution.¹⁸⁷ Moreover, Ayatollah Ali Khamenei, as president, stressed the need to make every effort to construct nuclear weapons in the interest of self-preservation.¹⁸⁸ Finally, after the war in which chemical weapons killed more than 50,000 Iranian soldiers, the speaker of Iran's parliament and commander-in-

¹⁸³ World Nuclear Association (WNA), "Nuclear Power in Iran," last modified May 24, 2014, <http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Iran/>.

¹⁸⁴ Robert Reardon, "Iran's Nuclear Ambitions: Motivations, Trajectory, and Global Implication," in *Strategic Asia 2013–14: Asia in the Second Nuclear Age*, ed. Ashley J. Tellis, Abraham M. Denmark, and Travis Tanner (Seattle, WA: National Bureau of Asian Research, 2013), 208.

¹⁸⁵ Spector and Smith, *Nuclear Ambitions*, 204.

¹⁸⁶ Chubin, "The Politics of Iran's."

¹⁸⁷ Spector and Smith, *Nuclear Ambitions*, 208.

¹⁸⁸ *Ibid.*

chief of the armed forces, Hashemi Rafsanjani stated that unconventional weapons “were very decisive,”¹⁸⁹ and “that the moral teachings of the world are not very effective when war reaches a serious stage.”¹⁹⁰

While the United States raised concerns over a possible weapons program during the 1980s, others offered support for Iran’s civilian program. Argentina, Spain, West Germany, and the Soviet Union offered assistance in the reconstruction of Bushehr, fuel for its research reactor, and training for its technicians.¹⁹¹ Iran signed a nuclear cooperation agreement with Pakistan after Abdul Qadeer (AQ) Khan visited the country in 1987. Khan designed Pakistan’s first generation centrifuge, the P-1, and allegedly supplied Iran with blueprints of the P-1 and more advanced centrifuges¹⁹² and instructions for enriching uranium to weapons-grade levels.¹⁹³

Although Iran received help from various sources, its nuclear progression continued at a “glacial pace” until Gholam Reza Aghazadeh took over as head of the program in 1997.¹⁹⁴ Five years later in 2002, the Iranian Marxist-Islamist group, Mujahedin-e Khalq (MEK) revealed that Iran had been working on a uranium enrichment facility at Natanz and a plutonium extraction plant at Arak. While these dual-use facilities could be used for peaceful purposes, as Iran contends, they still needed to be declared to the International Atomic Energy Agency. Iran argued that it did not need to inform the IAEA until construction was complete,¹⁹⁵ but under its safeguards commitment it should have provided information to the IAEA “before nuclear material is introduced into a new facility.”¹⁹⁶ In addition to concealing its facilities, Iran also experimented with laser

¹⁸⁹ Solingen, *Nuclear Logics*, 165.

¹⁹⁰ Ibid, 165–166.

¹⁹¹ Spector and Smith, *Nuclear Ambitions*, 211–212.

¹⁹² Pollack, *Unthinkable: Iran*, 36.

¹⁹³ Albright and Stricker, “Iran’s Nuclear Program.”

¹⁹⁴ Pollack, *Unthinkable: Iran*, 37.

¹⁹⁵ Ibid., 38.

¹⁹⁶ “The Text of the Agreement Between Iran and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons,” IAEA Information Circular 214, International Atomic Energy Agency (IAEA), December 13, 1974, 11, <http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc214.pdf>.

enrichment and plutonium separation, acquired nuclear material from China, and continued to conduct business with the AQ Khan network.¹⁹⁷

Pressured by the IAEA, Iran cooperated with France, Germany, and the UK, known as the E3, and agreed to suspend its enrichment activities, sign and implement the Additional Protocol, and cooperate with IAEA inspectors.¹⁹⁸ Between October 2003 and August 2005, Iran and the E3 worked toward a long-term agreement in which the Europeans proposed that Iran receive nuclear fuel supplies and cooperation on security and economic concerns if it ceased its uranium enrichment and plutonium separation activities, stopped pursuing the nuclear fuel cycle and heavy water reactor, ratified the Additional Protocol, and agreed to never back out of the NPT.¹⁹⁹ Offended by the proposal, Iran denounced all aspects of the E3 agreement and restarted its enrichment and uranium conversion activities.²⁰⁰ In response, the IAEA referred Iran to the United Nations Security Council in February 2006.²⁰¹

Over the next four years, the UN Security Council adopted six resolutions, which attempted to limit Iran's nuclear program. Adopted on July 31, 2006, Resolution 1696 demanded that Iran abide by past IAEA resolutions that called for increased transparency and enrichment suspension. Successive resolutions built on this first one, mandating that Iran cease work on its heavy-water reactor, adopt the IAEA's Additional Protocol, and install advanced monitoring devices. The resolutions also imposed sanctions that targeted the state, the economy, specific industries and companies, and individuals.²⁰²

¹⁹⁷ Gaukhar Mukhatzhanova, "Pride and Prejudice: Understanding Iran's Nuclear Program," in *Forecasting Nuclear Proliferation in the 21st Century: A Comparative Perspective*, vol. 2, ed. William C. Potter and Gaukhar Mukhatzhanova (Stanford, CA: Stanford University Press, 2010), 44.

¹⁹⁸ Paul K. Kerr, *Iran's Nuclear Program: Tehran's Compliance with International Obligations* (CRS Report No. R40094) (Washington, DC: Congressional Research Service, 2014), 5, <http://www.fas.org/sgp/crs/nuke/R40094.pdf>.

¹⁹⁹ Mukhatzhanova, "Pride and Prejudice," 44; Dilip Hiro, "Iran Nuclear Dispute Could Split World Community," *Yale Global Online*, Yale Center for the Study of Globalization, September 13, 2005, <http://yaleglobal.yale.edu/print/2678>.

²⁰⁰ Albright and Stricker, "Iran's Nuclear Program."

²⁰¹ Kerr, *Iran's Nuclear Program*, 5.

²⁰² Kelsey Davenport, "UN Security Council Resolutions on Iran," *Arms Control Association*, August 2012, <https://www.armscontrol.org/factsheets/Security-Council-Resolutions-on-Iran>; Kerr, *Iran's Nuclear Program*, 8–9.

Despite these sanctions, Iran continued to expand its program. One month after the UN adopted Resolution 1696, Ahmadinejad announced the opening of the heavy-water plant at Arak and began construction for another enrichment facility at Fordow. The presence of this underground facility was revealed in 2009.²⁰³ In 2010, after failed attempts by the United States to convince Iran to exchange its enriched uranium for foreign 20 percent enriched uranium, the Natanz facility began enriching to 20 percent.²⁰⁴ After Russian help on completing the reactor and providing fuel elements, Iran brought its first reactor online at Bushehr in May 2011. It took until 2013 for the reactor to enter commercial operation, but after 55 years Iran began producing nuclear energy. Although it has taken this long for its first functioning reactor, Iran, with Russia's assistance plans to build two more at Bushehr and at least six others in the future.²⁰⁵

Shortly after the success at Bushehr, President Ahmadinejad's second term came to an end, and the former nuclear negotiator, moderate cleric Hassan Rouhani won the 2013 presidential election. Focused on correcting past economic and foreign policy failures, Rouhani is open to diplomatically engaging the West.²⁰⁶ This is evident in the continued negotiations and the implementation of the November 20, 2013 agreement known as the Joint Plan of Action. Despite this cooperation, Iran adamantly defends its NPT rights and continues to advance its nuclear program.

C. CURRENT CAPABILITIES

Iran maintains mining, milling, enrichment, and fuel fabrication capabilities. Although Iran announced in February 2013 that it discovered additional natural uranium deposits,²⁰⁷ the World Nuclear Association suggests that Iran continues to rely on the 450 tons of uranium it purchased from South Africa in the 1980s and its small deposits at the

²⁰³ "Fordow Fuel Enrichment Plant," Nuclear Iran, Institute for Science and International Security, accessed June 16, 2014, <http://www.isisnucleariran.org/sites/detail/fordow/>.

²⁰⁴ Reardon, "Iran's Nuclear Ambitions," 209.

²⁰⁵ WNA, "Nuclear Power in Iran."

²⁰⁶ Pollack, *Unthinkable: Iran*, 33.

²⁰⁷ Marcus George, "Iran Announces Uranium Finds, Days before Nuclear Talks," *Reuters*, February 23, 2013, <http://www.reuters.com/article/2013/02/23/us-iran-nuclear-idUSBRE91M07920130223>.

mine in Gachin.²⁰⁸ Milling and fuel fabrication take place at Esfahan. In addition, the facility produces fuel for the heavy-water reactor at Arak.²⁰⁹

In addition to Esfahan, other major facilities are located at Natanz, Fordow, and Arak. The Natanz Enrichment Facility complex consists of a Pilot Fuel Enrichment Plant (PFEP), Fuel Enrichment Plant (FEP), and a uranium conversion plant. Prior to the Joint Plan of Action, the PFEP, which began operations in 2003, enriched uranium up to 20 percent for the Tehran Research Reactor. Since February 2013, approximately 1,177 kg of 3.5 percent LEU from the FEP had been enriched to produce roughly 150 kg of near 20 percent U-235.²¹⁰ Although the JPA forces Iran to convert half of its 20 percent stockpile, Iran justifies its enrichment by claiming that it will construct additional research reactors to replace its aging Tehran Research Reactor (TRR).²¹¹ Located underground, the Natanz Fuel Enrichment Plant began operating in 2007 and has the capacity to house more than 50,000 centrifuges.²¹² Currently, 15,420 IR-1 and 1,000 advanced IR-2 centrifuges are installed. Approximately, 14,000 IR-1s are operational, while the IR-2s remain offline.²¹³

Also situated inside a mountain, the Fordow Fuel Enrichment Plant (FFEP) currently contains 2,976 IR-1 centrifuges.²¹⁴ Although Iran announced that the facility would house improved centrifuges, their installation has yet to take place. Prior to the JPA, Iran enriched uranium to 19.75 percent, but currently enriches to only five percent.²¹⁵

²⁰⁸ WNA, “Nuclear Power in Iran.”

²⁰⁹ “Arak Complex,” Nuclear Iran, Institute for Science and International Security, accessed June 16, 2014. <http://www.isisnucleariran.org/sites/detail/arak/>.

²¹⁰ WNA, “Nuclear Power in Iran.”

²¹¹ Ibid.

²¹² Pollack, *Unthinkable: Iran*, 49.

²¹³ WNA, “Nuclear Power in Iran.”

²¹⁴ Ibid.

²¹⁵ Nuclear Iran, “Fordow Fuel Enrichment Plant”; Director General, “Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran,” International Atomic Energy Agency, May 23, 2014, 7, <http://www.iaea.org/Publications/Documents/Board/2014/gov2014-28.pdf>.

Iran's enrichment capabilities concern nonproliferation advocates because as of May 2014 Iran had produced a total of 11,977 kg of 3.5 percent UF₆ at a rate of 233 kg per month.²¹⁶ A portion of this was further enriched to produce approximately 450 kg of 19.75 percent UF₆.²¹⁷ Not only is this amount too much for the TRR to consume, but when the 20 percent enrichment mark is reached, roughly 90 percent of the work toward weapons grade uranium (WGU) is accomplished.²¹⁸ The JPA reduces Iran's stockpile of 20 percent UF₆ by mandating that half must be diluted to no more than five percent and half must be converted into uranium oxide powder to be used in the TRR.²¹⁹ While Iran has completed the dilution, the IAEA's May 2014 report indicates that Iran still needs to convert 38 kg.²²⁰

An Institute of Science and International Security (ISIS) report takes these figures into consideration and argues that Iran would still produce a significant quantity of weapons grade uranium. It suggests that even with JPA constraints and UF₆ conversion, Iran could still produce 25 kg of uranium in less than five months. ISIS calculates that Iran could produce 12.5 kg of WGU in three months using its stock of 3.5 percent enriched uranium and currently operating centrifuges. Also during these three months, Iran could construct a reconversion line to turn the oxide back into UF₆. After this transformation, 3.5 and 19.75 percent enriched uranium could be further processed into another 12.5 kg of WGU in less than two months.²²¹ This time could be further reduced if Iran's more advanced centrifuges become operational.

Originally intended to host a hot cell facility to separate plutonium, the Arak nuclear site currently contains a heavy-water production plant and a heavy-water reactor, designated as IR-40.²²² Concerns exist over the reactor's reported plutonium production

²¹⁶ WNA, "Nuclear Power in Iran."

²¹⁷ Nuclear Iran, "Fordow Fuel Enrichment"; Director General, "Implementation of the NPT," 1.

²¹⁸ Pollack, *Unthinkable Iran*, 49–50.

²¹⁹ Nuclear Iran, "Fordow Fuel Enrichment"; Director General, "Implementation of the NPT," 1.

²²⁰ *Ibid.*, 5.

²²¹ ISIS, *Defining Iranian Nuclear*.

²²² Nuclear Iran, "Arak Complex"; WNA, "Nuclear Power in Iran."

rate of 9 kg of plutonium per year, but currently Iran does not have a plutonium separation or reprocessing capability.²²³ IR-40 is under IAEA safeguards, and since January 20, 2014, the agency reports that Iran has not installed any major components to the reactor.²²⁴ Under the JPA, fuel production stopped for Arak with only 10 of 150 needed fuel assemblies installed.²²⁵ Conversely, the heavy-water production plant is not under safeguards, but in 2011, Iran allowed IAEA inspectors to visit the site. Presently, Iran allows inspectors “managed access” to this plant and a heavy-water storage facility in Esfahan.²²⁶

D. JOINT PLAN OF ACTION

Agreed to on November 24, 2013, and effective on January 20, 2014, the Joint Plan of Action among the five permanent members of the UN Security Council and Germany, known as the P5+1 and Iran outlines the responsibilities of both sides to ensure that the latter’s nuclear program remains peaceful. The agreement lasts for a six-month period with the option of extending the terms in an effort to a “long-term comprehensive solution.”²²⁷

To remain faithful to the agreement, Iran is allowed to enrich uranium, but only to five percent and will refrain from making “any further advances” at Natanz, Fordow, or the Arak reactor.²²⁸ Iran agrees that it will not install additional centrifuges, nor operate its advanced IR-2 centrifuges. It will dilute half of its 20 percent enriched uranium to no more than five percent with the other half going to the TRR. Iran will also grant IAEA greater access to its program. In return, Iran will receive sanctions relief with the assurance of no new sanctions during the six month period.²²⁹ Although Iran has

²²³ Ibid.

²²⁴ Nuclear Iran, “Fordow Fuel Enrichment Plant;” Director General, “Implementation of the NPT,” 9.

²²⁵ WNA, “Nuclear Power in Iran.”

²²⁶ Director General, “Implementation of the NPT,” 9.

²²⁷ P5+1 Nations and Iran, “Joint Plan of Action,” November 24, 2013, http://eeas.europa.eu/statements/docs/2013/131124_03_en.pdf, 1.

²²⁸ Ibid., 2.

²²⁹ Ibid., 1-4.

completed or is currently complying with a majority of its Plan of Action commitments, IAEA questions and concerns surrounding Iran's past and current military involvement remain unanswered.²³⁰

Despite its cooperation thus far, Iran continues to advance its program. The Islamic Republic has increased its production rate and stockpile of 3.5 percent enriched uranium and continues to research advanced centrifuge models. While these actions are not prohibited by the JPA, Blaise Misztal of the Bipartisan Policy Center argues that Iran "is not living up to the spirit of the agreement."²³¹ He explains that Iran is progressing in three areas. First, due to the stoppage of 20 percent enrichment, approximately 1,000 more centrifuges have increased the 3.5 percent enrichment rate by 13 percent.²³² Second, the Fordow centrifuges now enriching to 3.5 are doing so at a 25 percent faster pace than those at Natanz.²³³ Third, Iran continues to research and develop new centrifuges that are more advanced than the original IR-1 design.²³⁴ The IAEA assesses that Iran enriches natural UF₆ with IR-1, IR-2m, IR-4, IR-6, and IR-6s centrifuges.²³⁵

In addition to continuing its enrichment activities, Iran refuses to adequately answer questions regarding the military's involvement in the nuclear program. The IAEA seeks to better understand recent activity, revealed by satellite imagery; past experiments; and the role of foreign scientists at the Parchin military complex.²³⁶ The IAEA received information from multiple countries, which indicated that Iran constructed containers for high explosive and hydrodynamic testing connected to nuclear weapons development and testing.²³⁷ UN Security Council Resolution 1929 requires Iran to provide IAEA access to

²³⁰ Blaise Misztal, "A Tale of Two Irans in New IAEA Report," Bipartisan Policy Center, February 24, 2014, <http://bipartisanpolicy.org/blog/foreignpolicy/2014/02/24/update-iran%E2%80%99s-nuclear-program>.

²³¹ Ibid.

²³² Ibid.

²³³ Ibid.

²³⁴ Ibid.

²³⁵ Director General, "Implementation of the NPT," 6.

²³⁶ Misztal, "A Tale of Two."

²³⁷ "Parchin," Institute for Science and International Security, accessed June 16, 2014, <http://www.isisnucleariran.org/sites/detail/parchin/>.

people, locations, equipment, and information as requested.²³⁸ David Albright suggests that an uninformative Iran in this regard will have detrimental effects on any long term deal. He ponders, “if Iran is able to successfully evade questions about a weapons program now, when biting sanctions...are in place, why would it address them when these sanctions are lifted?”²³⁹

Iran’s rebuttal to the Parchin allegations is that the information the IAEA acquired from others is categorically wrong.²⁴⁰ Despite its hesitancy to discuss past nuclear activities, Iran offered general information about its use of detonators that could be used to trigger nuclear weapons. In May 2014, Iran informed the IAEA that its use of exploding bridge wire detonators was geared toward civilian applications.²⁴¹ Although the Iranians remained silent on their specific use, these devices are sometimes used in drilling for oil and gas.²⁴² Furthermore, Iran agreed to inform the IAEA about its research regarding high explosives and their use in implosion devices.²⁴³ Refraining from specifics, the IAEA has reports concerning Iran’s interest in neutron generators, which increase the efficiency of nuclear weapons; advanced modeling and computing capabilities, which are used in both military and civilian applications; and information dealing with uranium conversion to metallic, hemispheric shapes.²⁴⁴ IAEA inspections conducted in 2010 revealed that Iran received uranium from China and samples of polonium-210, which is used in initiators for nuclear weapons.²⁴⁵

²³⁸ Davenport, “UN Security Council.”

²³⁹ David Albright, “Making Iran Come Clean About its Nukes: What is the Point of Striking an Agreement with Iran if Tehran Will Be Able to Hide its Weapons Work?” *Wall Street Journal*, May 14, 2014, <http://search.proquest.com.libproxy.nps.edu/docview/1524268972/8715690F0CDB41B0PQ/1?accountid=12702>.

²⁴⁰ Director General, “Implementation of the NPT,” 5.

²⁴¹ Kelsey Davenport, “Iran Provides Detonator Details to IAEA,” Arms Control Association, June 2014, https://www.armscontrol.org/act/2014_06/news/Iran-Provides-Detonator-Details-to-IAEA.

²⁴² *Ibid.*

²⁴³ Nima Gerami, “Background on the ‘Possible Military Dimensions’ of Iran’s Nuclear Program,” The Washington Institute for Near East Policy, June 13, 2014, <http://www.washingtoninstitute.org/policy-analysis/view/background-on-the-possible-military-dimensions-of-irans-nuclear-program>.

²⁴⁴ Jon Wolfsthal, “Iran and IAEA: On Past Military Dimensions,” The Iran Primer, United States Institute of Peace, May 20, 2014, <http://iranprimer.usip.org/blog/2014/may/20/iran-and-iaea-past-military-dimensions>.

²⁴⁵ Pollack, *Unthinkable: Iran*, 39–40.

E. POLITICS

Since 1979, Iranian leaders have had disagreements on the proper direction of the nuclear program. Shahram Chubin suggests that the biggest disagreement is based on whether Iran should continue with a revolutionary attitude or assimilate into the international community as a “normal state.”²⁴⁶ Prior to 2002, Iranian officials agreed that nuclear power represented energy diversification, technological advancement, and a must have for “any self-respecting country.”²⁴⁷

As the Global War on Terror spread throughout the region, Iran’s nuclear program gained greater recognition as a potential source of weapons and terrorism. As mentioned above, Natanz and Arak were revealed in 2002 and Iran subsequently dealt with the E3. Although Iran willingly negotiated with this group, it could not be convinced to give up its right to enrich uranium. This period demonstrated that when pressure is placed on Iran, the country is willing to negotiate, but only to a certain extent. It also showed that Ayatollah Khamenei made the country’s most important decisions.

Khamenei announced that the voluntary suspension of enrichment insufficiently benefitted Iran and issued the order to restart enrichment in late 2005.²⁴⁸ In April 2014, Khamenei outlined redlines concerning talks with the P5+1. Although speaking in general terms, he stated that nuclear progress should not be “halted or slowed down,” that “nuclear achievements” should be defended, and that Iran should only accept a “normalized” relationship with the IAEA.²⁴⁹ These demands signify that Iran covets the technology and capability to progress its nuclear program as it sees fit. The Supreme Leader’s comments also suggest that Iran is unfairly treated by the IAEA.

²⁴⁶ Chubin, “The Politics of Iran’s.”

²⁴⁷ Ibid.

²⁴⁸ Akbar Ganji, “Who is Ali Khamenei?,” *Foreign Affairs* 92, no. 5 (2013), <http://web.ebscohost.com.libproxy.nps.edu/ehost/detail?vid=4&sid=27019b0f-f673-4969-98e1-97b372a14f79%40sessionmgr111&hid=122&bdata=JnNpdGU9ZWwhvc3QtbGl2ZSZzY29wZT1zaXRl#db=bth&AN=89749127>.

²⁴⁹ “Khamenei’s Red Lines on Nuclear Talks,” *The Iran Primer*, United States Institute of Peace, April 16, 2014, <http://iranprimer.usip.org/blog/2014/apr/16/khamenei%E2%80%99s-red-lines-nuclear-talks>.

Although Iran suspended its enrichment and conformed to the Additional Protocol, these actions were not as genuine as one might believe. In a 2007 interview with Hassan Rouhani, the current president and former nuclear negotiator explained that Iran continued with the technical aspects of the nuclear process: “we built the centrifuges, we built the Arak plant...whatever was incomplete, we completed under the shadow of suspension.”²⁵⁰ Rouhani further admitted that he personally conversed with engineers and scientists, advising them that when they were prepared to enrich, the regime would terminate the suspension.²⁵¹ Thus, the overbearing proposal by the E3 supplied the justification for Iran to restart enrichment with more advanced facilities. Moreover, this period represented another example of how Iran will abide by an agreement intended to limit its program, but continues to improve its nuclear potential.

The nuclear issue not only highlights who is in charge, but also the informal, personalized landscape of Iranian politics. While the political system maintains many powerful offices such as the Assembly of Experts, the Judiciary, Guardian Council, and the Expediency Council, the Islamic Revolutionary Guard Corps (IRGC) holds great sway over the direction of the nuclear program.

Instituted to protect the revolution and the Supreme Leader, the Guard has amassed significant military, political, and economic power. The IRGC stakes claim in various sectors and provides security, procurement, and research for nuclear matters.²⁵² Until recently it has spoken out against any negotiations with the West. IRGC Deputy Commander, Brigadier General Hossein Salami stated in February 2013 that “we are at the apex of our power today and taking the last steps towards victory, and this [P5+1] is the final obstacle.”²⁵³ Besides continuing the revolution and wanting to defy western

²⁵⁰ Akbar Ganji, “The Latter-Day Sultan: Power and Politics in Iran,” *Foreign Affairs* 87, no. 6 (2008): 62, <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/20699371.pdf?acceptTC=true&acceptTC=true&jpdConfirm=true>.

²⁵¹ *Ibid.*, 62.

²⁵² Samara Greenberg, review of *The Pasdaran: Inside Iran’s Islamic Revolutionary Guard Corps*, by Emanuele Ottolenghi. “Wanted: Iran’s Islamic Revolutionary Guards,” *inFocus Quarterly* 6, no. 1 (2012), <http://www.jewishpolicycenter.org/3234/pasdaran>.

²⁵³ Will Fulton, “IRGC Messaging: Insight into a Revolutionary Regime,” *Iran Tracker*, AEI Critical Threats Project, May 20, 2013, <http://www.irantracker.org/analysis/fulton-irgc-messaging-insight-revolutionary-regime-may-20-2013>.

influence, the IRGC stresses the need to challenge international norms through its nuclear program. Part of this desire is due to economic sanctions that benefit the Corps because it not only exploits the government for funds, but also manages Iran's black market, which covers its domestic losses.²⁵⁴

Recently, Ayatollah Khamenei advised IRGC leader General Mohammad Ali Jafari from interfering with negotiations with the P5+1.²⁵⁵ Since November 2013, Jafari has obeyed Khamenei and changed his tone from one of outright opposition to arrogant optimism. He now views the talks as beneficial to Iran in the long-run. He stated that "either the pressures of the sanctions will be relieved or the country's officials will be disappointed at the foreigners and focus on domestic power."²⁵⁶

Similarly, Khamenei views sanctions as a mixed blessing. On one hand, he believes that they represent an attack on Islam and a tactic to undermine the regime. On the other hand, he believes that sanctions have made Iran stronger and more resilient in its quest for self-sufficiency.²⁵⁷ Although he distrusts the United States and dislikes negotiations, Khamenei explained that he supports talks only if they benefit Iran. This means recognizing the regime and Iran's right to enrich uranium.²⁵⁸ Furthermore, in February 2013, he explained that Iran does not have nuclear weapons, not because America forbids it, but because the Islamic Republic does not want them. He stated that

²⁵⁴ "Analysis: Iran's Nuclear Dealmakers Hone New Pitch for Revolutionary Guard," *Associated Press*, November 26, 2013, <http://www.foxnews.com/world/2013/11/26/analysis-iran-nuclear-dealmakers-hone-new-pitch-for-revolutionary-guard/>.

²⁵⁵ *Ibid.*

²⁵⁶ "Commander: IRGC Pessimistic About Iran-Powers Talks, but Keeps Silent to See Results," *FARS News Agency*, February 19, 2014, <http://english.farsnews.com/newstext.aspx?nn=13921130000833>.

²⁵⁷ Juan C. Zarate, *Treasury's War: The Unleashing of a New Era of Financial Warfare* (New York: PublicAffairs, 2013), 342.

²⁵⁸ Ganji, "Who is Ali Khamenei?"

“if we wanted to make nuclear weapons, how could you prevent it?”²⁵⁹ Khamenei also professes that nuclear weapons are “un-Islamic”²⁶⁰ and that “we regard the use of these weapons as illegal and haram,” or forbidden.²⁶¹

Although Khamenei is in charge, the power struggle between conservatives and moderates continues to drive the nuclear issue. Strong consensus exists on preserving the right to enrich and generating nuclear energy.²⁶² Iranian officials also believe that their country is the “vanguard of an international movement” to rid the region of U.S. influence.²⁶³ Conversely, disagreement exists over the military’s involvement, costs and benefits, and the conditions under which a long-term deal could exist.

Conservatives are more willing to accept sanctions and costs to society because defying the West continues the revolution. Like Khamenei, this group views penalties as an attack on Iran’s technological advancement and an attempt to undermine the country’s regional influence. Moderates are more open to compromise and view negotiations not as a weakness, but as a means to gain greater recognition and integration within the internationally community.²⁶⁴

Presently, it appears that the regime is unwilling to risk further sanctions. Although negotiations toward a long term deal continue, Iran has opened its program to inspections and stopped its enrichment of 20 percent uranium in exchange for sanctions relief. With the surprise election of Rouhani, Khamenei may believe that this is the best opportunity to achieve international and domestic victories by diplomatically engaging the West and appeasing its population. Sensitive to public sentiment, Rouhani observed that “if the country’s political decisions conflict with the public opinion, we definitely

²⁵⁹ Ibid.

²⁶⁰ Pollack, *Unthinkable: Iran*, 57.

²⁶¹ Sayyid Ali Khamenei, “Only U.S. Has Committed Nuclear Offence,” The Office of the Supreme Leader, April 17, 2010, <http://www.leader.ir/langs/en/?p=contentShow&id=6676>.

²⁶² Wyn Q. Bowen and Jonathan Brewer, “Iran’s Nuclear Challenge: Nine Years and Counting,” *International Affairs* 87, no. 4 (2011), 938, http://www.chathamhouse.org/sites/default/files/87_4_bowenbrewer.pdf.

²⁶³ Reardon, “Iran’s Nuclear Ambitions,” 205.

²⁶⁴ Ibid., 206.

would have problems.”²⁶⁵ A November 6, 2013, Gallup article explained that 68 percent of Iranians favor a peaceful nuclear program in the face of tough sanctions and only 34 percent support the development of a military capability.²⁶⁶

Attempting to gain leverage and respect on the international scene, Rouhani shows support for human rights and has increased its participation in UN committees. Although they were rejected, the current president proposed Cabinet members sympathetic to the Green Movement.²⁶⁷ He also appointed a woman, Elham Aminzadeh, as a vice president within his Cabinet.²⁶⁸ Furthermore, Iran is making inroads with the UN by acting as the chair of the Non-Aligned Movement (NAM), which represents 119 of the 193 UN countries. NAM countries defend Iran for standing firm against western pressure as the final outcome of the Iranian program could affect their own nuclear futures.²⁶⁹ Rouhani also led a nuclear disarmament summit in the General Assembly and won the position of rapporteur for the Assembly’s committee on Disarmament and International Security.²⁷⁰

F. CONCLUSION

Similar to many nuclear power aspirants of the 1950s, Iran took advantage of the U.S. Atoms for Peace initiative. Although a revolution and war delayed progress, Iran realized that unconventional weapons could be useful. It also confirmed Iranian thought that a double standard exists in regards to war and international relations. As Iraq used chemical weapons, the world did little to help Iran. The inaction to uphold the “moral

²⁶⁵ Herzog, *Iranian Public Opinion*, 2.

²⁶⁶ Loschky, “Most Iranians Say.”

²⁶⁷ Abbas Milani, “The Biggest Mystery in Tehran.” *New Republic* 244, no. 16 (2013), 8, <http://web.ebscohost.com.libproxy.nps.edu/ehost/detail?vid=4&sid=b567c659-1e39-4bc2-96ed-1a46154d13e4%40sessionmgr111&hid=122&bdata=JnNpdGU9ZWZwhvc3QtbG12ZSZzY29wZT1zaXRl#db=bth&AN=90368272>.

²⁶⁸ Andrew Friedman, “6 Reasons Hassan Rouhani is No Ahmadinejad,” *Policy.Mic*, September 19, 2013, <http://www.policymic.com/articles/64271/6-reasons-hassan-rouhani-is-no-ahmadinejad>.

²⁶⁹ Hiro, “Iran Nuclear Dispute.”

²⁷⁰ Claudia Rosett, “Iran, the U.N.’s New Authority on Nuclear Disarmament,” *Forbes*, September 30, 2013, <http://www.forbes.com/sites/claudiarosett/2013/09/30/iran-the-u-n-s-new-authority-on-nuclear-disarmament/>.

principles” of war bred further distrust within Iran of foreigners.²⁷¹ The war along with numerous sanctions and blocked deals proved to Iran that external support could not be relied upon for its security needs.²⁷²

Despite sanctions and international condemnation, Iran continues to improve its nuclear capabilities. Current deals limit aspects of the program such as enrichment levels and facility improvements, but Iran has demonstrated in the past that it will improve on other areas not covered by negotiations. While evidence suggests a weapons intention, it does not definitively mean that Iran is pursuing such a course, as the decision to achieve weapons remains unknown.²⁷³ Regardless of the decision, Iran’s efforts to improve its nuclear infrastructure allow the country to approach the nuclear threshold.

²⁷¹ Spector and Smith, *Nuclear Ambitions*, 210.

²⁷² Solingen, *Nuclear Logics*, 165–166.

²⁷³ Pollack, *Unthinkable: Iran*, 39.

THIS PAGE INTENTIONALLY LEFT BLANK

VI. CONCLUSION

A. THRESHOLD STATUS

A nuclear threshold state is one that could quickly operationalize its “peaceful” nuclear program into one capable of producing a nuclear weapon. Japan and Brazil both possess advanced technologies and expertise to be considered threshold states. Although Iran does not have the facilities the other two have and has restrictions placed on its program, it too can be considered a nuclear threshold state.

A country’s past nuclear weapons program may have contributed to its civilian advancements, but does not mean it will ultimately pursue a weapon. Japan, Brazil and Iran all had weapons programs and not one currently possesses nuclear weapons. Politics also play a role in the nuclear futures of a country. Japan maintains its aversion to nuclear weapons for domestic and international reasons. Brazil views its non-nuclear posture as more beneficial to its economic and political future than what a nuclear weapon could provide. Iran, like Japan and Brazil has a population with mixed feelings about nuclear energy, but a majority of its citizens are against nuclear weapons.²⁷⁴

Nuclear energy and self-sufficiency are important to the three countries and their threshold statuses. Although constructing a weapon requires more than the fuel cycle, uranium enrichment and plutonium reprocessing are the most difficult parts. According to Joseph Cirincione, testing and putting together the components of a bomb design “pale in comparison to that of making the fissile material.”²⁷⁵ Former director of the Defense Threat Reduction Agency at the U.S. Department of Defense Stephen M. Younger agrees that the correct amount of nuclear material is difficult to produce, but further explains that the device, even a gun-type assembly, thought by many to be fool-proof is no small feat.²⁷⁶ Japan has very little domestic energy resources and relies on nuclear energy for a

²⁷⁴ Robert Litwak, *Iran’s Nuclear Chess: Calculating America’s Moves* (Washington, DC: Woodrow Wilson Center, Middle East Program, 2014), 61, http://www.wilsoncenter.org/sites/default/files/irans_nuclear_chess_calculating_americas_moves.pdf.

²⁷⁵ Joseph Cirincione, *Bomb Scare: The History and Future of Nuclear Weapons* (New York: Colombia University Press, 2007), 74.

²⁷⁶ Stephen M. Younger, *The Bomb: A New History* (New York: Harper Collins, 2009), 140–46.

substantial portion of its electricity. Desiring to remain energy independent, Japan believes it needed to make the most of its imported uranium and therefore constructed reprocessing facilities and breeder reactors that subsequently produced stockpiles of plutonium. Although a majority of its reprocessed plutonium is stored in Europe, Japan controls more than 10 tons within its borders. This amount is sufficient to fuel more than 1,000 bombs.

Similarly, Brazil worries about its energy resources. Citing unpredictable weather patterns and fluctuating petroleum prices, Brazilian officials argue that nuclear energy is an important source of electricity, although it relies on nuclear energy to produce only three percent of its electricity.²⁷⁷ Brazil's program is not as robust as Japan's and relies on foreigners for a majority of its uranium conversion and enrichment. The small percentage of uranium conversion and enrichment that takes place domestically is accomplished by the Brazilian Navy. As the first and only non-nuclear weapon state to have a program dedicated to a nuclear submarine, Brazil worries nonproliferation advocates. Since nuclear propulsion reactors are not covered by the NPT, HEU can be produced and stored under the auspices that it will be used for non-explosive purposes.

Brazil also discusses the importance of self-sufficiency and the discriminatory nature of the NPT. From its past, the South American country has learned that relying on foreigners for nuclear technology was detrimental to its progress. In the early 1970s, Brazil relied heavily on the United States and others for fuel and technology, but since it had not yet signed the NPT, both contracts and equipment were denied. To circumvent these issues, its military proposed and advanced its nuclear ascendancy through a parallel program. Related to its desires for self-sufficiency, Brazil believes that the NPT is controlled by the nuclear weapon states and restricts those without weapons. Some Brazilians express concern that the NPT is more focused on nonproliferation and less on disarmament. Due to this difference, Brazil refuses to sign the Additional Protocol and protect its indigenous nuclear technology.

²⁷⁷ Kassenova, *Brazil's Nuclear Kaleidoscope*, 42.

Very much like Japan and Brazil, Iran also argues for the benefits of nuclear energy. Shah Pahlavi set a trend in Iran when he professed that nuclear energy would free up the country's oil supplies for export. In 2013, Iran's Energy Minister explained that Iran saved \$2 billion per year in oil and gas since the Bushehr reactor came online in 2011.²⁷⁸ Although this is true, Iran's argument that it is cost effective is untrue. Since Iran began its nuclear program in the 1950s, Scott Peterson of *The Christian Science Monitor* suggests that it is impossible to determine the total investment made by Iran thus far, but explained that over the last 60 years, Iran has spent more than \$100 billion of its oil revenues.²⁷⁹ In addition, Peterson noted that relying on domestic facilities for nuclear fuel production Iran could spend more than \$125 million more than purchasing it from other countries.²⁸⁰ Nevertheless it continues to enrich uranium for its "future" reactors and make improvements to its heavy-water reactor.

In addition to its claims of energy security and other motivations such as prestige, technical achievement, and economics, Iran cites its rights under the NPT, which allow it to develop and maintain nuclear technology as long as it is used for peaceful purposes. In its negotiations with the P5+1, Iran remains adamant about its rights regarding uranium enrichment and centrifuge numbers. Less than two weeks before the July 20, 2014, JPA deadline, Ayatollah Khamenei asserted that Iran will not surrender its right to enrich uranium, and further stressed that the country will need many more centrifuges over the next two to five years.²⁸¹

Although Iran seeks to further its research and development that could produce weapons-usable material and has experimented with equipment that is used in nuclear weapons, it does not mean that it will ultimately achieve such a device. In addition to the difficulty of constructing a nuclear weapon, a decision to pursue a nuclear weapon may

²⁷⁸ WNA, "Nuclear Power in Iran."

²⁷⁹ Scott Peterson, "How Much is a Nuclear Program Worth? For Iran, Well Over \$100 Billion," *The Christian Science Monitor*, April 3, 2013, <http://www.csmonitor.com/World/Middle-East/2013/0403/How-much-is-a-nuclear-program-worth-For-Iran-well-over-100-billion>.

²⁸⁰ Ibid.

²⁸¹ Siavosh Ghazi, "Iran's Supreme Leader Reveals Demands in Nuclear Talks," *Agence France-Presse*, July 8, 2014, <http://news.yahoo.com/nuclear-team-defend-irans-rights-khamenei-194020395.html>.

not have been made and may never be. As Cohen and Frankel suggest, ambiguity in regard to these decisions is an aspect of the threshold state.²⁸² Regardless of what the future holds for Iran's nuclear program, the Center of Arms Control and Non-Proliferation explains that Iran requires nuclear material, a bomb, and a delivery vehicle to weaponize its program.²⁸³

First, there is a need for nuclear material. Secretary of State John Kerry announced before the Senate Foreign Relations Committee in April 2014 that Iran's breakout capability is approximately two months.²⁸⁴ According to ISIS, Iran could produce a significant quantity of weapons-grade uranium within five months.²⁸⁵ This accounts for JPA restrictions and Iran's current supply of enriched uranium. Second, Iran requires a warhead. Some experts such as Michael Elleman, a senior fellow at the International Institute for Strategic Studies claims that the technical skill to construct a warhead is not beyond Iran's capability,²⁸⁶ but Younger refutes this popular notion and states that "while some nuclear weapons experts claim that making a primitive nuclear explosive is as simple as shooting two slugs of uranium against each other in an old artillery barrel, in reality it is much more complicated."²⁸⁷ Third, Iran would likely use a ballistic missile to deliver its nuclear payload. Director of National Intelligence, James Clapper informed the Senate Select Committee in January 2014 that Iran has the largest inventory of ballistic missiles in the region, and that its Shahab series missiles are capable of delivering weapons of mass destruction.²⁸⁸ Despite the lack of an order to weaponize, P5+1 attempts to roll-back the program, and estimates that the construction of device

²⁸² Cohen and Frankel, "Opaque Nuclear Proliferation," 17.

²⁸³ Brenna Gautam, "Fact Sheet: Iran's Nuclear and Ballistic Missile Programs," The Center for Arms Control and Non-Proliferation, last modified July 2014, http://armscontrolcenter.org/publications/factsheets/fact_sheet_irans_nuclear_and_ballistic_missile_programs/.

²⁸⁴ Patricia Zengerle, "Kerry Says Iran Nuclear 'Breakout' Window Now Seen as Two Months," *Reuters*, April 8, 2014, <http://www.reuters.com/article/2014/04/08/us-iran-nuclear-usa-breakout-idUSBREA3719I20140408>.

²⁸⁵ ISIS, *Defining Iranian Nuclear*.

²⁸⁶ Gautam, "Fact Sheet: Iran's."

²⁸⁷ Younger, *Bomb*, 140.

²⁸⁸ Clapper, *Worldwide Threat Assessment*; Gautam, "Fact Sheet: Iran's."

ranges from “a couple months...to more than a year,”²⁸⁹ the Islamic Republic has the capability to produce a significant quantity of HEU for a nuclear weapon within six months. With these capabilities, Iran is a nuclear threshold state.

B. IMPLICATIONS FOR NONPROLIFERATION

What does Iran’s threshold status imply for U.S. nonproliferation policy and the international nonproliferation regime? First and foremost, Iran must remain below the threshold, or as some argue, it could lead to an arms race in the region, a possible collapse of the nonproliferation regime, a military attack, or a combination of the three.

Promoting multilateral and bilateral treaties, security alliances, the NPT and IAEA, effective enforcement, and nuclear disarmament, U.S. nonproliferation policy seeks to prevent the spread of nuclear weapons by assisting those without nuclear weapons and reducing the U.S. nuclear weapons inventory.²⁹⁰ Preventing Iran from a nuclear weapon is America’s goal, and its strategy is to use a dual-track approach that utilizes both diplomacy and sanctions, backed by the threat of military force. The threat of Iran’s nuclear future is its potential to become a model for the 24 non-nuclear weapons states with civilian programs.²⁹¹ These are similar to Iran in that they are members of the NPT and have or could have future enrichment or reprocessing capabilities. While it is unlikely for these states to follow Iran’s approach, some may “develop their present peaceful programs with one eye cocked to the future possibility that they may eventually decide to develop an operational nuclear capability independently.”²⁹²

While this dual-track method appears to have gotten Iran to at least negotiate with the P5+1 and abide by the provisions within the JPA, changes should be instituted. Both

²⁸⁹ David Albright, interview by Hari Sreenivasan, *PBS Newshour*, PBS, November 9, 2013, http://www.pbs.org/newshour/bb/world-july-dec13-albright_11-09/.

²⁹⁰ Department of Defense, *Nuclear Posture Review Report* (Washington, DC: Author, April 2010), 9–13, <http://www.defense.gov/npr/docs/2010%20Nuclear%20Posture%20Review%20Report.pdf>.

²⁹¹ “World Nuclear Power Plants in Operation,” Nuclear Energy Institute, last modified May 2014, <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics/World-Nuclear-Power-Plants-in-Operation>; “Nuclear Units Under Construction Worldwide,” Nuclear Energy Institute, last modified May 2014, <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics/Nuclear-Units-Under-Construction-Worldwide>.

²⁹² Cirincione, *Bomb Scare*, 133.

the supply and demand side of nuclear technology should be addressed. As the Iran case demonstrates, nuclear material and expertise is readily available. Export controls and nuclear deals, such as those with Vietnam, the United Arab Emirates, and India should be heavily scrutinized before finalization.

Named after Section 123 of the Atomic Energy Act, “123 agreements” are civilian nuclear cooperation deals between the United States and foreign countries that offer technology and material for peaceful purposes. Section 123’s nine provisions on the trade of material include the application of IAEA safeguards, the use of material for only non-explosive purposes, adequate physical security, U.S. permission for enrichment or reprocessing, adequate storage facilities, and the right of the United States to recall its material, equipment, or any material produced by its use.²⁹³ A 123 agreement only applies to the material originating from the United States. Other factors such as human rights and past nuclear activities are considered, but depending on U.S. interests and nonproliferation concerns, exemptions can be made.²⁹⁴

Vietnam’s agreement is still under Congressional review, but meets all nine of the Atomic Energy Act’s nonproliferation criteria. Although Vietnam states that it has no interest in enrichment or reprocessing, Congress should consider binding documentation that guarantees such.²⁹⁵ The US-United Arab Emirates nuclear deal of 2009 is viewed by some to represent the “new gold standard”²⁹⁶ in 123 agreements. This is because the UAE voluntarily renounced enrichment and reprocessing capabilities.²⁹⁷ Although a bill

²⁹³ Office of the General Counsel, *Nuclear Regulatory Legislation* (NUREG-0980) (Washington, DC: Nuclear Regulatory Commission, 2013), 59–61, <http://pbadupws.nrc.gov/docs/ML1327/ML13274A489.pdf#page=23>.

²⁹⁴ *Ibid.*, 61.

²⁹⁵ Mary Beth D. Nikitin, Mark Holt and Mark E. Manyin, *U.S.-Vietnam Nuclear Cooperation Agreement: Issues for Congress* (CRS Report No. R43433) (Washington, DC: Congressional Research Service, June 13, 2014), 2, <http://fas.org/sgp/crs/nuke/R43433.pdf>.

²⁹⁶ Brad Sherman, “Avoiding Future Irans: A New Course for U.S. Nonproliferation Policy,” Nonproliferation Policy Education Center, December 11, 2013, <http://npolicy.org/article.php?aid=1239&tid=4>.

²⁹⁷ Daryl Kimball, “The U.S. Atomic Energy Act Section 123 At a Glance,” Arms Control Association, last modified March 2013, <https://www.armscontrol.org/factsheets/AEASection123>.

was presented that would make renouncing enrichment and reprocessing capabilities mandatory, the 112th Congress rejected the recommendation.²⁹⁸

Conversely, India's deal with the United States is significantly different than Vietnam's and the UAE's. First, the agreement had to have exemptions because India is not an NPT member state and has exploded nuclear devices. To include India in the international nuclear arena, the United States agreed to allow the South Asian country access to nuclear markets and a reprocessing capability in exchange for placing some of its reactors and its future reprocessing facilities under IAEA safeguards.²⁹⁹ In addition, India agreed to continue its weapons test moratorium, support efforts toward a Fissile Material Cutoff Treaty, separate its military and civilian programs, and commit to signing an Additional Protocol.³⁰⁰

Although the differences among these deals may be advantageous to the United States, giving one country one thing and forbidding it from others creates feelings of resentment and demonstrates that the nuclear suppliers or the United States distinguishes between good nuclear programs and bad ones. George Perkovich and others state that "as each deal is cut it sets a new expectation for the next proliferator."³⁰¹ Despite the need for stringent universal standards, rewarding states that uphold nonproliferation norms and values could be an incentive to refrain from questionable nuclear practices such as enriching more uranium than is necessary or leaving questions of military involvement unanswered.

Consensus should be generated to control the means of producing fuel for nuclear reactors. Strengthened export controls, international fuel banks, and a Fissile Material

²⁹⁸ Kimball, "U.S. Atomic Energy."

²⁹⁹ Daniel Horner, "India, U.S. Agree on Terms for Reprocessing," Arms Control Association, May 2010, https://www.armscontrol.org/act/2010_05/US-IndiaReprocessing.

³⁰⁰ Jayshree Bajoria and Esther Pan, "The U.S.-India Deal," Council on Foreign Relations, November 5, 2010, <http://www.cfr.org/india/us-india-nuclear-deal/p9663>; Sharon Squassoni, "The U.S.-Indian Deal and Its Impact," Arms Control Association, July/August 2010, https://www.armscontrol.org/act/2010_07-08/squassoni.

³⁰¹ George Perkovich et al., *Universal Compliance: A Strategy for Nuclear Security* (Washington, DC: Carnegie Endowment for International Peace, June 2007), 94, http://carnegieendowment.org/files/univ_comp_rpt07_final1.pdf.

Cutoff Treaty could hinder access. In 2004, President Bush stated that countries seeking nuclear energy do not require enrichment and reprocessing capabilities.³⁰² Management of the fuel cycle could be handled by international agencies that guarantee the delivery of reactor fuel and the disposal of spent fuel at a price that benefits the state. The use of these services from a nuclear energy seeking state could confirm its nonproliferation commitment and reduce the argument that nuclear energy is economically beneficial.³⁰³

Some countries, such as Iran argue that their NPT rights are being infringed upon and international entities cannot be trusted to fulfill peaceful nuclear demands.³⁰⁴ To combat this dilemma, the agency could be run by an international organization such as the IAEA and guarantee fuel at reduced prices through long-term contracts. To prevent political disruptions to supply, the fuel bank system should be arranged in a fashion that separates the suppliers from the consumers. The suppliers should only provide nuclear fuel and not dictate who gets what or how much, this would be arranged by the consumer and international organization.³⁰⁵

Although one aspect of fuel banks is to postpone enrichment and reprocessing capabilities, it is unfair to demand that NPT member states give up their nuclear rights. Countries should be able to pursue peaceful nuclear endeavors, but also should accomplish them under strict transparency. While some countries believe that using a fuel bank means they need to give up enrichment and reprocessing, the IAEA states that “the rights of the member state... shall remain intact and shall not in any way be compromised or diminished by the establishment of international assurance of supply mechanisms.”³⁰⁶ In effect the fuel bank promotes energy security for developing countries by offering

³⁰² Cirincione, *Bomb Scare*, 147.

³⁰³ Sverre Lodgaard, “Challenge from Within: The Case of Iran,” in *Nuclear Proliferation and International Order: Challenges to the Non-Proliferation Treaty*, ed. Olav Njølstad (London: Routledge Global Security Studies, 2011), 85–86.

³⁰⁴ Kenneth Katzman, *Iran: U.S. Concerns and Policy Responses* (CRS Report No. RL32048) (Washington, DC: Congressional Research Service, 2014), 21, <http://fas.org/sgp/crs/mideast/RL32048.pdf>.

³⁰⁵ National Academy of Sciences and National Research Council, *Internationalization of the Nuclear Fuel Cycle: Goals, Strategies, and Challenge* (Washington, DC: National Academies, 2009), 27–28.

³⁰⁶ “Assurance of Supply for Nuclear Fuel,” International Atomic Energy Agency (IAEA), last modified October 31, 2011, <http://www.iaea.org/OurWork/ST/NE/NEFW/Assurance-of-Supply/overview.html>.

LEU and encouraging nonproliferation by reducing the need for advanced fuel cycle capabilities without denying members their NPT rights.

Committing to a fissile material cutoff that prohibits the production of HEU and plutonium, would signal that states are serious about reducing weapons grade material and that weapons arsenals are limited.³⁰⁷ The 2010 Nuclear Posture Review adds that a fissile material cutoff treaty would enhance U.S. security and nuclear stability throughout the world.³⁰⁸

In addition, tougher regulations focused on nonproliferation should be complemented with efforts by the weapons states to disarm. According to Cirincione, nuclear weapons, similar to biological and chemical, need to become universally rejected.³⁰⁹ This means that the United States and the rest of the nuclear weapon states would be required to eliminate their nuclear arsenals. Although total elimination is not likely to occur soon, continued reductions could reaffirm weapons states' disarmament commitments and strengthen the NPT. In addition to numbers, the prestige these weapons possess should be minimized and the benefits of not obtaining them or the option of possession should be promoted. In addition, the U.S. should publicize efforts to transform HEU and plutonium to non-weapons uses and utilize a transparent program that allows others to understand its disarmament.³¹⁰

The demand for competencies leading to the threshold and nuclear weapons capabilities also should be reduced. Thirty years ago, Smith and Rathjens understood this concept and argued that “the best hope of stemming nuclear proliferation lies in dealing effectively with the motives that lead nations to want to have nuclear weapons.”³¹¹ Nuclear weapons proponents within states should be weakened, while opponents should be strengthened. International institutions could provide positive and negative incentives

³⁰⁷ William J. Perry, Brent Scowcroft, and Charles D. Ferguson, *U.S. Nuclear Weapons Policy* (Independent Task Force Report No. 62) (Washington, DC: Council on Foreign Relations, 2009), 60, <http://www.cfr.org/proliferation/us-nuclear-weapons-policy/p19226>.

³⁰⁸ DOD, *Nuclear Posture Review*, 9.

³⁰⁹ Cirincione, *Bomb Scare*, 130–31.

³¹⁰ Perry, Scowcroft, and Ferguson, *U.S. Nuclear Weapons*, 6.

³¹¹ Smith and Rathjens, “Reassessing Nuclear Nonproliferation,” 888.

in areas that are related to a state's nuclear program.³¹² These include banking, trade, health, education, human rights, and the military. Iranian human rights activist, Shirin Ebadi was awarded the Nobel Peace Prize in 2003 in an effort to strengthen human rights groups. As Etel Solingen argues, "the stronger these constituencies become, the less willing they will be to bear the economic, social, and political consequences of nuclear programs and the external instability they often induce."³¹³ In addition, it is important to have insight into a country's political economy and nuclear policy relationship, as this could lead an understanding of its nuclear desires.³¹⁴ It could also reveal vulnerabilities, which nonproliferation efforts could focus on.

Furthermore, the United States should reaffirm its security alliances with its allies and promote security cooperation based on mutual interests with others. This could dispel security fears that others claim to justify an infrastructure that could lead to weapons production. Some argue that reductions in the U.S. arsenal would lessen the reliability of its nuclear umbrella that protects and prevents some of its allies from acquiring nuclear weapons. James Schlesinger testified to the House Armed Services Committee that of all the countries that enjoy the protection of U.S. extended deterrence, Japan is the most likely to go nuclear if it loses confidence in U.S. protection.³¹⁵ Since the two concluded its Treaty of Mutual Cooperation and Security in 1960, Japan has occasionally voiced its concerns surrounding the reliability of the U.S. nuclear umbrella, but still does not have nuclear weapons. In 1960, the United States had more than 20,000 nuclear weapons, which equated to roughly 93 percent of the world's total.³¹⁶ From its peak in 1966, the U.S. has reduced its arsenal from more than 32,000 weapons to approximately 7,400

³¹² Solingen, *Nuclear Logics*, 293.

³¹³ *Ibid.*, 294.

³¹⁴ *Ibid.*, 292.

³¹⁵ *Report of the Congressional Commission on the Strategic Posture of the United States: Hearing Before the Committee on Armed Services, House of Representatives, 111th Cong., 1 (2009)* (statement of James Schlesinger), <http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg53569/pdf/CHRG-111hhrg53569.pdf>.

³¹⁶ "Table of Global Nuclear Weapons Stockpiles, 1945–2002," Natural Resources Defense Council, last modified November 25, 2002, <http://www.nrdc.org/nuclear/nudb/datab19.asp>.

today.³¹⁷ This latter figure represents approximately 45 percent of the world's nuclear weapons. Since 1960, the total number of nuclear weapons states increased by five, including Japan's neighbors China and North Korea. Aside from Japan's domestic stance on nuclear weapons, these numbers suggest that further reductions to the U.S. arsenal will not force Japan into starting a nuclear weapons program.

This does not mean that the U.S. should eliminate its arsenal overnight. Rather, it should continue to work with its allies and steadily reduce the inventory. With a smaller arsenal, the United States could still affirm its security commitments for its allies by utilizing its superior conventional forces and maintaining a presence in tenuous areas. Similarly, the United States should promote stability by developing assistance programs that could lead to understanding, cooperation, and integration into the global community for those states, which harbor potentially destabilizing nuclear aspirations.³¹⁸ These incentives could persuade some to refrain from nuclear capabilities related to the full fuel cycle. In addition, they could be diminished or revoked if a state began to conduct nuclear experiments.

The United States and the rest of the world's responsibility is to reduce future proliferation by working with these countries and preventing them from reaching the threshold. In this realm the United States should take a leading role and form a consensus that stronger methods of nonproliferation need to be implemented. After all, the U.S. Department of Defense *2010 Nuclear Posture Review Report* states that nonproliferation merits a "priority atop the U.S. nuclear agenda."³¹⁹

Although its leadership is important, the United States should refrain from dominating efforts in a way that could cause others to perceive it as acting alone or in its own self-interest.³²⁰ The United States should continue to use multilateral approaches

³¹⁷ "World Nuclear Stockpile Report," Ploughshares Fund, last modified January 7, 2014, <http://www.ploughshares.org/world-nuclear-stockpile-report>.

³¹⁸ James E. Doyle and Peter Engstrom, "The Utility of Nuclear Weapons: Tradeoffs and Opportunity Costs," in *Pulling Back from the Nuclear Brink: Reducing and Countering Nuclear Threats*, ed. Barry R. Schneider and William L. Dowdy (London: Frank Cass, 1998), 52–53.

³¹⁹ DOD, *Nuclear Posture Review*, 9.

³²⁰ Crincione, *Bomb Scare*, 137.

and include developing countries with similar interests that could take leading roles to prevent others from developing nuclear programs capable of reaching the threshold. This appears to make sense because in the context of nuclear proliferation, these states seem to have more in common with others, particularly their non-nuclear weapons state status. Conversely, the United States is often accused of dictating negotiations, which strengthens the argument that the NPT and nonproliferation regime is discriminatory.

The United States should be more proactive in disarmament efforts. Currently, it possesses 4,804 nuclear warheads³²¹ ready to be delivered and another 2,600 in retirement status. Rather than reducing the amount of deployed warheads and delivery vehicles stated in the New Strategic Arms Reduction Treaty (START) with Russia, the United States could unilaterally destroy warheads. Dismantling these weapons may have a greater psychological impact on non-nuclear weapons states than eventual arsenal reduction due to retirement of aging systems.³²² This could have a two-fold impact. First, it could signal to the world, such as President Obama's speech did, that the United States is committed to nonproliferation. Second, it could lower the prestige these weapons have affixed to them in terms of security and international respect. Reducing the number of warheads would complement the Nuclear Posture Review's negative security assurance. Some nuclear analyst view this concept as a way the United States is reducing its reliance on nuclear weapons as a deterrent and eliminating situations in which weapons would be used.³²³

The United States should also ratify the Comprehensive Nuclear Test Ban Treaty that outlaws nuclear explosive testing. Ratification would strengthen the nonproliferation regime by increasing the costs of conducting a test. Although a successful test could reveal competence, under a CTBT a test would violate an international treaty. This breach could therefore cost the state in terms of prestige, sanctions, and isolation.³²⁴ In

³²¹ Daryl Kimball, "Nuclear Weapons: Who Has What at a Glance," Arms Control Association, June 23, 2014, <https://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat>.

³²² Hans M. Kristensen, "U.S. Nuclear Policy: A Mixed Message," *The Monthly Komei*, June 2013, http://fas.org/programs/ssp/nukes/publications1/2013_TheMonthlyKomei.pdf.

³²³ *Ibid.*

³²⁴ Perry, Scowcroft, and Ferguson, *U.S. Nuclear Weapons*, 55.

March 2012, the National Academy of Science encouraged the CTBT's ratification by explaining that as long as the United States dedicates resources for the nuclear field, its technical supremacy will not suffer.³²⁵

If the United States is serious about being a leader of nonproliferation, it is going to have to make major adjustments to its own policy. Its commitment to disarmament should show tangible results that occur quickly rather than being initiated in years or decades in the future. The United States should pursue a "world without nuclear weapons," but publically forgo the promotion of a "safe, secure, and effective arsenal to deter any adversary."³²⁶ Another major hurdle for U.S. efforts will be forming a consensus with others to hold nonproliferation standards to the level the United States has. This will prove especially difficult in the transfer of nuclear material and equipment that could be used to produce economic benefits to the seller. This will include convincing others that it is necessary to sacrifice billions of dollars for infrastructure to stem the supply side of nuclear material. It will be tedious and require long-term commitments from all states with nuclear capabilities and aspirations, but a starting point that demonstrates serious results is essential.

³²⁵ Lawrence Krauss, "It's Time for the U.S. to Finally Sign the Nuclear-Test-Ban Treaty," *Slate*, April 25, 2012, http://www.slate.com/articles/technology/future_tense/2012/04/comprehensive_nuclear_test_ban_treaty_the_u_s_should_ratify_it_now_.html.

³²⁶ Barack Obama, "Remarks by President Barack Obama" (speech, Hradcany Square, Prague, Czech Republic, April 5, 2009), http://www.whitehouse.gov/the_press_office/Remarks-by-President-Barack-Obama-in-Prague-as-Delivered.

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

- Albright, David. Interview by Hari Sreenivasan. *PBS Newshour*. PBS, November 9, 2013. http://www.pbs.org/newshour/bb/world-july-dec13-albright_11-09/.
- . “Making Iran Come Clean About its Nukes: What is the Point of Striking an Agreement with Iran if Tehran Will Be Able to Hide its Weapons Work?” *Wall Street Journal*, May 14, 2014.
- Albright, David and Serena Kelleher-Vergantini. *Changes Visible at Parchin Nuclear Site: Why Parchin Matters to a Final Deal*. Washington, DC: Institute for Science and International Security, February 25, 2014. <http://isis-online.org/isis-reports/detail/changes-visible-at-parchin-nuclear-site/8>.
- Albright, David and Andrea Stricker. “Iran’s Nuclear Program.” The Iran Primer, United States Institute for Peace. <http://iranprimer.usip.org/resource/irans-nuclear-program>.
- Arguello, Irma. “The Position of an Emerging Global Power: Brazilian Responses to the 2010 U.S. Nuclear Posture Review.” *The Nonproliferation Review* 18, no. 1 (2011): 183–200. <http://www.tandfonline.com/doi/pdf/10.1080/10736700.2011.549180>.
- Associated Press. “Analysis: Iran’s Nuclear Dealmakers Hone New Pitch for Revolutionary Guard.” *Fox News*. November 26, 2013. <http://www.foxnews.com/world/2013/11/26/analysis-iran-nuclear-dealmakers-hone-new-pitch-for-revolutionary-guard/>.
- Bajoria, Jayshree, and Esther Pan, “The U.S.-India Deal.” Council on Foreign Relations. November 5, 2010. <http://www.cfr.org/india/us-india-nuclear-deal/p9663>.
- Baldor, Lolita C. “U.S. Sends Ballistic Missile Destroyers to Counter North Korean Threat After Pyongyang Announces ‘New’ Nuclear Tests.” Associated Press, April 6, 2014. <http://news.nationalpost.com/2014/04/06/u-s-sends-ballistic-missile-destroyers-to-counter-north-korean-threat-after-pyongyang-announces-new-nuclear-test/>.
- Barletta, Michael. *The Military Nuclear Program of Brazil*. Working Paper. Stanford, CA: Center for International Security and Arms Control, 1997. <http://iis-db.stanford.edu/pubs/10340/barletta.pdf>.
- Barzegar, Kayhan. “Sanctions Won’t End Iran’s Nuclear Program.” In *Iran and the Bomb: Solving the Persian Puzzle*, edited by Gideon Rose and Jonathan Tepperman, 158–162. New York: Council on Foreign Relations, 2012.

- Bowen, Wyn Q., and Jonathan Brewer. "Iran's Nuclear Challenge: Nine Years and Counting." *International Affairs* 87, no. 4 (2011): 923–943. http://www.chathamhouse.org/sites/default/files/87_4bowenbrewer.pdf.
- Brazil. Chamber of Deputies. *Constitution of the Federative Republic of Brazil*. 3rd ed. Brasilia: Documentation and Information Center Publishing Coordination, 2010. <http://english.tse.jus.br/arquivos/federal-constitution>.
- Brazil Ministry of Defense. *National Strategy of Defense*. Brasilia: Brazil Ministry of Defense, 2008. http://www.defesa.gov.br/projetosweb/estrategia/arquivos/estrategia_defesa_nacional_ingles.pdf.
- Campbell, Kurt M., and Tsuyoshi Sunohara. "Japan: Thinking the Unthinkable." In *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*, edited by Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss, 218–253. Washington, DC: The Brookings Institution, 2004.
- Chanlett-Avery, Emma, and Mary Beth Nikitin. *Japan's Nuclear Future: Policy Debate, Prospects, and U.S. Interests* (CRS Report No. RL34487). Washington, DC: Congressional Research Service, 2009. <https://www.fas.org/sgp/crs/nuke/RL34487.pdf>.
- Chubin, Shahram. "The Politics of Iran's Nuclear Program." *The Iran Primer*. United States Institute of Peace. 2010. <http://iranprimer.usip.org/resource/politics-irans-nuclear-program>.
- Cirincione, Joseph. *Bomb Scare: The History and Future of Nuclear Weapons*. New York: Colombia University Press, 2007.
- Clapper, James. *Worldwide Threat Assessment of the U.S. Intelligence Community*. Senate Select Committee on Intelligence. January 29, 2014. http://www.dni.gov/files/documents/Intelligence%20Reports/2014%20WWTA%20%20SFR_SSCI_29_Jan.pdf.
- Cohen, Avner, and Benjamin Frankel. "Opaque Nuclear Proliferation." *Journal of Strategic Studies* 13, no.3 (1990): 14–44. <http://www.tandfonline.com/doi/pdf/10.1080/01402399008437417>.
- Cordesman, Anthony H. *Iran's Military Forces in Transition: Conventional Threats and Weapons of Mass Destruction*. Westport, CT: Praeger, 1999.
- Damkani, Goel. "Iran as a Nuclear Threshold Country." *The Interdisciplinary Center Herzliya*. Accessed January 23, 2014. http://portal.idc.ac.il/he/main/about_idc/news_events/doclib2/84_nuclear_iran.pdf.

- Davenport, Kelsey. "Iran Provides Detonator Details to IAEA." Arms Control Association. June 2014. https://www.armscontrol.org/act/2014_06/news/Iran-Provides-Detonator-Details-to-IAEA.
- Department of Defense. *Nuclear Posture Review Report*. Washington, DC: April 2010. <http://www.defense.gov/npr/docs/2010%20Nuclear%20Posture%20Review%20Report.pdf>.
- . "UN Security Council Resolutions on Iran." Arms Control Association. August 2012. <https://www.armscontrol.org/factsheets/Security-Council-Resolutions-on-Iran>.
- Diehl, Sarah, and Eduardo Fujii. "Brazil's New National Defense Strategy Calls for Strategic Nuclear Developments." Nuclear Threat Initiative. October 30, 2009. <http://www.nti.org/analysis/articles/brazils-new-defense-strategy/>.
- Director of Central Intelligence. *Brazil's Changing Nuclear Goals: Motives and Constraints* (SNIE 93-89). October 21, 1983. http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000787519.pdf.
- Director General. "Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran." International Atomic Energy Agency. May 23, 2014. <http://www.iaea.org/Publications/Documents/Board/2014/gov2014-28.pdf>.
- Dowdy, William L. "Nuclear Proliferation Issues and Prospects in the Middle East." In *Pulling Back from the Nuclear Brink: Reducing and Countering Nuclear Threats*, edited by Barry R. Schneider and William L. Dowdy, 136–147. London: Frank Cass, 1998.
- Doyle, James E., and Peter Engstrom. "The Utility of Nuclear Weapons: Tradeoffs and Opportunity Costs." In *Pulling Back from the Nuclear Brink: Reducing and Countering Nuclear Threats*, edited by Barry R. Schneider and William L. Dowdy, 39–59. London: Frank Cass, 1998.
- Elliot, David. "The Legacy of Fukushima: Two Year On." Our World. January 25, 2013. <http://ourworld.unu.edu/en/the-legacy-of-fukushima-two-years-on>.
- FARS News Agency. "Commander: IRGC Pessimistic About Iran-Powers Talks, but Keeps Silent to See Results." February 19, 2014. <http://english.farsnews.com/newstext.aspx?nn=13921130000833>.
- Ferguson, Charles D. "Proliferation Risks of Nuclear Power Programs." Nuclear Threat Initiative. December 1, 2007. <http://www.nti.org/analysis/articles/risks-nuclear-power-programs/>.

- Fortmann, Michel. "The Other Side of Midnight: Opaque Proliferation Revisited." *International Journal* 48, no. 1 (1992/1993): 151–175. <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/40202824.pdf?acceptTC=true&acceptTC=true&jpdConfirm=true>.
- Friedman, Andrew. "6 Reasons Hassan Rouhani is No Ahmadinejad." Policy.Mic. September 19, 2013. <http://www.policymic.com/articles/64271/6-reasons-hassan-rouhani-is-no-ahmadinejad>.
- Fulton, Will. "IRGC Messaging: Insight into a Revolutionary Regime." Iran Tracker, AEI Critical Threats Project. May 20, 2013. <http://www.irantracker.org/analysis/fulton-irgc-messaging-insight-revolutionary-regime-may-20-2013>.
- Furukawa, Katsuhisa. "Japan's Nuclear Option." In *Over the Horizon Proliferation Threats*, edited by James J. Wirtz and Peter R. Lavoy, 13–32. Stanford, CA: Stanford University Press, 2012.
- Gamba-Stonehouse, Virginia. "Argentina and Brazil." In *Security with Nuclear Weapons?: Different Perspectives on National Security*, edited by Regina Cowen Karp, 229–257. New York: Oxford University Press, 1991.
- Ganji, Akbar. "The Latter-Day Sultan: Power and Politics in Iran." *Foreign Affairs* 87, no. 6 (2008): 45–62, 64–66. <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/20699371.pdf?acceptTC=true&acceptTC=true&jpdConfirm=true>.
- . "Who is Ali Khamenei?" *Foreign Affairs* 92, no. 5 (2013): 24–48. <http://web.ebscohost.com.libproxy.nps.edu/ehost/detail?vid=4&sid=27019b0f-f673-4969-98e1-97b372a14f79%40sessionmgr111&hid=122&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#db=bth&AN=89749127>.
- Gasiorowski, Mark. "Islamic Republic of Iran." In *The Government and Politics of the Middle East and North Africa*, 6th ed., edited by David E. Long, Bernard Reich, and Mark Gasiorowski, 49–90. Boulder, CO: Westview Press, 2011.
- Gautam, Brenna. "Fact Sheet: Iran's Nuclear and Ballistic Missile Programs." The Center for Arms Control and Non-Proliferation. Last modified July 2014. http://armscontrolcenter.org/publications/factsheets/fact_sheet_irans_nuclear_and_ballistic_missile_programs/.
- General Counsel, Office of the. *Nuclear Regulatory Legislation* (NUREG-0980). Washington, DC: Nuclear Regulatory Commission, 2013. <http://pbadupws.nrc.gov/docs/ML1327/ML13274A489.pdf#page=23>.
- George, Marcus. "Iran Announces Uranium Finds, Days Before Nuclear Talks." Reuters, February 23, 2013. <http://www.reuters.com/article/2013/02/23/us-iran-nuclear-idUSBRE91M07920130223>.

- Gerami, Nima. "Background on the 'Possible Military Dimensions' of Iran's Nuclear Program." The Washington Institute for Near East Policy. June 13, 2014. <http://www.washingtoninstitute.org/policy-analysis/view/background-on-the-possible-military-dimensions-of-irans-nuclear-program>.
- Ghazi, Siavosh. "Iran's Supreme Leader Reveals Demands in Nuclear Talks." *Agence France-Presse*, July 8, 2014. <http://news.yahoo.com/nuclear-team-defend-irans-rights-khamenei-194020395.html>.
- Ghoshal, Debalina. "South America Goes Nuclear: Now Brazil." Gatestone Institute. August 20, 2013. <http://www.gatestoneinstitute.org/3941/nuclear-brazil>.
- GlobalSecurity.org. "MRX (Marine Reactor X)." Last modified July 16, 2012. <http://www.globalsecurity.org/military/world/japan/ns-mrx.htm>.
- . "Nuclear Ship Mutsu - Development." Last modified July 16, 2012. <http://www.globalsecurity.org/military/world/japan/ns-mutsu-dev.htm>.
- . "Nuclear Ship Mutsu - Operations." Last modified July 16, 2012. <http://www.globalsecurity.org/military/world/japan/ns-mutsu-ops.htm>.
- Gold, Dore. "The Dangers of Accepting Iran as a Nuclear Threshold State." Israel Hayom. August 31, 2012. http://www.israelhayom.com/site/newsletter_opinion.php?id=2490.
- Greenberg, Samara. Review of *The Pasdaran: Inside Iran's Islamic Revolutionary Guard Corps*, by Emanuele Ottolenghi. "Wanted: Iran's Islamic Revolutionary Guards." *In Focus* 6, no. 1 (2012). http://www.jewishpolicycenter.org/3234/pasdaran_
- Grunden, Walter E., Walker, Mark, and Masakatsu Yamazaki. "Wartime Nuclear Weapons Research in Germany and Japan." *Osiris* 20 (2005): 107–130. <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/3655253.pdf?acceptTC=true&jpdConfirm=true>.
- Guzansky, Yoel, and Jonathan Schachter. "Iran Japanese Option: Arms within Arms' Reach." *The Jerusalem Post*, August 22, 2011. <http://www.jpost.com/Opinion/Op-Ed-Contributors/Irans-Japanese-option-Arms-within-arms-reach>.
- Herzog, Michael. *Iranian Public Opinion on the Nuclear Program: A Potential Asset for the International Community*. Washington, DC: Washington Institute for Near East Policy, 2006. <http://www.washingtoninstitute.org/uploads/Documents/pubs/PolicyFocus56.pdf>.
- Hindell, Juliet. "The Power of Tomodachi: U.S. Military's Humanitarian Efforts Cemented an Alliance." *Japan Society* (blog). November 21, 2011. <http://japansocietyny.blogspot.com/2011/11/operation-admiral-patrick-m-walsh.html>.

- Hiro, Dilip. "Iran Nuclear Dispute Could Split World Community." Yale Global Online. Yale Center for the Study of Globalization. September 13, 2005. <http://yaleglobal.yale.edu/print/2678>.
- Hirsch, Theodore. "The IAEA Additional Protocol: What It Is and Why It Matters." *The Nonproliferation Review* 11 no. 3 (2004): 140–166. <http://cns.miis.edu/npr/pdfs/113hirsch.pdf>.
- Horner, Daniel. "India, U.S. Agree on Terms for Reprocessing." Arms Control Association. May 2010. https://www.armscontrol.org/act/2010_05/US-IndiaReprocessing.
- Institute for Science and International Security (ISIS). *Defining Iranian Nuclear Programs in a Comprehensive Solution under the Joint Plan of Action*. Washington, DC: Author, January 15, 2014. http://www.isis-online.org/uploads/isis-reports/documents/Elements_of_a_Comprehensive_Solution_20Jan2014_1.pdf.
- International Atomic Energy Agency (IAEA). *Treaty of the Non-Proliferation of Nuclear Power*. Vienna: IAEA, 1970. <http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc140.pdf>.
- . "The Text of the Agreement Between Iran and the Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons." IAEA Information Circular 214. December 13, 1974. <http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc214.pdf>.
- . "Assurance of Supply for Nuclear Fuel." Last modified October 31, 2011. <http://www.iaea.org/OurWork/ST/NE/NEFW/Assurance-of-Supply/overview.html>.
- . "IAEA Safeguards Overview: Comprehensive Safeguards Agreements and Additional Protocols." Last modified September 20, 2012. http://www.iaea.org/Publications/Factsheets/English/sg_overview.html.
- Iran Primer, The. "Khamenei's Red Lines on Nuclear Talks." United States Institute of Peace. April 16, 2014. <http://iranprimer.usip.org/blog/2014/apr/16/khamenei%E2%80%99s-red-lines-nuclear-talks>.
- James Martin Center for Nonproliferation Studies. "Japan—Inventory of International Nonproliferation Organizations and Regimes." Last modified May 25, 2012. <http://cns.miis.edu/inventory/pdfs/japan.pdf>.
- Japan. Ministry of Defense. "Defense of Japan" 2013. http://www.mod.go.jp/e/publ/w_paper/2013.html.

- Johnson, Toni. "Fifteen Nuclear Agendas to Watch." Council on Foreign Relations. May 27, 2010. <http://www.cfr.org/proliferation/fifteen-nuclear-agendas-watch/p22023#p8>.
- Kassenova, Togzhan. *Brazil's Nuclear Kaleidoscope: An Evolving Identity*. Washington, DC: Carnegie Endowment for International Peace, March 12, 2014.
- Kato, Norihiro. "Ambiguities of Japan's Nuclear Policy." *The New York Times*, April 13, 2014. http://www.nytimes.com/2014/04/14/opinion/kato-ambiguities-of-japans-nuclear-policy.html?_r=0.
- Katzman, Kenneth. *Iran Sanctions* (CRS Report No. RS20871). Washington, DC: Congressional Research Service, 2014. <https://www.fas.org/sgp/crs/mideast/RS20871.pdf>.
- . *Iran: U.S. Concerns and Policy Responses* (CRS Report No. RL32048). Washington, DC: Congressional Research Service, 2014. <http://fas.org/sgp/crs/mideast/RL32048.pdf>.
- Kerr, Paul K. *Iran's Nuclear Program: Tehran's Compliance with International Obligations* (CRS Report No. R40094). Washington, DC: Congressional Research Service, 2014. <http://www.fas.org/sgp/crs/nuke/R40094.pdf>.
- Kerr, Paul K., Holt, Mark, and Mary Beth Nikitin. *Nuclear Energy Cooperation with Foreign Countries: Issues for Congress* (CRS Report No. R41910). Washington, DC: Congressional Research Service, 2011. <http://fas.org/sgp/crs/nuke/R41910.pdf>.
- Khamenei, Sayyid Ali. "Only U.S. Has Committed Nuclear Offence." The Office of the Supreme Leader. April 17, 2010. <http://www.leader.ir/langs/en/?p=contentShow&id=6676>.
- Kimball, Daryl. "The U.S. Atomic Energy Act Section 123 At a Glance." Arms Control Association. Last modified March 2013. <https://www.armscontrol.org/factsheets/AEASection123>.
- . "Nuclear Weapons: Who Has What at a Glance." Arms Control Association. June 23, 2014. <https://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat>.
- Krauss, Lawrence. "It's Time for the U.S. to Finally Sign the Nuclear-Test-Ban Treaty." *Slate*, April 25, 2012. http://www.slate.com/articles/technology/future_tense/2012/04/comprehensive_nuclear_test_ban_treaty_the_u_s_should_ratify_it_now_.html.

- Kristensen, Hans M. "U.S. Nuclear Policy: A Mixed Message." *The Monthly Komei*. June 2013. http://fas.org/programs/ssp/nukes/publications1/2013_TheMonthlyKomei.pdf.
- Kroenig, Matthew. "Time To Attack Iran: Why a Strike Is the Least Bad Option." *Foreign Affairs* 91, no. 1 (2012): 76–86. <http://web.ebscohost.com/ehost/detail?vid=3&sid=44cce68e-0858-432d-b874-ecf919efe375%40sessionmgr112&hid=119&bdata=JnNpdGU9ZWVhc3QtbGl2ZSZzY29wZT1zaXRl#db=bth&AN=69880008>.
- . "Still Time to Attack Iran: The Illusion of a Comprehensive Nuclear Deal." *Foreign Affairs*, January 7, 2014. <http://www.foreignaffairs.com/articles/140632/matthew-kroenig/still-time-to-attack-iran>.
- Litwak, Robert. *Iran's Nuclear Chess: Calculating America's Moves*. Washington, DC: Woodrow Wilson Center, Middle East Program, 2014. http://www.wilsoncenter.org/sites/default/files/irans_nuclear_chess_calculating_americas_moves.pdf.
- Live Science. "Facts About Uranium." September 18, 2013. <http://www.livescience.com/39773-facts-about-uranium.html>.
- . "Facts About Plutonium." September 23, 2013. <http://www.livescience.com/39871-facts-about-plutonium.html>.
- Logaard, Sverre. "Challenge From Within: The Case of Iran." In *Nuclear Disarmament and Non-Proliferation: Towards a Nuclear-weapon-free World?* edited by Sverre Logaard, 133–150. London: Routledge Global Security Studies, 2011.
- Lodgaard, Sverre. "Challenge from Within: The Case of Iran." In *Nuclear Proliferation and International Order: Challenges to the Non-Proliferation Treaty*, edited by Olav Njølstad, 84–103. London: Routledge Global Security Studies, 2011.
- Loschky, Jay. "Most Iranians Say Sanctions Hurt Their Livelihoods." Gallup World, November 6, 2013. http://www.gallup.com/poll/165743/iranians-say-sanctions-hurting-livelihoods.aspx?utm_source=alert&utm_medium=email&utm_campaign=syndication&utm_content=morelink&utm_term=All%20Gallup%20Headlines.
- Milani, Abbas. "The Biggest Mystery in Tehran." *New Republic* 244, no. 16 (2013): 7–9. <http://web.ebscohost.com.libproxy.nps.edu/ehost/detail?vid=4&sid=b567c659-1e39-4bc2-96ed-1a46154d13e4%40sessionmgr111&hid=122&bdata=JnNpdGU9ZWVhc3QtbGl2ZSZzY29wZT1zaXRl#db=bth&AN=90368272>.
- Milhollin, Gary. "Iran's Long Nuclear Game, or How Iran Could Get the Bomb." Iran Watch. Wisconsin Project on Nuclear Arms Control. May 13, 2013. <http://www.iranwatch.org/our-publications/article-oped-report/irans-long-nuclear-game-or-how-iran-could-get-bomb>.

- Misztal, Blaise. "A Tale of Two Irans in New IAEA Report." *Bipartisan Policy Center*, February 24, 2014. <http://bipartisanpolicy.org/blog/foreignpolicy/2014/02/24/update-iran%E2%80%99s-nuclear-program>.
- Moltz, James Clay. "Closing the NPT Loophole on Exports of Naval Propulsion." *The Nonproliferation Review* 6, no. 1 (1998): 108–114. <http://cns.miis.edu/npr/pdfs/cmoltz61.pdf>.
- Mukhatzhanova, Gaukhar. "Pride and Prejudice: Understanding Iran's Nuclear Program." In *Forecasting Nuclear Proliferation in the 21st Century: A Comparative Perspective*, vol. 2, edited by William C. Potter with Gaukhar Mukhatzhanova, 42–75. Stanford, CA: Stanford University Press, 2010.
- Nakano, Jane. "Civilian Nuclear Energy Cooperation Between the United States and Japan." In *The New Nuclear Agenda: Prospects for US-Japan Cooperation*, edited by Yuki Tatsumi, 41–56. Washington, DC: Henry L. Stimson Center, 2012. http://www.stimson.org/images/uploads/research-pdfs/New_Nuclear_Agenda_FINAL_3_15_12.pdf.
- National Academy of Sciences and National Research Council. *Internationalization of the Nuclear Fuel Cycle: Goals, Strategies, and Challenge*. Washington, DC: National Academies, 2009.
- Natural Resources Defense Council. "Table of Global Nuclear Weapons Stockpiles, 1945–2002." Last modified November 25, 2002. <http://www.nrdc.org/nuclear/nudb/datab19.asp>.
- Naval Reactors, Office of. *Report on Low Enriched Uranium for Naval Reactor Cores*. Washington, DC: Department of Energy, 2014. <http://fissilematerials.org/library/doe14.pdf>.
- Nikitin, Mary Beth D., Holt, Mark, and Mark E. Manyin. *U.S.-Vietnam Nuclear Cooperation Agreement: Issues for Congress* (CRS Report No. R43433). Washington, DC: Congressional Research Service, 2014. <http://fas.org/sgp/crs/nuke/R43433.pdf>.
- Nikkei Asian Review*. "Japan to Drop Troubled Fast Breeder Reactor From Energy Plan." February 7, 2014. <http://asia.nikkei.com/Politics-Economy/Policy-Politics/Japan-to-drop-troubled-fast-breeder-reactor-from-energy-plan>.
- Nuclear Energy Institute. "Nuclear Units under Construction Worldwide." Nuclear Energy Institute. Last modified May 2014. <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics/Nuclear-Units-Under-Construction-Worldwide>.

- . “World Nuclear Power Plants in Operation.” Last modified May 2014. <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/World-Statistics/World-Nuclear-Power-Plants-in-Operation>.
- Nuclear Iran. “Arak Complex,” Institute for Science and International Security. Accessed June 16, 2014. <http://www.isisnucleariran.org/sites/detail/arak/>.
- . “Fordow Fuel Enrichment Plant.” Institute for Science and International Security. Accessed June 16, 2014. <http://www.isisnucleariran.org/sites/detail/fordow/>.
- . “Parchin.” Institute for Science and International Security. Accessed June 16, 2014. <http://www.isisnucleariran.org/sites/detail/parchin/>.
- Nuclear Regulatory Commission. “Stages of the Nuclear Fuel Cycle.” Last modified May 21, 2013. <http://www.nrc.gov/materials/fuel-cycle-fac/stages-fuel-cycle.html>.
- . “Backgrounder on Plutonium.” Last modified January 8, 2014. <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/plutonium.html>.
- . “Uranium Enrichment.” Last modified February 21, 2014. <http://www.nrc.gov/materials/fuel-cycle-fac/ur-enrichment.html>.
- Nuclear Threat Initiative. “Brazil Submarine Import and Export Behavior.” July 18, 2013. <http://www.nti.org/analysis/articles/brazil-submarine-import-and-export-behavior/>.
- Obama, Barack. “Remarks by President Barack Obama.” Speech. Hradcany Square, Prague, Czech Republic, April 5, 2009. http://www.whitehouse.gov/the_press_office/Remarks-by-President-Barack-Obama-in-Prague-as-Delivered.
- Ogilvie-White, Tanya. “Is There a Theory of Nuclear Proliferation?: An Analysis of the Contemporary Debate.” *The Nonproliferation Review* 4, no. 1 (1996): 43–60. <http://cns.miis.edu/npr/pdfs/ogilvi41.pdf>.
- P5+1 Nations and Iran. “Joint Plan of Action.” November 24, 2013. http://eeas.europa.eu/statements/docs/2013/131124_03_en.pdf.
- Paternoster, Richard R. *Nuclear Weapon Proliferation Indicators and Observables*. Los Alamos, NM: Los Alamos National Laboratory, 1992. <http://www.fas.org/sgp/othergov/doe/lanl/la-12430-ms.pdf>.
- Perkovich, George, Mathews, Jessica T., Cirincione, Joseph, Gottemoeller, Rose, and Jon B. Wolfsthal. *Universal Compliance: A Strategy for Nuclear Security*. Washington, DC: Carnegie Endowment for International Peace, 2007. http://carnegieendowment.org/files/univ_comp_rpt07_final1.pdf.

- Perry, William J., Scowcroft, Brent, and Charles D. Ferguson. *U.S. Nuclear Weapons Policy* (Independent Task Force Report No. 62). Washington, DC: Council on Foreign Relations, 2009. <http://www.cfr.org/proliferation/us-nuclear-weapons-policy/p19226>.
- Peterson, Scott. "How Much is a Nuclear Program Worth? For Iran, Well Over \$100 Billion." *The Christian Science Monitor*, April 3, 2013. <http://www.csmonitor.com/World/Middle-East/2013/0403/How-much-is-a-nuclear-program-worth-For-Iran-well-over-100-billion>.
- Ploughshares Fund. "World Nuclear Stockpile Report." Last modified January 7, 2014. <http://www.ploughshares.org/world-nuclear-stockpile-report>.
- Pollack, Kenneth M. *Unthinkable: Iran, the Bomb, and American Strategy*. New York: Simon and Schuster, 2013.
- Quester, George H. "Conceptions of Nuclear Threshold Status." In *Security with Nuclear Weapons?: Different Perspectives on National Security*, edited by Regina Cowen Karp, 209–228. New York: Oxford University Press, 1991.
- Reardon, Robert. "Iran's Nuclear Ambitions: Motivations, Trajectory, and Global Implication." In *Strategic Asia 2013–14: Asia in the Second Nuclear Age*, edited by Ashley J. Tellis, Abraham M. Denmark, and Travis Tanner, 201–231. Seattle, WA: National Bureau of Asian Research, 2013.
- Rosett, Claudia. "Iran, the U.N.'s New Authority On Nuclear Disarmament." *Forbes*, September 30, 2013. <http://www.forbes.com/sites/claudiarosett/2013/09/30/iran-the-u-n-s-new-authority-on-nuclear-disarmament/>.
- Rowberry, Ariana. "Sixty Years of "Atoms for Peace" and Iran's Nuclear Program." Up Front. The Brookings Institution. December 18, 2013. <http://www.brookings.edu/blogs/up-front/posts/2013/12/18-sixty-years-atoms-peace-iran-nuclear-program-rowberry>.
- Ruble, Maria Rost. "The Future of Japanese Nuclear Policy." *Strategic Insights* 8, no. 2 (2009). <http://calhoun.nps.edu/public/bitstream/handle/10945/11379/rubleApr09.pdf?sequence=1>.
- . "The Nuclear Threshold States: Challenges and Opportunities Posed by Brazil and Japan." *Nonproliferation Review* 17, no. 1 (March 2010): 49–70. http://cns.miis.edu/npr/pdfs/npr_17-1_rost_ruble.pdf.
- Sadjadpour, Karim. "Iranians Don't Want to Go Nuclear." *The Washington Post*, February 3, 2004. <http://www.crisisgroup.org/en/regions/middle-east-north-africa/iraq-iran-gulf/iran/iranians-dont-want-to-go-nuclear.aspx>.

- Sagan, Scott D. "Nuclear Latency and Nuclear Proliferation." In *Forecasting Nuclear Proliferation in the 21st Century: A Comparative Perspective*, vol. 1, edited by William C. Potter with Gaukhar Mukhatzhanova, 80–101. Stanford, CA: Stanford University Press, 2010.
- Santos Vieira de Jesus, Diego. "The Brazilian Way: Negotiation and Symmetry in Brazil's Nuclear Policy." *The Nonproliferation Review* 17, no. 3 (2010): 551–567. <http://www.tandfonline.com/doi/pdf/10.1080/10736700.2010.517003>.
- Schneider, Barry R. *Radical Responses to Radical Regimes: Evaluating Preemptive Counter-Proliferation*. Washington, DC: National Defense University, 1995.
- Shapley, Deborah. "Nuclear Weapons History: Japan's Wartime Bomb Projects Revealed." *Science* 199, no. 4325 (1978): 152–57. <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/1745136.pdf?acceptTC=true&jpdConfirm=true>.
- Sherman, Brad. "Avoiding Future Irans: A New Course for U.S. Nonproliferation Policy." Nonproliferation Policy Education Center. December 11, 2013. <http://npolicy.org/article.php?aid=1239&tid=4>.
- Smith, Gerard C., and George W. Rathjens. "Reassessing Nuclear Nonproliferation Policy." *Foreign Affairs* 59, no. 4 (1981): 875–894. <http://www.jstor.org.libproxy.nps.edu/stable/pdfplus/20040826.pdf?acceptTC=true&acceptTC=true&jpdConfirm=true>.
- Sokolski, Henry. "Avoiding Future Irans: A New Course for U.S. Nonproliferation Policy." Nonproliferation Policy Education Center. December 11, 2013. <http://www.npolicy.org/article.php?aid=1239&rtid=9>.
- Solingen, Etel. *The Domestic Sources of Nuclear Postures: Influencing 'Fence-Sitters' in the Post-Cold War Era* (IGCC Policy Paper 8). Irvine, CA: Institute on Global Conflict and Cooperation, 1994. <http://igcc.ucsd.edu/assets/001/501216.pdf>.
- . *Nuclear Logics: Contrasting Paths in East Asia and the Middle East*. Princeton, NJ: Princeton University Press, 2007.
- . "The Perils of Prediction: Japan's Once and Future Nuclear Status." In *Forecasting Nuclear Proliferation in the 21st Century: A Comparative Perspective*, vol. 2, edited by William C. Potter and Gaukhar Mukhatzhanova, 131–157. Stanford, CA: Stanford University Press, 2010.
- . "Hindsight and Foresight in South American Nonproliferation Trends in Argentina, Brazil, and Venezuela." In *Over the Horizon Proliferation Threats*, edited by James J. Wirtz and Peter R. Lavoy, 136–159. Stanford, CA: Stanford University Press, 2012.

- Spector, Leonard S. "Can Proliferation Be Stopped?: A Look at Events and Decisions in the mid-1990s." In *Pulling Back from the Nuclear Brink: Reducing and Countering Nuclear Threats*, edited by Barry R. Schneider and William L. Dowdy, 60–66. London: Frank Cass, 1998.
- Spector, Leonard S. and Jacqueline R. Smith. *Nuclear Ambitions: The Spread of Nuclear Weapons, 1989–1990*. Boulder, CO: Westview, 1990.
- Squassoni, Sharon. "The U.S.-Indian Deal and Its Impact." Arms Control Association. July/August 2010. https://www.armscontrol.org/act/2010_07-08/squassoni.
- Suzuki, Tatsujiro. "Japan's Plutonium Breeder Reactor and its Fuel Cycle." In *Fast Breeder Reactor Programs: History and Status*, 53–62. Princeton, NJ: International Panel on Fissile Materials, February 2010. <http://fissilematerials.org/library/rr08.pdf>.
- Tabuchi, Hiroko. "Japan Pushes Plan to Stockpile Plutonium, Despite Proliferation Risks." *The New York Times*, April 9, 2014. http://www.nytimes.com/2014/04/10/world/asia/japan-pushes-plan-to-stockpile-plutonium-despite-proliferation-risks.html?_r=0.
- Takubo, Masafumi and Frank N. von Hippel. *Ending Reprocessing in Japan: An Alternative Approach to Managing Japan's Spent Nuclear Fuel and Separated Plutonium*. Princeton, NJ: International Panel of Fissile Materials, 2013. <http://fissilematerials.org/library/rr12.pdf>.
- Taylor, Paul D. "Why Does Brazil Need Nuclear Submarines?" *Proceedings* 135, no. 6 (June 2009). <http://www.usni.org/magazines/proceedings/2009-06/why-does-brazil-need-nuclear-submarines>.
- Thielmann, Greg, and Wyatt Hoffman. "Submarine Nuclear Reactors: A Worsening Proliferation Challenge." The Arms Control Association. July 26, 2012. http://www.armscontrol.org/files/TAB_Submarine_Nuclear_Reactors.pdf.
- Tiezzi, Shannon. "Japan's Plutonium Problem." *The Diplomat*, February 19, 2014. <http://thediplomat.com/2014/02/japans-plutonium-problem/>.
- U.S. Congress. Office of Technology Assessment. *Technologies Underlying Weapons of Mass Destruction* (OTA-BP-ISC-115). Washington DC: U.S. Government Printing Office, 1993.
- Wilcox, Robert K. *Japan's Secret War: Japan's Race against Time to Build Its Own Atomic Bomb*. New York: Marlowe, 1995.
- Windrem, Robert. "Japan Has Nuclear 'Bomb in the Basement,' and China Isn't Happy." *NBCNews.com*, March 11, 2014. <http://www.nbcnews.com/storyline/fukushima-anniversary/japan-has-nuclear-bomb-basement-china-isnt-happy-n48976>.

- Wisconsin Project on Nuclear Arms Control. "Iran's Nuclear Timetable." Iran Watch. June 16, 2014. <http://www.iranwatch.org/our-publications/articles-reports/irans-nuclear-timetable>.
- Wolfsthal, Jon. "Iran and IAEA: On Past Military Dimensions." The Iran Primer. United States Institute of Peace. May 20, 2014. <http://iranprimer.usip.org/blog/2014/may/20/iran-and-iaea-past-military-dimensions>.
- World Nuclear Association. "Plutonium." Last modified March 2012. <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Fuel-Recycling/Plutonium/>.
- . "Processing of Used Nuclear Fuel." Last modified September 2013. <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Fuel-Recycling/Processing-of-Used-Nuclear-Fuel/>.
- . "Nuclear Power in Japan." Last modified February 26, 2014. <http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Japan/>.
- . "Emerging Nuclear Energy Countries." Last modified February 28, 2014. <http://www.world-nuclear.org/info/Country-Profiles/Others/Emerging-Nuclear-Energy-Countries/>.
- . "Nuclear Power in Brazil." Last modified March 2014. <http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Brazil/>.
- . "Nuclear-Powered Ships." Last modified April 2014. <http://www.world-nuclear.org/info/non-power-nuclear-applications/transport/nuclear-powered-ships/>.
- . "Nuclear Power in Iran." Last modified May 24, 2014. <http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Iran/>.
- Xu, Beina. "The U.S.-Japan Security Alliance." Council on Foreign Relations. Last modified December 3, 2013. <http://www.cfr.org/japan/us-japan-security-alliance/p31437#p3>.
- Yates, Ronald E. "Setbacks Submerge Japan's Nuclear Ship." *Chicago Tribune*, September 2, 1990. http://articles.chicagotribune.com/1990-09-02/news/9003130692_1_reactor-radiation-ship.
- Younger, Stephen M. *The Bomb: A New History*. New York: Harper Collins, 2009.
- Zarate, Juan C. *Treasury's War: The Unleashing of a New Era of Financial Warfare*. New York: PublicAffairs, 2013.

Zengerle, Patricia. "Kerry Says Iran Nuclear 'Breakout' Window Now Seen as Two Months." Reuters, April 8, 2014. <http://www.reuters.com/article/2014/04/08/us-iran-nuclear-usa-breakout-idUSBREA3719I20140408>.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
Ft. Belvoir, Virginia
2. Dudley Knox Library
Naval Postgraduate School
Monterey, California