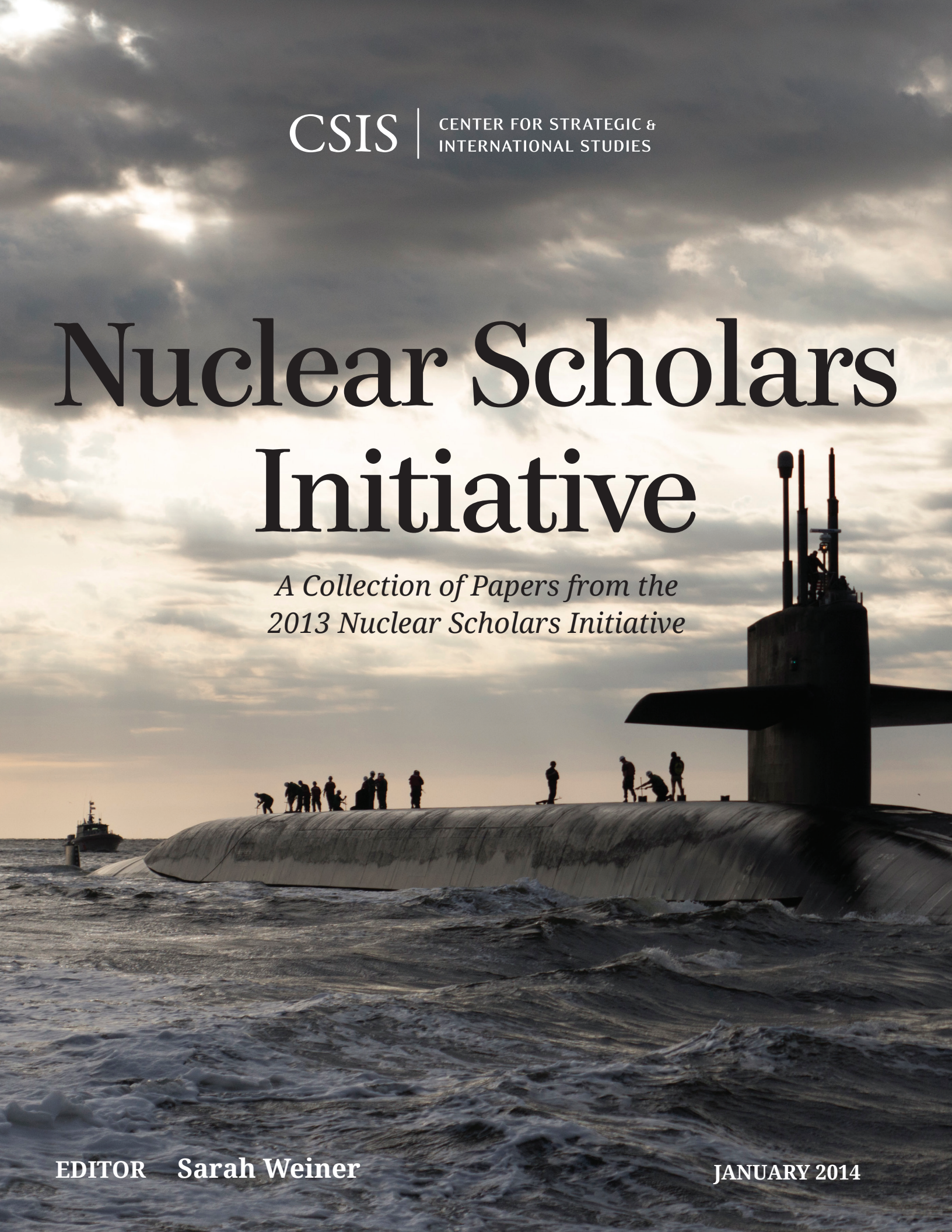

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Nuclear Scholars Initiative

A Collection of Papers from the 2013 Nuclear Scholars Initiative

EDITOR Sarah Weiner

JANUARY 2014

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Many of the most pressing national and international security challenges are tied to nuclear weapons. The need to reduce the prevalence of nuclear weapons globally and prevent their use by states and nonstate actors runs parallel with the need to maintain certain nuclear capabilities and the intellectual assets that support them. Both tracks present long-term challenges that, to be managed, will require sustained effort by talented and dedicated professionals. The Project on Nuclear Issues (PONI) seeks to help improve the effectiveness of U.S. nuclear strategy and policy through professional development and networking activities that target the next generation of leaders in the field.

PONI maintains an enterprise-wide membership base; hosts four major conferences and several smaller events each year; maintains an online blog; holds live debates on critical nuclear weapons issues; runs a six-month academic program for young experts; organizes bilateral exchanges involving young experts from the United States and abroad; and distributes regular news and event announcements to members. More information can be found at www.csis.org/isp/poni.

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Introduction and Acknowledgments

Addressing an increasingly complex array of nuclear weapons challenges in the future will require talented young people with the necessary technical and policy expertise to contribute to sound decisionmaking on nuclear issues over time. To that end, the CSIS Project on Nuclear Issues (PONI) runs a yearly Nuclear Scholars Initiative for graduate students and young professionals. Those accepted into the program are hosted once per month at CSIS in Washington, DC, where they participate in daylong workshops with senior government officials and policy experts. Over the course of the six-month program, Scholars are required to prepare a research paper. This volume is a collection of those papers.

PONI owes many thanks to the outstanding Nuclear Scholars Class of 2013 for their dedication and outstanding work. Special thanks are due to Dr. Clark Murdock, Dr. Richard Wagner, and Ms. Amy Woolf for providing valuable feedback to the Nuclear Scholars about their research and to Amb. Linton Brooks for chairing several meetings and serving as a consistent mentor to the Class of 2013. PONI would also like to thank all the experts who came to speak to the Nuclear Scholars during their workshop sessions. The Nuclear Scholars Initiative could not function without the generosity of these knowledgeable individuals.

Lastly, PONI would like to thank our partners, especially the Defense Threat Reduction Agency and the National Nuclear Security Administration, for their continued support. Without them, the Nuclear Scholars Initiative would not be possible.

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A Gentleman's Agreement

Isabelle Anstey[1]

This paper will examine the pressures, incentives, and restraints that form the politics of multilateral nuclear export control arrangements by examining the evolution of nuclear supplier arrangements from the 1950s to the 1990s. Focusing on the Nuclear Suppliers Group (NSG), this paper identifies six key pressures that shape the form and behavior of multilateral nuclear export control regimes. A deeper understanding of these pressures and how they resulted in the NSG offers a more nuanced backdrop against which to consider future policies for nuclear export control.

Introduction

This paper will examine the pressures, incentives, and restraints that form the politics of multilateral nuclear export control arrangements by examining the evolution of nuclear supplier arrangements from the 1950s to the 1990s. The primary mechanism during this time was the Nuclear Suppliers Group (NSG) formed in 1975, a voluntary, secretive, elite club of countries that offered nonbinding guidelines for national nuclear supply practice. Very little has been written to date on the history of multilateral nuclear export control regimes, and even less specifically on the NSG itself. This gap was recognized by leading nuclear studies scholar Scott Sagan in his 2011 article surveying the field.[2] The majority of work that exists focuses on ways to improve multilateral mechanisms and/or national export controls. It is therefore forward-looking and policy proscriptive in nature, rather than historical and analytical. Researchers, in evaluating the nuclear export control regime, have identified the nonbinding, voluntary nature of the guidelines as fundamental flaws, and some have called for a nuclear export treaty or similar universal, binding, verified regime to control the trade in sensitive nuclear and dual-use technology.[3] A deeper understanding of the pressures that form multilateral supplier arrangements through historical analysis will offer a more nuanced backdrop against which to consider such future policies.

1. Isabelle Anstey is a Ph.D. candidate with the Centre for Science and Security Studies, Department of War Studies, King's College London.

2. Scott D. Sagan, "The Causes of Nuclear Weapons Proliferation," *Annual Review of Political Science* 14 (2011): 239.

3. Jacob Blackford, *Multilateral Nuclear Export Controls After the AQ Khan Network* (Washington, DC: Institute for Science and International Security, January 2005); and Andrea Viski, "International Nuclear Law and Nuclear Export Controls," *International Journal of Nuclear Law* 3, no. 3 (2011): 216–29.

The NSG and its guidelines have been controversial and politically sensitive since their inception, sparking accusations of discrimination and illegitimacy under international law.[4] As an exclusive "club" of nuclear suppliers, the Group has been plagued by suspicions of cartel formation and commercial self-interest. Its decision to waive restrictions on nuclear trade with India in 2008, under pressure from the United States following the U.S.-India civil nuclear agreement, prompted concerns over the future of the nonproliferation regime and the NSG's role in it.[5] That India should be granted such an exemption is an interesting irony in the history of the NSG, which was set up following India's peaceful nuclear explosion in 1974. The current pressures to allow India membership into the Group and to extend a similar waiver to Pakistan come amid concern over the nuclear intentions of Iran and North Korea and the still pending civil nuclear "renaissance." Given these concerns, it has never been more important to understand the politics of nuclear supply.

There are six dominant pressures at work on efforts to establish common suppliers' policies, and these have varied in importance over time. These forces are both internal and external. Outside sources, such as the competition with commercial interests, the competing priorities from foreign and domestic politics, and legitimacy on the international stage, are matched by internal aspects inherent to the Group itself—its membership and the technology it is endeavoring to control. Finally, the goal of nonproliferation and how proliferation is viewed by member states plays a role. Six factors—commerce, politics, legitimacy, membership, technology, and nonproliferation—form a comprehensive analytical framework. What pressures they bring to bear, how they are treated, the way they interact, and how and when individual issues dominate will bring a powerful understanding to the nature and actions of multilateral export control regimes.

Multilateral Nuclear Export Control Regimes

THE COMBINED DEVELOPMENT AGENCY, 1945–1961

The early history of nuclear weapons development is one of U.S. unilateral denial and its brief monopoly of the bomb, while other countries developed their own programs without (willing) U.S. help. Nuclear technology does not lend itself easily to unilateralism, however, and the United States discovered the limits of unilateral denial even before the decision to use the bomb was made.[6] In order to complete the development of its nuclear weapon, the United States needed British scientists and British help to access uranium in the Belgian Congo; in return the British wanted to resume information sharing on the U.S. Manhattan Project.[7] The result in 1943 was the Quebec Agreement, which reestablished cooperation

4. Ian Anthony, Christer Ahlstrom, and Vitaly Fedchenko, *Reforming Nuclear Export Controls: The Future of the Nuclear Suppliers Group*, SIPRI Research Report No. 22 (Oxford: Oxford University Press, 2007), 17.

5. William C. Potter, "India and the New Look of US Nonproliferation Policy," *Nonproliferation Review* 12, no. 2 (2005): 343–54.

6. Bertrand Goldschmidt, *Atomic Complex: AWorldwide Political History of Nuclear Energy* (La Grange Park, IL: American Nuclear Society, 1982), 100.

7. Barton J. Bernstein, "The Uneasy Alliance: Roosevelt, Churchill, and the Atomic Bomb, 1940–1945," *Western Political Quarterly* 29, no. 2 (June 1976): 223–24.

and information exchange on the understanding that neither would share that information with a third party. Bertrand Goldschmidt characterizes it as the first nonproliferation treaty[8]; Richard Rhodes describes it as the first act of proliferation by giving nuclear secrets to the British.[9] In a way both scholars are right, because the Quebec Agreement allowed a limited degree of proliferation in return for greater control over further proliferation. As well as the agreement not to share information, the Quebec Agreement set up a trust between the parties to secure global supplies of uranium and deny it to potential proliferators.

The Combined Development Trust (later Agency) arranged contracts for uranium and thorium with Brazil, Belgium, Portugal, the Netherlands, India, and later South Africa and Australia. Those contracts included an agreement that the supplier would not sell to a third party without consulting the United States, giving the United States an option on all uranium supplies and establishing a group of nations with very basic export controls. The United States failed to reach an agreement with Sweden, which, after seeing the ends for which uranium was being used in 1945, declined to part with its domestic supplies.[10] Nevertheless, it agreed not to export to a third country without informing the United States and claimed its export licensing system would ensure this could not happen.[11]

The Combined Development Agency (CDA) was secret until about 1956, when its name, if not its entire purpose, was declassified. It relied almost entirely upon the economic power of the United States, and rather than a negotiated diplomatic arrangement, it was a system of industrial contracts and trade agreements. The arrangement between the dominant three—the United States, the United Kingdom, and Canada—was described in British records as "nothing more than a gentleman's agreement"[12] designed to deny the materials necessary for making a weapon to any other country, whether ally (France) or enemy (the Soviet Union). To that extent the CDA was a forebearer of later efforts. The fact that it continued to operate even after relations between the United States and the United Kingdom concerning nuclear weapons technology had deteriorated, and while efforts toward international control were ongoing, is a recurring theme of such arrangements.

THE WESTERN SUPPLIERS GROUP

The CDA became increasingly ineffective as global uranium supplies outstripped the economic capacity of the United States. The Agency refused to renew its remaining contracts with South Africa, Australia, and Belgium, leaving these countries in need of new customers for their domestic uranium supplies. The newly minted International Atomic Energy Agency (IAEA) was developing its safeguards concept at the same time. A group of

8. Goldschmidt, *Atomic Complex*, 52.
9. Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon & Schuster, 1986), 523.
10. Margaret Gowing, *Britain and Atomic Energy, 1939–1945* (New York: St. Martin's Press, 1964), 314.
11. "Memorandum by the Minister in Sweden," August 10, 1945, in *Foreign Relations of the United States, 1945, Vol. II* (Washington, DC: Government Printing Office, 1945): 38.
12. Thomas Barnes to W.L. Gorell Barnes, letter, March 24, 1944, CAB 126/92, The National Archives (TNA): Public Records Office (PRO).

Western nations started to meet to coordinate efforts to apply safeguards on bilateral sales of uranium, especially to India and Japan, which were seen as the "bad boys" of proliferation.[13] The United States wanted other states to have to apply the sort of controls the U.S. Congress had implemented in 1954 for two reasons—to prevent unsafeguarded sales to India and Japan and to level the playing field for U.S. industry. Britain and Canada, the latter having initially only asked for assurances of peaceful use, began to ask for safeguards. These three had some success convincing South Africa and Australia, albeit reluctantly, to ask for safeguards, whereas Belgium and France made deals that did not involve safeguards. The group's efforts continued to be limited, and despite meeting from 1958 through 1967, they obtained only a "gentleman's agreement" to refrain from supply without safeguards.[14]

To some extent the Western Suppliers Group (WSG) was the NSG a decade early, but its priorities were limited to applying IAEA safeguards to bilateral sales of nuclear materials and technology. Its members produced no guidelines document, although they did circulate a model contract containing the requirement for safeguards to be applied. The WSG shared other notable features with the NSG—it was secret, informal, and nonbinding. Unlike the NSG, it was unable to pressure France into accepting uniform conditions of supply. Its members began to develop a rudimentary trigger list, but no formal agreement was reached, and the trigger list debate would be continued after the Non-Proliferation Treaty (NPT) came into force.[15]

THE ZANGGER COMMITTEE

After the NPT came into force in 1970, Article III.2 required that states not provide "source or special fissionable material . . . or . . . equipment or material especially designed or prepared for the processing, use or production of special fissionable material" to a non-nuclear weapons state without safeguards.[16] In order to ensure a uniform approach and to determine treaty obligations on sales to nonmember states, the Zangger Committee was formed to determine a precise list of the items that came under the NPT and would trigger safeguards. The trigger list was aimed at reactors and did not include forms of enrichment, production of heavy water, or fuel reprocessing. The Zangger Committee published its "understandings" and trigger list in 1974, just after India detonated a peaceful nuclear

13. Minutes of Meeting in Ottawa to Discuss Safeguards (November 5 and 6, 1958), November 7, 1958; File: "July 1, 1958–December 31, 1958"; Safeguards 1956–59–Safeguards 6/59–9/59 (Safeguards 56–59); Classified Records of the Mission to the International Atomic Energy Agency, 1955–63, Vienna Embassy (Mission to IAEA 55–63); Record Group 84: Records of the Foreign Service Posts of the Department of State (RG84); National Archives at College Park (NACP).

14. "Nuclear Exports of Other Countries," December 11, 1964, Item # NP01076, Nuclear Non-Proliferation, Digital National Security Archive, http://gateway.proquest.com/openurl?url_ver=Z39.88-2004&res_dat=xri:dnsa&rft_dat=xri:dnsa:article:CNP01076.

15. It is notable that Claude Zangger was the Swiss representative of the last Western Suppliers Group meeting in 1967; he would later chair the Zangger Committee (also known as the Nuclear Exporters Committee) after 1970. which continued the work on a trigger list under the auspices of the NPT.

16. Treaty on the Non-Proliferation of Nuclear Weapons, www.fas.org/nuke/control/npt/text/npt2.htm.

explosion. Even though it was clarifying aspects of a legally binding treaty, the committee declared early on that it would only produce "understandings" for what the treaty obligations were regarding sales to non-NPT members (an NPT member had to have full-scope safeguards with the IAEA if it was a nonnuclear weapon state) and that its recommendations would be nonbinding.[17]

THE NUCLEAR SUPPLIERS GROUP

India's unexpected "peaceful nuclear explosion" in May 1974 focused U.S. attention on the dangers posed by unrestrained export of nuclear technology. Deeming the Zangger Committee inadequate to meet the challenge, the United States induced six other Western suppliers between 1975 and 1977 to agree on a set of guidelines for nuclear trade. The India test played a catalytic role in a nonproliferation environment that already had significant weaknesses: the Zangger Committee was unable to include important suppliers outside the NPT regime, notably France and Japan, and the U.S. administration was not closely focused on the nonproliferation issue.[18] After the test and a nonproliferation policy review conducted under Secretary of State Henry Kissinger, which suggested France be included, the United States changed tack and took the lead in arranging supplier club meetings. While the U.S. response to India's test was muted, the United States was deeply concerned about proposed deals to supply Brazil and Pakistan with nuclear technology. Washington faced reluctance from its partners, particularly those in Europe.[19] France was traditionally opposed to multilateral organizations and unenthusiastic about uniform export standards, preferring to take a case-by-case approach.

Despite disagreements, the Group released *Guidelines on Nuclear Transfers* in 1977, stating its intention to comply with the IAEA safeguards. The guidelines applied to a trigger list of items whose export, to any state, would require national licensing and the application of safeguards, as well as physical protection measures and government assurances of nondiversion to a weapons program. The United States also obtained an agreement from the other members to exercise restraint in exporting enrichment and reprocessing technology but was unsuccessful in obtaining a ban on sales, as it had hoped. The guidelines also did not stipulate full-scope safeguards as a condition of supply, although some members adopted this condition in the early 1980s. As successive U.S. administrations took a tougher line on plutonium-producing reactors, like those favored by European producers, the fragile agreements reached in the early NSG came under increasing pressure.[20] The members could not come to agreement on further conditions, such as full-scope safeguards, and

17. Fritz W. Schmidt, "The Zangger Committee: Its History and Future Role," *Nonproliferation Review* 2, no. 1 (1994): 38–44.

18. Samuel J. Walker, "Nuclear Power and Nonproliferation: The Controversy over Nuclear Exports, 1974–1980," *Diplomatic History* 25, no. 2 (Spring 2000): 222.

19. Pierre Lellouche, "Breaking the Rules Without Quite Stopping the Bomb: European Views," *Madison: International Organization* 35, no. 1 (1981): 39–58.

20. Paul L. Joskow, "The International Nuclear Industry Today: The End of the American Monopoly," *Foreign Affairs* 54 (July 1976).

the European members were increasingly uncomfortable with the negative reception of the Club in the developing world, their key market.[21]

The full NSG did not meet from 1978 until the early 1990s. In 1979, the Soviet Union invaded Afghanistan, reigniting Cold War tensions. The U.S. position toward India and Pakistan changed dramatically as they became strategically important allies in the region. Nuclear trade was hit hard, and overcapacity on the supply side increased pressure to find a competitive edge by adding enrichment or reprocessing as "sweeteners."[22] In practice this meant exporting sensitive nuclear technologies where commercially viable, not necessarily where there was a low risk of proliferation.[23]

A series of revelations concerning Iraq's nuclear weapons program prompted the NSG to meet again in 1992, leading to the introduction of a second trigger list, this time of so-called "dual use" items. The inclusion of dual-use items was billed as a big step forward in improving the effectiveness of nuclear export controls.[24] In 1994 the Group introduced the "non-proliferation clause," requiring states to consider if they thought their exports might lead to proliferation before making an export decision. This was the first time a subjective and potentially discriminatory principle was introduced into the guidelines, showing a marked difference from the 1970s. An outreach campaign attempted to explain the NSG's actions and motives and to invite new members in an attempt to mitigate the harm done by the secrecy of the early years. As of mid-2013, the NSG has 48 participating states.

Problems remain, however. Levels of implementation vary widely across members, and there is no systematic way of tracking or verifying effective implementation. Due to the voluntary nature of the guidelines, they cannot be enforced, and the NSG has almost no independent character outside its member states. Unlike other organizations, it lacks a secretariat or directorship; instead there is a rotating chair, a consultative group, an annual plenary, and a point of contact with the Japanese Mission to the International Organizations in Vienna. Despite its outreach efforts, the group still suffers from a lack of legitimacy due to its status outside more established mechanisms of international law and its perceived commercial, discriminatory character. Observers have also lamented a lack of information sharing, either with similar organizations or within the group itself.[25] These are ongoing problems that have long plagued the group and are tied up with the fundamental nature of multilateral export control regimes.

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21. Peter van Ham, *Managing Non Proliferation Regimes in the 1990s: Power, Politics and Policies* (London: Pinter/Royal Institute of International Affairs, 1993), 16.

22. Lewis A. Dunn, *Controlling the Bomb: Nuclear Proliferation in the 1980s* (New Haven, CT: Yale University Press, 1982), 33.

23. Michael J. Wilmshurst, "The Development of Current Non-Proliferation Policies," in *The International Nuclear Non-Proliferation System: Challenge and Choices*, ed. John Simpson and Anthony G. McGrew (London: Macmillan, 1984), 28–33.

24. Tadeusz Strulak, "The Nuclear Suppliers Group," *Nonproliferation Review* 1, no. 1 (1993): 2–10.

25. Mark Hibbs, *The Future of the Nuclear Suppliers Group* (Washington, DC: Carnegie Endowment for International Peace, 2011), 47–48, http://carnegieendowment.org/files/future_nsg.pdf.

Analysis

The nuclear export control regimes have certain key features in common: secrecy, nonbinding guidelines, informal organizational structure, the lack of a basis in international law, and a cartel-like appearance. Tracing the existence of these similarities from the 1940s to the 1990s through varying stages of nuclear export control regimes allows the influences on these regimes to be evaluated and examined. Six key formative pressures have acted upon multilateral efforts to harmonize export controls. Two are internal or inherent to the regime: membership and technology; three are external pressures: commercial interest, geopolitics, and legitimacy; and the final, commitment to nonproliferation, lies at the intersection of internal and external forces.

MEMBERSHIP

Supplier regimes are often accused of having the wrong members, either including states that are not committed to the groups' ends or leaving out crucial suppliers.[26] There is currently strong debate over how to determine new NSG membership.[27] Modern mechanisms like UN Security Council Resolution 1540 have attempted to universalize certain export control standards. Expansions in membership, however, have often been damaging or even fatal to the supplier regimes. Letting in too many new members undermines the features of limited membership that make it successful—what Michael Wilmshurst, one of the key British negotiators in the NSG in the 1970s, describes as the "feeling of identity and co-operation" is lost.[28]

The Western Suppliers Group met for the last time in 1967, largely overtaken by the negotiations over Article III of the NPT. Most of the members expressed a desire to meet again once those negotiations were completed. On the other hand, the South African representative, in agreeing that no further meeting should be held, remarked "that the membership of fourteen nations was now too large for genuinely private discussions."[29] The final Western Suppliers Group (now calling itself the Nuclear Suppliers Group or NSG) meeting had involved the "usual nine"—the United States, Canada, Britain, France, Belgium, Australia, South Africa, West Germany, and Japan—plus five new members: Switzerland, Sweden, Italy, the Netherlands, and Norway. The unpopularity of South Africa on the international stage due to apartheid may go some way in explaining its position, but it expressed a pertinent problem with multilateral mechanisms in such a sensitive field, combining security and economic interests with tightly guarded technology. Small membership improves the chances of successful cooperation by lowering some of the perceived costs of cooperation and fostering a joint identity, both of which can make consensus easier to

26. Seema Gahlaut and Victor Zaborsky, "Do Export Control Regimes Have Members They Really Need?," *Comparative Strategy* 23, no. 1 (2004): 73–91.

27. Mark Hibbs and Toby Dalton, "Nuclear Suppliers Group: Don't Rush New Membership," Carnegie Endowment for International Peace, June 14, 2012, http://carnegieendowment.org/2012/06/14/nuclear-suppliers-group-don-t-rush-new-membership/btzo.

28. Wilmshurst, "The Development of Current Non-Proliferation Policies," 33.

29. U.S. Embassy Pretoria to State Department, telegram, January 4, 1968; AE 13, 1/1/67; Central Foreign Policy Files (CFPF), 1967–1969; Science, AE12 to AE 13; Record Group 59: General Records of the Department of State (RG59); NACP.

reach.[30] The NSG itself maintained its small membership throughout the negotiation of the guidelines and only felt the negative impact of an expanded membership in the early 1980s, alongside a number of other pressures that made cooperation difficult.

The NSG's membership had another advantage over the earlier incarnation; it involved the most important suppliers. In 1974, the State Department recognized immediately that for the conference of nuclear suppliers to be a success, it would have to contain both the Soviet Union and France. The United States admitted in 1958 that a Western group would be only of minor interest compared with ongoing negotiations with the Soviet Union.[31] France was invited to join the Western Suppliers Group in 1959, but a combination of pique at their late invitation, a general antipathy toward the common-front approach to export controls, and skepticism over the efficacy of safeguards made it a very unwilling participant.[32] France's refusal to hold to a common approach made it extremely difficult for the other suppliers to commit. By being part of the Western Suppliers Group but consistently refusing to agree to a common front, France may have done more to undermine the regime than it would have done had it not been a member. By the 1970s France's position had changed enough to allow it to agree and commit to the guidelines, although it remained one of the more reluctant members. Henry Kissinger was reluctantly considering the alternative of multiple bilateral approaches to individual suppliers in the event that France refused to attend the first London suppliers meeting.[33] The case of France makes it clear that membership alone is not enough; the members must be equally committed.

TECHNOLOGY

Nuclear technology is rapidly evolving and inextricably dual use in nature, posing very particular problems for a control regime. There was an early hope that a way would be found to separate peaceful from military uses of nuclear technology by somehow "denaturing" uranium, despite strong voices maintaining that such a separation was impossible.[34] The United States, along with the United Kingdom and Canada, announced in 1945 that they would share "detailed information concerning the practical industrial applications of atomic energy just as soon as effective enforceable safeguards against its use for destructive purposes can be devised."[35] Until that point, the technology would be kept secret.

President Truman, shortly after coming to power, was convinced by his advisers, particularly General Leslie Groves, that the atomic secret could be kept.[36] Based on this

30. Benjamin N. Schiff, *International Nuclear Technology Transfer: Dilemmas of Dissemination and Control* (Totowa, NJ: Rowman & Allanheld, 1984), 11.

31. Minutes of Meeting in Ottawa to Discuss Safeguards (November 5 and 6, 1958), November 7, 1958; File: "July 1, 1958–December 31, 1958"; Safeguards 56–59; Mission to IAEA 55–63; RG84; NACP.

32. Goldschmidt, *Atomic Complex*, 286.

33. Memorandum of Conversation, "Nuclear Suppliers Conference," March 26, 1975, Item: KT01550, Kissinger Transcripts, Digital National Security Archive, http://gateway.proquest.com/openurl?url_ver=Z39.88-2004&res_dat=xri:dnsa&rft_dat=xri:dnsa:article:CKT01550.

34. Walker, "Nuclear Power," 216.

35. President Truman quoted in Goldschmidt, *Atomic Complex,* 71.

36. Gregg Herken, "'A Most Deadly Illusion': The Atomic Secret and American Nuclear Weapons Policy, 1945–1950," *Pacific Historical Review* 49, no. 1 (1980): 51–76.

technological assumption, he pursued a policy of unilateral denial rather than control, leaving the United Kingdom and the Soviet Union to develop their own weapons separately from the United States. While some areas of technology remained limited in distribution, the raw materials were increasingly widespread. In the face of an overwhelmingly negative public attitude toward the atom, President Eisenhower reversed the secrecy policy and presided over one of the largest distributions of technological knowledge through Atoms for Peace and the Geneva Conferences on the Peaceful Uses of Atomic Energy.

The WSG focused its early efforts on uranium, but as the nuclear trade took off, the group turned its attention to reactor technology. The WSG only included very broad categories in its trigger list; it took the Zangger Committee to focus on specific components, and the NSG extended that list to include types of enrichment and reprocessing technology. The list has to keep up with fast-changing technology, and the variety of technologies that can be co-opted into a weapons program. Iraq used a mixture of dual-use and apparently obsolete technology in its program, prompting the introduction of the dual-use list in the 1990s.

States cannot always agree on what technology constitutes a proliferation risk. For example, during the NPT negotiations there was a debate between the United States and the United Kingdom over gas centrifuge technology, which would provide a much smaller, therefore easily hidden, method to enrich uranium. The United Kingdom recognized this, but the technology was left out of the NPT because the United States was unconcerned about the risks, considering safeguards to be an adequate protection.[37]

GEOPOLITICS

Nonproliferation is just one interest among many for states when considering their foreign policy goals, and it will compete for primacy. Within the British government there was a fight in 1960 between the Board of Trade and the Foreign Office; the latter had to defend why safeguards as a condition of supply, as part of a common Western front, should be UK policy. While the danger of spreading a weapons capability was listed, it was backed up by the dangers of UK "embarrassment" at the IAEA, damaging the relationship with Commonwealth countries and upsetting the United States, potentially jeopardizing other fields of U.S. support.[38] The latter argument proved to be the most persuasive and was the core of the argument eventually sent to the prime minister. The role of U.S. influence and leadership is a recurring theme of supply regimes, conferred early on by U.S. supplier primacy and the crucial U.S. role in postwar Europe. U.S. presence at meetings of the WSG was often the only guarantee that other participants would attend. France might not have attended the early NSG meetings without extensive and high-level U.S. diplomatic pressure.

37. John Krige, "The Proliferation Risks of Gas Centrifuge Enrichment at the Dawn of the NPT," *Nonproliferation Review* 19, no. 2 (2012): 224.

38. Henry Hainworth and Sir Hugh Stephenson, Foreign Office Minute, November 9, 1960, FO371/149471, TNA: PRO.

The impact of the Cold War on multilateral nuclear export control agreements is complex. Nuclear supply was an area where the United States and the Soviet Union could continue to cooperate and negotiate while general relations were otherwise poor. On a basic level, the WSG was affected the most, as Cold War politics playing out in the IAEA Board of Governors made it impossible to include the Soviet Union in its discussions on conditions of supply. The WSG began partially as a Cold War tool to ensure a common Western front on IAEA safeguards development, in opposition to India backed by the Soviet Union. Bilateral safeguards were a secondary concern. After 1963, however, the Soviet Union shifted to support safeguards, and bilateral sales became the focus of the WSG. By 1967, the WSG was discussing inviting the Soviet Union to join the group.[39]

When the NSG ceased to meet in the late ’70s and early ’80s, the role of Cold War politics was ambiguous. On one hand, the Soviet invasion of Afghanistan turned India and Pakistan into strategic allies in the region for the United States. This consideration was crucial in securing U.S. supplies of uranium fuel to India in 1980 in the face of domestic opposition from Congress and the Nuclear Regulatory Commission.[40] On the other hand, Michael Wilmshurst, Roland Timberaev, and Tadeusz Strulak, who were personally involved and present at NSG meetings, all concluded in their writing on the NSG that worsening Cold War relations were not the reason for the deadlock in the NSG.[41] Instead they point to rising commercial competition.

COMMERCE

Restricting profitable commercial exports on multilateral grounds requires states to balance industrial pressure against what can be gained by adhering to the common front. Commercial interests and nuclear technology have been closely tied since the early years of atomic development. The United Kingdom, for example, was required to disavow any interest in commercial applications or industrial use before the United States would agree to reestablish nuclear cooperation in 1943.[42] As the civilian nuclear energy market has shifted, pressure on nonproliferation has waxed and waned. Industrial interests helped bring the CDA to an end. The need to sell uranium undermined the WSG. The expansion of domestic programs in Europe following the 1973 oil crisis created a need for profitable external markets to justify the investment. The decline in the market corresponded with greater collaboration in the 1990s.

States will risk paying a high commercial price for their involvement in common-front arrangements. Both nationally within their own governments and internationally with potential consumers, there was opposition to the export controls considered necessary by

39. Robert Eisenberg, Pretoria to Department of State, telegram, August 3, 1965; AE 6 Peaceful Uses of Technology; CFPF 1964–1966; RG59; NACP.

40. Samuel J. Walker, “Nuclear Power,” 245.

41. Roland Timerbaev, *The Nuclear Suppliers Group: Why and How It Was Created* (Moscow: PIR Centre, 2000); Wilmshurst, “The Development of Current Non-Proliferation Policies”; and Strulak, “The Nuclear Suppliers Group.”

42. Gowing, *Atomic Energy*, 154–64.

the United States to prevent proliferation but considered harmful to trade by others. The high priority given to commercial interests, in particular during the WSG negotiations, was an insurmountable obstacle to any formal agreement. The states reiterated over a decade of meetings that each time a state broke the agreement and sold uranium without safeguards, it increased the pressures on the others to do likewise, and a flood of unsafeguarded sales would follow.[43]

Whether the NSG was a victory for U.S. power or nonproliferation is questionable. It represents, however, a remarkable victory over commercial interests. From Europe's perspective, the U.S. nonproliferation policies under President Carter could easily be interpreted as favoring U.S. reactor design over European models to confer a competitive advantage to U.S. firms.[44] The United States argued that its design of light-water reactors, which produced only very small quantities of plutonium, was more proliferation proof than European natural uranium reactors, which produced large quantities of potentially weapons-grade material. In other words, an alignment of interests resulted in strong concerted action from the United States. When national policies are in opposition, strong action is less likely, as when industrial interests in the late 1950s made it impossible for the United States to continue to buy up uranium, even though it feared the consequences for proliferation.[45]

Commercial pressures working inside the group against cooperation were dominant until the 1990s. The appearance of the NSG as a cartel when it published its guidelines in 1978 did not reflect reality; the nuclear market was not conducive to cartelization.[46] The negative reaction, which threatened commercial relations with the developing world, was a major pressure on the group's members to distance themselves from it. Nevertheless, the group represented the most powerful suppliers, and while it was not a cartel in the classic sense, it came to represent a nuclear "club." In the 1990s to be a member of the NSG was to be in the nuclear club. It is noteworthy that in later years the NSG moved from using the term "members" to favoring "participants," as it attempted to shed its elitist aura.[47] The rebranding of the NSG that took place in the 1990s was an attempt to overcome a lack of legitimacy stemming from its appearance as a commercial cartel working outside the NPT.

LEGITIMACY

By bypassing the NPT, the NSG inevitably angered many nonnuclear weapon states, which held the promise of nuclear power in return for nonproliferation as enshrined in the NPT to be a cornerstone of the nonproliferation regime. These states saw the NSG as a threat to

43. For example, see State Department to U.S. Embassy Brussels, telegram, August 6, 1959; July 1–September 30, 1959; Safeguards 1956–59; Mission to IAEA 55–63; RG84, NACP.

44. Joskow, "The International Nuclear Industry."

45. Robert Winfree to Sydney Mellen, memorandum, March 17, 1958, Combined Development Agency General, 1962; General Records Relating to Atomic Energy Matters: 1948–1962; Office of the Secretary Special Asst. to Secretary of State for Atomic Energy & Outer Space; RG59; NACP.

46. Joskow, "The International Nuclear Industry."

47. Hibbs, "Future of the NSG."

that bargain. Given their status outside the NPT, the guidelines had no basis in international law and were not seen to flow from the principles of the treaty in the same way the equally voluntary Zangger Understandings did. Nevertheless, compared to the WSG, the NSG had the background of a growing nonproliferation norm based on treaty law, which, while still nascent in the 1970s and 1980s, grew much stronger in the 1990s and may explain the greater success of the later group.[48] Staying within the NPT framework might have conferred greater legitimacy but was practically impossible given the need to engage France.

The early meetings in 1975 were kept under a tight blanket of secrecy at the insistence of France. Fearful of damaging its relations with the developing world, France did not want to be seen as too close to the NPT regime and the Soviet Union.[49] The secrecy, however, only added to the mistrust and indignation felt by nuclear importers, for whom assurances of supply were crucial to their nuclear industries and energy security. Excluding the importers also gave them no say in how nuclear technology would be supplied. The resulting resentment severely damaged the legitimacy of the NSG and its guidelines, which may have had a negative impact on the supply-side aspects of the nonproliferation regime. The 1980s saw backsliding by several countries on their commitments to the NSG. One reason for this could have been the relatively weak restraining effect of voluntary guidelines seen as illegitimate by a large section of the international community.

The suppliers themselves were not unaware of the legitimacy problem. When the WSG began meeting in 1958/59, its meetings were also kept secret. The United Kingdom was particularly keen to avoid being accused of "atomic colonialism."[50] The United States remarked upon the importance of keeping the meetings secret to avoid "misunderstandings by other countries which might . . . misrepresent the meetings as an effort by the nuclear suppliers to 'gang up' on the nuclear importers."[51] The WSG managed to keep its meetings quiet; the NSG made a more laudable attempt at transparency by lodging letters of intention with the IAEA and circulating its guidelines as INFCIRC/254. By 1978, however, the damage had been done, especially as the news of a secret uranium cartel engaged in price fixing leaked at around the same time. The first statement issued by the reconvened NSG in 1992 included commitments to the IAEA safeguards regime and the NPT.[52] The NSG held two seminars in 1997 and 1999 aimed at promoting NSG transparency, with speakers from within and outside the NSG. Membership swelled as a result.

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48. Aaron Karp, "Controlling weapons proliferation: The role of export controls," *Journal of Strategic Studies* 16, no. 1 (1993): 18–45.

49. Alec Baer, "The Nuclear Suppliers Group and Its Time" (Paper presented at the 2nd NSG International Seminar on the Role of Export Controls in Nuclear Non-Proliferation, April 8–9, 1999, United Nations Headquarters, New York), 7.

50. Minutes of Meeting in Ottawa to Discuss Safeguards (November 5 and 6, 1958); File: "July 1, 1958–December 31, 1958"; Safeguards 56–59; Mission to IAEA 55–63; RG84; NACP.

51. Secretary of State to Bern, Bonn, Brussels, Canberra, London, Oslo, Tokyo, Ottawa, Paris, Pretoria, Rome, Stockholm, The Hague, and Vienna; AE 13 7/1/67; CFPF 1967–1969; Science, AE12 to AE 13; RG59; NACP.

52. Press Statement of Nuclear Suppliers Meeting (Meeting of States Adhering to the Nuclear Suppliers Guidelines, Warsaw, Poland, April 3, 1992), www.nuclearsuppliersgroup.org/A_test/press/1992-Press.pdf.

NONPROLIFERATION

Nonproliferation is both an internal and external pressure; the commitment of members to the goal of nonproliferation can be separate from both global and national threat perceptions of proliferation (i.e., one state may perceive a threat from a single act of proliferation while remaining uncommitted to nonproliferation as a general goal). Proliferation concerns were muted in the 1950s and 1960s, although they later increased. The UK Foreign Office in 1960 expressed concerns over Chinese and Indian ambitions for nuclear weapons, as well as the risks of allowing unsafeguarded fissile material to exist in Japan and West Germany.[53] Proliferation was rarely a primary foreign policy goal of any country to the detriment of other interests, however. The United Kingdom was aware of the proliferation risks of gas centrifuge technology during the NPT negotiations but opted not to press the matter because it had commercial interests in the technology that it did not want to risk.[54]

International control after the end of World War II might have been the only way to restrict the number of countries with independent weapons programs, but the security interests of the United States and the Soviet Union in the context of the growing Cold War made agreement impossible, even at the risk, seen as very low, of other nations acquiring a capability.[55] Proliferation threat assessment seems to follow large shocks: the NSG was formed amid concerns about India, Pakistan, and Brazil, and the resurgence in the 1990s is connected to discoveries about Iraq and post–Cold War concerns about international order. Nevertheless, the WSG was unable to act decisively on supply matters in the face of China's entry into the nuclear club, so proliferation shocks alone do not necessarily force reevaluations. The Indian and Iraq shocks demonstrated the weakness of the supply system, against a background of nonproliferation as a growing global norm following the ratification of the NPT.

Conclusion

The NSG and its guidelines are the result of the complex interaction and evolution of six pressures, sometimes competing, sometimes complementary: membership, technology, geopolitics, commerce, legitimacy, and nonproliferation. The effect of these competing concerns over time was to keep multilateral nuclear export control regimes informal, exclusive, secretive, and voluntary.

In the 1960s the United States hoped for an intergovernmental agreement, South Africa was interested in some tangible signs of regularizing the common front, and Canada described what was wanted as a "pledge" by all the suppliers not to export without safeguards.[56] The WSG could not achieve this, predominantly as a result of involving an intransigent France against a background of heavy commercial pressures. The NSG's public

53. Hainworth and Stephenson, FO Minute, November 9, 1960, FO371/149471, TNA:PRO.
54. Krige, "Gas Centrifuge Enrichment," 224.
55. Herken, "Most Deadly Illusion," 68.
56. Minutes of Meeting in Ottawa to Discuss Safeguards (November 5 and 6, 1958); File: "July 1, 1958–December 31, 1958"; Safeguards 56–59; Mission to IAEA 55–63; RG84; NACP.

commitment in 1978, expressed in open letters to the IAEA, represented something far more tangible. The threat of proliferation had been demonstrated by India; the United States had shown high-level commitment to a common front; France and the Soviet Union were willing participants; and the NPT had made nonproliferation a global aim. Nevertheless, the competitive energy market and questionable legitimacy of the NSG commitments resulted in many of the participants' making sales in the 1980s that might be regarded as reneging on their responsibilities.

Commercial interests from the 1960s to 1980s largely worked against cooperation between suppliers, but the perceived commercial motivation for cooperating caused resentment among importing countries. In the 1990s, the commercial advantages of being in the club became more apparent, as the disadvantages of being outside the nonproliferation regime increased in the wake of the end of the Cold War. The geopolitical shift, coupled with a less competitive nuclear energy market, a heightened threat perception of proliferation, and an active outreach and transparency program, resulted in a more active, open, and inclusive NSG. Membership had been slowly broadening through the 1980s, eroding the exclusivity of the group. The informality of the mechanism allowed for flexibility in response to the dual-use gap in the regime, something the more rigid NPT was less able to address. Nevertheless, despite greater information sharing, implementation remained voluntary, and verification and enforcement impossible.

The NSG represents a middle ground between the pressures influencing control regimes. It is a gentleman's agreement between states that, despite the pressures to do otherwise, try to hold the line. Such agreements confer certain advantages: they are flexible, responsive to rapid changes in situation or technology, and obtainable when more formal mechanisms are not. These are predominantly useful advantages in nuclear export. The main disadvantage—that commitments are impossible to enforce—is less relevant if the alternative is no commitment at all. The historical record suggests that the NSG represents a slightly better outcome than might have been anticipated, given the pressures working against cooperation.

Beyond New START: The IAEF Initiative and the New Dynamism of Nuclear Policy

Lee Aversano[1]

In order to limit and thwart the continued proliferation of nuclear weapons while simultaneously addressing the needs of an energy-hungry world, synergy among the various international nuclear organizations must be attained. The new reality we face in this prolonged global nuclear malaise requires dynamism—bold vision and even bolder action. In such a course, the creation of two sister agencies to the International Atomic Energy Agency—the International Nuclear Sustainment Agency and the International Nuclear Forensics Agency—will provide an unprecedented set of new, dynamic nuclear policy opportunities. Each sister agency allows for the control of third-party effects (i.e., the behavior of nuclear countries) with a proven system of best practices, working in concert with one another to create and sustain a fuel-cycle management program for nonnuclear states, as well as creating and guaranteeing safeguards that deter state-sponsored nuclear terrorism. The Comprehensive Test Ban Treaty (CTBT) will likely never enter into force, and, without the CTBT vision being completely abandoned, political energies should be redirected elsewhere. Accordingly, the creation of an organizational oversight body over these three agencies, dubbed the International Atomic Energy Fellowship, which is similar in design and structure to the Preparatory Commission for Comprehensive Test Ban Treaty Organization, will provide a platform for the exercise of power and influence necessary to curb global proliferation as well as pave the way for the next round of Strategic Arms Reduction Treaty negotiations. The infrastructure for this synergistic plan already predominantly exists in our world (as of the summer of 2013). These policy goals can be achieved through a reallocation of current manpower and resources with relatively minor ideological shifts among current international organizations.

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The Roadmap: A Closer Look

In his 2009 Prague speech, President Barack Obama hypothesized the roadmap to a world free of nuclear weapons: "Let me describe to you the trajectory we need to be on. First, the United States will take concrete steps towards a world without nuclear weapons. To put an end to Cold War thinking, we will reduce the role of nuclear weapons in our national security strategy, and urge others to do the same. Make no mistake: As long as these weapons exist, the United States will maintain a safe, secure, and effective arsenal to deter any adversary, and guarantee that defense to our allies."[2]

Giving our president the benefit of the doubt, recent major events demand that the United States undergo a serious gut check as to how to "put an end to Cold War thinking." Without our critically evaluating how to achieve this essential piece of the Global Zero roadmap, it will remain nothing more than a utopian pipe dream in the minds of most academics and military leaders. With all due respect to the current administration's political approaches, unilateral arms reductions by the United States will not be the impetus to Global Zero but may in fact elicit the opposite desired effect with regard to diminishing guarantees to defend our allies under a diversified and effective nuclear umbrella.[3] The key to ending Cold War thinking is for the United States of America and the Russian Federation to jointly and equally participate in an international endeavor that draws upon our common nuclear heritages. The nuclear enterprise is a great source of national pride for each country. It is through this vein that collaboration and respect must flow during all future discourse, beyond the New Strategic Arms Reduction Treaty (New START), if we are to truly abandon yesteryear's distrust and antipathy.

Juxtaposed with the vital nuclear issues addressed since the end of the Cold War, the hundreds of North Atlantic Treaty Organization (NATO) battlefield weapons remaining in Europe and the thousands remaining in Russian territory seem to be practically an afterthought. Such complacency is most imprudent. Tactical nuclear weapons represent the longest "stalemate" in the history of arms control and are the one thing absent for a true reset of relations between the East and the West.[4]

Tactical nuclear weapons (or "nonstrategic nuclear weapons") still exist because NATO and Russia have not fully resolved their doubts about how a nuclear war might begin and be ultimately engaged. While the warhead numbers of the 2010 New START are lower than at any point in history, they are based on leaving each side the ability to destroy up to 300 urban targets each. However, these levels completely omit tactical nuclear weapons.

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2. Office of the White House Press Secretary, "Remarks by President Barack Obama, Hradcany Square, Prague, Czech Republic," press release, April 5, 2009, www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered.

3. Ben Lerner, "Top National Security Leaders to Obama: Stop the Unilateral Denuclearization of the US," Center for Security Policy, February 22, 2013, www.centerforsecuritypolicy.org/2013/02/22/20-top-national-security-leaders-to-obama-stop-the-unilateral-denuclearization-of-the-us/.

4. Miles Pomper, William Potter, and Nikolai Sokov, *Reducing and Regulating Tactical (Non-strategic) Nuclear Weapons in Europe* (Monterey, CA: James Martin Center for Nonproliferation Studies, December 2009), 19.

Tactical weapons play a dangerous role, for they would be the armaments that provide the indispensable bridge from peace to nuclear war.[5] Thus, the structures of Cold War nuclear doctrines on both sides remain in place, only on a smaller scale.

Tactical nuclear weapons mean, strategically, that the Cold War has never ended. Russia still demands that the United States provide "legally binding statements" that European missile defense systems developed by NATO to deal with ballistic missile threats from certain rogue states will not evolve into a system threatening Russian offensive ballistic missiles and undermine deterrence.[6] Without a cooperative agreement on missile defense, there will never be a true reset of U.S.-Russian relations and tactical nuclear weapons will never be put on the negotiations table. Accordingly, our calculus must extend beyond New START.

This paper recommends a new, international matrix for all things nuclear that is both synergistic and omnipresent in nature. No longer will New START, the Comprehensive Test Ban Treaty (CTBT), and other international nuclear matters be discussed periodically over the course of years. Rather, a venue will be created where such dialogues will continue in an ongoing manner, 365 days a year. A bold step must be made toward ending once and for all the old Cold War mentalities, while at the same time addressing the most pressing issues—both foreign and domestic—within the nuclear enterprise, from peaceful uses of nuclear power to proliferation of nuclear weapons.

Peaceful Nuclear Power: Supply and Demand Myopia

Fifty years ago, nuclear power was in its infancy. Today, nuclear power delivers as much electricity as the entire global electrical output from all sources in 1960. In turn, in every decade since 1960, nuclear power has been the world's fastest-growing major source of energy. Currently, 30 nations use nuclear power to produce one-sixth of global electrical output. [7] Developing nations recognize that the poverty line directly correlates with access to electrical power. Even countries like Egypt, Turkey, Jordan, Iran, the United Arab Emirates, and Saudi Arabia are interested in diversifying their energy portfolios by exploring an increased reliance on nuclear power as a proven emission-free, scalable, and reliable source for electricity generation.[8] The international reality of nuclear power must be fully embraced and the implications of increased demand for fissile materials thoroughly

5. Tom Nichols, Douglas Stuart, and Jeffrey McCausland, eds., *Tactical Nuclear Weapons and NATO* (Carlisle, PA: Strategic Studies Institute, April 2012), www.strategicstudiesinstitute.army.mil/pdffiles/PUB1103.pdf.

6. Dmitri Trenin, "Russia's Threat Perception and Strategic Posture," in *Russian Security Strategy under Putin: U.S. and Russian Perspectives*, eds. R. Craig Nation and Dmitri Trenin (Carlisle, PA: Strategic Studies Institute, November 2007), 35–47, www.strategicstudiesinstitute.army.mil/pdffiles/pub829.pdf.

7. John Ritch, "The Necessity of Nuclear Power: A Global and Environmental Imperative," World Nuclear Association, 2008, www.world-nuclear.org/Archive/The-Necessity-of-Nuclear-Power/.

8. Govinda Avasarala, John Banks, Charles Ebinger, Kevin Massy, "Models for Aspirant Civil Nuclear Energy Nations in the Middle East," Brookings Institution, September 2011, www.brookings.edu/research/papers/2011/09/27-middle-east-nuclear-ebinger-banks.

considered.[9] Although the aftermath of the Fukushima accident invoked several dire predictions for nuclear power, demand for it is predicted to grow.

Nuclear energy has long posed a dilemma for environmentalists. As a cheap, clean source of power that does not use fossil fuels or add greenhouse gases to the atmosphere, it offers an appealing alternative to power from traditional coal-fired plants. Yet nuclear energy is associated with troubling environmental issues, including the problem of radioactive waste disposal and uranium hexafluoride container exposure to moisture over time. Even the most ardent supporters of "green" technologies are now facing an inescapable reality: rising international energy demands cannot be adequately addressed with supplies of fossil fuels and/or alternative energy production alone.

The international community cannot afford shortsightedness and must recognize the reality that the demand for nuclear power is skyrocketing. Such myopia will undoubtedly open a Pandora's box, leading toward nuclear proliferation and regional destabilization.

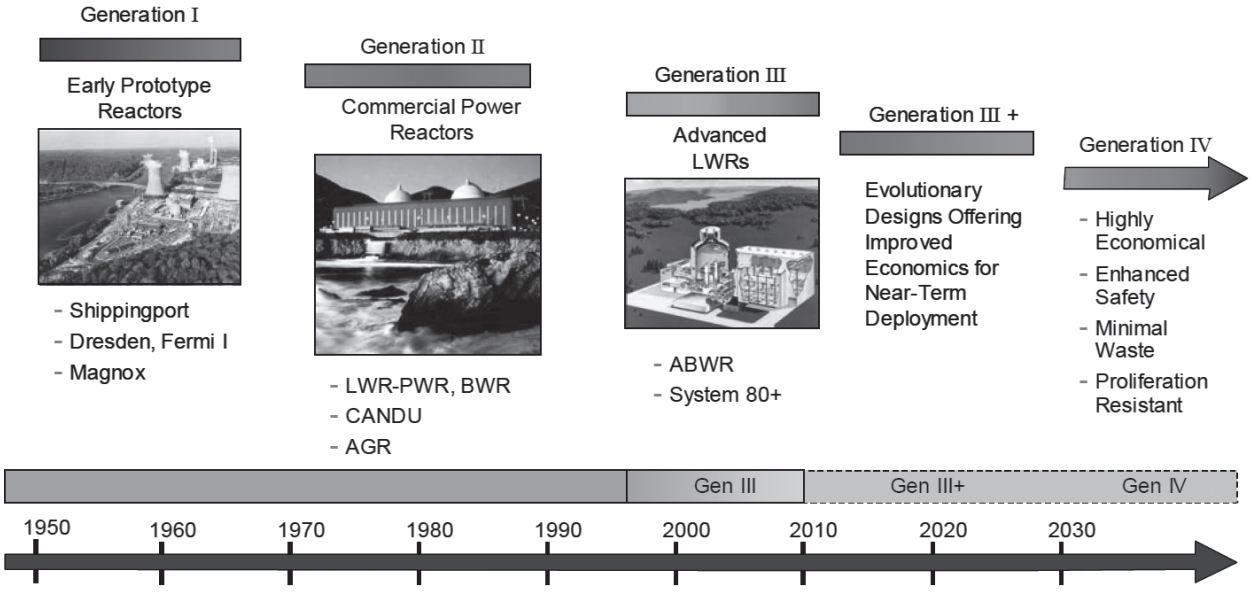
In the future, states around the world will demand fissile material and reactor technologies from the least restrictive vendors. If the international community fails to anticipate this impending demand without setting up the proper international infrastructure to ethically regulate the low-enriched uranium (LEU) trade, the multilateral pathways leading toward proliferation will become vulnerable to abuse. Nonnuclear weapons states (NNWS) maintain the right under the Non-Proliferation Treaty (NPT) to enrichment and reprocessing (ENR) of fissile materials using any of the known uranium-235 (U-235) enrichment methods: gaseous centrifuge, molecular laser isotope separation/separation of isotopes by laser excitation, gaseous diffusion, electromagnetic isotope separation using calutrons, aerodynamic nozzle processes, chemical separation, or atomic vapor laser isotope separation (AVLIS). The latter is the only known enrichment process that does not use the highly corrosive uranium hexafluoride (UF4); instead it uses a vaporized uranium metal, making it the most environmentally friendly enrichment process known to humankind.[10] There is also the danger of plutonium extraction from reactors. The evolution of reactor designs has produced several options (Figure 1) that are of key interest in proliferation discussions—past, present, and future.

Research into the subject of the feasibility of plutonium enrichment among these various reactor types reveals that Generation I and II reactors are more conducive to the proliferation of fissile bomb material. Consequently, each enrichment capability represents a unique, variable threat to the nonproliferation regime. An NNWS can use its ENR

9. Ibid.

10. Steven Hargrove, "Laser Technology Follows in Lawrence's Footsteps," *Science and Technology Review* (May 2000), www.llnl.gov/str/pdfs/05_00.2.pdf. It should also be noted that, in addition to not using the highly corrosive UF4, AVLIS technology enjoys a large enrichment factor of 5–15, has fewer stages than centrifuges, has a smaller carbon footprint, and cannot be used on its own to produce weapons-grade uranium. ("Enrichment factor" can be defined as the ratio of U235 to U238 in the product divided by the ratio of U235 to U238 in the feed for a single stage.) The U.S. Enrichment Corporation dropped the ball by suspending funding for the project in mid-1999 after a $2 billion taxpayer investment in the project had proved full-production capability. Although the technology is currently finding useful applications in the fields of energy, medicine, astronomy, and industry, significant advancement slowed considerably.

Figure 1. Evolution of Reactor Design



Source: Charles J. Bridgman, *Nuclear Weapons and Proliferation* (Air Force Institute of Technology, August 2012), 137. The figure can also be found at: *A Technology Roadmap for Generation IV Nuclear Energy Systems*, U.S. Department of Energy Research Advisory Committee and the Generation IV International Forum, December 2002, http://www.gen-4.org/PDFs/GenIVRoadmap.pdf, 5.

capabilities to produce fissile material just below 20 percent, invoke Article 10 of the NPT (effectively withdrawing from the treaty), and then use a well-developed enrichment infrastructure and medical U-235 as feed to rapidly develop a weapons-grade nuclear capability without ever having broken any rules or commitments.

Because of a confluence of legal pathways, it is both difficult and costly for the International Atomic Energy Agency (IAEA) to safeguard and inspect enrichment facilities. The IAEA was originally franchised in 1968 by the NPT to be a watchdog for treaty noncompliance as well as an instrument for promoting the peaceful uses of nuclear energy. However, this twofold mission has not received a balanced effort, prioritizing the former mission over the latter. The dual-purpose nature of the IAEA (if more fully embraced) might have negated the destabilizing effect of the AQ Khan terrorist network upon the world. Concomitantly, the IAEA's fundamental role within the proposed International Atomic Energy Fellowship (IAEF) will exclusively focus on enforcement of Fellowship programs and verification mandates.

The IAEA, acting as a watchdog agency reporting to the UN, has had its fair share of successes. The question lies in whether or not its overinvestment in inspecting countries that pose a low proliferation risk (such as Japan, Germany, and Canada) has resulted in the utter demise of its secondary mission to promote peaceful uses of nuclear energy and its overall international clout.[11] In the mid-1970s, the Nuclear Suppliers Group (NSG) sought to fill the void left by the IAEA in the promotion of peaceful uses of nuclear power. If Global

11. David Crawford and Max Colchester, "IAEA Draws Fire Over Japan Crisis," *Wall Street Journal*, June 8, 2011, http://online.wsj.com/article/SB10001424052702304906004576371781243470772.html.

Zero is to come to fruition in the foreseeable future, the IAEA and the NSG must be effectively integrated into a larger international model of nuclear cooperation.

The NSG Becomes the INSA

The NSG was created following the explosion of a nuclear device in 1974 by an NNWS—a time when the world shockingly realized that nuclear technology transferred for peaceful purposes could be abused. The NSG consists of nuclear supplier countries that sought to contribute to the nonproliferation of nuclear weapons through the implementation of two sets of guidelines[12] for nuclear exports and nuclear-related exports. Together with the Zangger Committee, the NSG developed a master list of key technologies fundamental to the internal production of nuclear materials (such as centrifuge and AVLIS components), called the nuclear technologies control list. This master list was used as a guideline for member states to enact export controls and detect potential proliferation activity.

The NSG is a landmark achievement; however, there are a few problems with the organization's ability to execute its mission. The aforementioned export controls are left to be legislated and enforced under the laws of each individual Participating Government (PG)—of which there are currently 48.[13] The potential exists for these export controls—by remaining both undocumented and unverifiable—to be abused by multinational corporations with transnational access to control list technologies and strong political lobbies in developing countries outside the NSG. Additionally, the NSG only works on the basis of consensus. Overall responsibility for activities lies within the NSG PGs, which meet only once a year in a plenary meeting, with a rotating chair state having responsibility for coordination of work and outreach.[14]

The NSG and Zangger Committee should be fused into a permanent organization like the IAEA with its own infrastructure, personnel, and budget. This new organization, called the International Nuclear Sustainment Agency (INSA), should be based in Vienna, Austria. The INSA would continue executing the core goals of its precursor organizations; however, its central mission would extend to: (1) maintenance and oversight of an international fuel bank, (2) cradle-to-the-grave fuel-cycle management, (3) development and cost-incentive promotion of Generation IV nuclear reactors (see Figure 1), and (4) ongoing collaboration with the IAEA with regard to safeguards and security protocols. Entrance into the group will be available to all voting member nations on the IAEF council.

12. The NSG Guidelines also contain the so-called Non-Proliferation Principle, adopted in 1994, whereby a supplier, notwithstanding other provisions in the NSG Guidelines, authorizes a transfer only when satisfied that the transfer would not contribute to the proliferation of nuclear weapons. The Non-Proliferation Principle seeks to cover the rare but important cases where adherence to the NPT or to a Nuclear Weapon Free Zone Treaty may not by itself be a guarantee that a state will consistently share the objectives of the treaty or that it will remain in compliance with its treaty obligations. See Nuclear Suppliers Group, www.nuclearsuppliers group.org/A_test/01-eng/index.php?%20button=1.

13. Nuclear Suppliers Group, "Participants," www.nuclearsuppliersgroup.org/A_test/01-eng/06-parti.php?%20button=6.

14. Ibid.

In the last decade, the open market price for reactor-grade fissile material has markedly declined. This is due in part to both foreign competition and recent strategic arms reductions between the United States and Russia, as both states now have a surplus of fissile material that can be down-blended and used in reactors. The historically exorbitant costs associated with nuclear fuel supply systems have been reduced to the point where they negate an NNWS's need for indigenous ENR, thereby de-incentivizing the proliferation of nuclear weapons. INSA, by promoting new proliferation-resistant nuclear energy technology (like small modular reactors), will accomplish policy objectives that in the past were considered either foolish optimism or wishful thinking.

An international fuel bank would be a transparent and secure means of fulfilling enrichment and reprocessing needs. These banks would further displace the need for indigenous ENR. Cost incentives to nations that either have ENR facilities or are currently pursuing them will smooth over the transitions necessary for instituting INSA multilateral controls. Dissemination of radiation portal monitoring systems would thwart theft and diversion. Such measures, together with a virtual, real-time import/export database and INSA's nuclear technology control list, would facilitate unprecedented verification capabilities for the international community.

Cradle-to-grave fuel cycle management offered at an "at-cost" basis to IAEF member nations is perhaps one of the most exciting nuclear policy opportunities with INSA. The security benefits to nuclear supplier states far outweigh the need for profit. While the IAEF initiative does not negate a country's right to ENR, it makes it so cost prohibitive that a nation that chooses ENR over INSA resources effectively raises the proliferation red flag to the international community. Nations that forsake this international benevolence will have to answer for their actions before the IAEF council—an unprecedented level of international scrutiny. INSA, as an integral piece of the IAEF triad, represents the next level of deterring nuclear proliferation in our complex global malaise.

From a nonproliferation standpoint, not all nuclear reactors are created equal (Figure 1). RBMK light-water, graphite-moderated reactors, like the one used in Chernobyl, are dual plutonium-energy producers and are a stable source of revenue. Generation II heavy water (CANDU) reactors are efficient plutonium producers as well, with similar proliferation concerns.[15] Although designs of these types are no longer built, existing reactors will likely continue to run, unless it becomes financially worthwhile for a state to prematurely close them. INSA can provide international subsidies to quantitatively ease the world into Generation IV nuclear reactor types, which pose no serious proliferation risks.

The United States and Russia must lead the world by infusing the best practices of their shared nuclear heritage into the constitution and bylaws of the newly created INSA. For example, Section 123 of the U.S. Atomic Energy Act led to the rise of "123 Agreements"—a system of bilateral nonproliferation controls and commitments necessary to enter into LEU

15. World Nuclear Association, "Advanced Nuclear Power Reactors," June 2013, www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Power-Reactors/Advanced-Nuclear-Power-Reactors/.

trade with the United States.[16] As the LEU market becomes increasingly diverse and complex, countries will likely choose vendors that have less stringent requirements and forsake 123 agreement benefits. The United States must realize it cannot directly control the behavior of the world; it can, however, attempt to control third-party effects by codifying its nuclear trade standards into international practices. In other words, the United States must bring other regional suppliers into the fold if it is to seriously realize its long-term nonproliferation goals. On the other side of the token, since the breakup of the Soviet Union, Russia has struggled with the effects of regionalism and a host of security concerns with regard to the safeguarding of its fissile material.[17] For better or worse, Russia has been able to incorporate many lessons learned over the past two-plus decades with regard to safeguarding nuclear assets over its vast territory. It behooves President Putin to abandon his anti-Western foreign policy political platform of recent months in exchange for cooperation on an international effort to stand up INSA. Russia can become a key contributor in the arena of nuclear security and sustainment best practices if it chooses to collaborate. This collective effort is absolutely necessary if we are to abandon exacerbated Cold War thinking. Furthermore, such cooperation will pave the way for the next round of New START negotiations.

The Formation of INFA

The 2010 *Nuclear Posture Review* (NPR) states, "In coming years, we must give top priority to discouraging additional countries from acquiring nuclear weapons capabilities and stopping terrorist groups from acquiring nuclear bombs or the materials to build them."[18] This policy goal requires an unprecedented level of transparency from all nuclear states. It is possible for documentation methods of chemical compounds and isotopic signatures to be standardized internationally and kept classified by each NWS, while at the same time making giant leaps toward safeguarding the world against state-sponsored nuclear terrorism.

Coexisting alongside the IAEA and INSA is the third sister of the IAEF triad: the International Nuclear Forensics Agency (INFA) to be based in Vienna. Consistent with the U.S. Nuclear Forensics and Attribution Act of February 2010, INFA would reinforce and promote international technical expertise in nuclear forensics in efforts to deter state-sponsored nuclear terrorism.[19] The Obama administration's commitment to nuclear forensics was made explicit in the 2010 Quadrennial Defense Review.[20] Research is well under way to develop new methods by which experts can more quickly determine the source of materials used in a nuclear attack. The deterrent value of such nuclear forensic assessments is

16. National Nuclear Security Administration, "123 Agreements for Peaceful Cooperation," http://nnsa.energy.gov/aboutus/ourprograms/nonproliferation/treatiesagreements/123agreementsforpeacefulcooperation.

17. Adam Stulberg, "Nuclear Regionalism in Russia: Decentralization and Control in the Nuclear Complex," *Nonproliferation Review* 9, nos. 3 (Fall/Winter 2002): 39, http://cns.miis.edu/npr/pdfs/93stul.pdf.

18. Department of Defense, *Nuclear Posture Review Report* (Washington, DC: Department of Defense, April 2010), v, www.defense.gov/npr/docs/2010%20nuclear%20posture%20review%20report.pdf.

19. "Nuclear Forensics and Attribution Act," 111th Congress, 2d session, February 16, 2010, www.govtrack.us/congress/bills/111/hr730/text.

20. Department of Defense, *Quadrennial Defense Review* (Washington, DC: Department of Defense, February 2010), 36, www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf.

without question. The science of nuclear forensics has made significant progress, but it still falls short of the level of advancement necessary to have an international impact.[21]

INFA, via year-round international collaboration, is intended to quickly advance the science to be of use to the global nonproliferation regime. Over time, a nuclear forensics database would be compiled and kept confidential by the IAEF. The data would be accessed when international incidents necessitate such action, requiring a majority IAEF council vote.

Oversight, maintenance responsibility and human resources of the International Monitoring System (IMS) would transfer from the Comprehensive Test Ban Treaty Organization (CTBTO) to INFA. Synergy of this data under the IAEF umbrella further promotes international stability and nuclear policy objectives of all three sister agencies.

When combined with law enforcement (IAEA) and intelligence (INSA), nuclear forensics (INFA) contributes to the overall attribution process by discerning the fissile material's movement, industrial processes, and last legal owner. The new dynamism of nuclear policy is realized within this synergistic relationship but still requires proper oversight.

The CTBT: A Closer Look

The CTBT's objective is to achieve nuclear disarmament through the cessation of nuclear explosive testing.[22] However, the silent embarrassment of the document is that it contains no definition of what constitutes a test. Without such a basic verification parameter, many scholars believe that the CTBT initiative was a doomed effort from its initiation. Additionally, the CTBT would not prevent countries from developing basic nuclear weapons (such as gun-type designs) because testing of these rudimentary weapons is unnecessary. Furthermore, a zero-yield prohibition is wholly unverifiable. Lastly, maintaining a safe, reliable nuclear stockpile in the absence of testing entails real technical risks. The next generation of scientists and engineers will be trained by people with no actual test experience, and their work cannot be corroborated by even the most sophisticated computer programs because validation of research and development requires testing over time.[23]

Of the 44 states that must sign and ratify the document to bring it into force, only 36 nations have done so. The United States, China, Egypt, Iran, and Israel have signed but not ratified. India, Pakistan, and North Korea have not signed.

In anticipation of the CTBT entering into force, the Preparatory Commission for the CTBTO was founded in 1996.[24] It has more than 260 staff members from more than 70 countries

21. Private interview, CSIS, May 2013.

22. Comprehensive Test Ban Treaty Organization, "Comprehensive Test Ban Treaty: Preamble," www.ctbto.org/fileadmin/content/treaty/treaty_text.pdf.

23. William J. Perry et al., *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States* (Washington, DC: U.S. Institute of Peace Press, 2009), 81–84, http://media.usip.org/reports/strat_posture_report.pdf.

24. CTBTO Preparatory Commission, "Who we are," 2013, www.ctbto.org/specials/who-we-are/.

and is conveniently based in Vienna.[25] It is also responsible for the IMS data center, supporting 50 primary and 120 auxiliary seismic monitoring stations to identify radioactive particles and gases released during a nuclear explosion, 60 infrasound (low frequency acoustic) stations to pick up the sounds of an explosion in the atmosphere, and 11 hydroacoustic stations to monitor for underwater explosions.[26]

CTBTO officials must face this reality: The treaty will never enter into force. However, since the organization has made tremendous contributions to further the global nonproliferation regime, it would be a monumental failure if the CTBT vision was completely lost. Accordingly, a reallocation of the CTBT's political energies, manpower, and resources is warranted.

The CTBTO Becomes the International Atomic Energy Fellowship

Article II of the CTBT frames the general provisions from which the CTBTO was outlined. Much of this document will be reconfigured into the constitution for the newly created International Atomic Energy Fellowship.[27] Article II.A(1) should be amended to read: "The State Parties hereby establish the International Atomic Energy Fellowship (hereinafter referred to as "the Fellowship") to achieve the object and purpose to proscribe IAEA, INSA, and INFA mandates, oversee implementation of each of the three agencies' provisions, make determinations of international events through its voting body, as well as provide a forum for consultation and cooperation among States Parties." Similarly, any state may become a voting member of the Executive Council, and the headquarters will continue to be based in Vienna. The Fellowship will make decisions on matters of procedure and adoption of sister agency bylaws by a majority of members present and voting. Further details will be provided in the future.

The Fellowship's Prime Directives are as follows: (1) promote a world where the proliferation of nuclear weapons is halted and existing nuclear stockpiles are reduced over time; (2) provide for the general welfare of nonnuclear nations by overseeing the production, dissemination, transportation, and removal of materials required for the sustainment of nuclear power production; (3) keep channels open for valuable exchanges of information influencing the world's nuclear development; and (4) maintain a nuclear forensics database to ensure that both the integrity and stewardship of nuclear nations are without question. The first task of the Fellowship must be to overcome the "highly pessimistic worldview" of Russian policymakers.[28] The Fellowship cannot work without Russia's active participation. As each has a rich nuclear heritage, the United States and Russia can work toward mutual foreign policy objectives—dispelling old Cold War mentalities over time through a series of small accomplishments.

25. Ibid.
26. Ibid.
27. Comprehensive Test Ban Treaty Organization, "Comprehensive Test Ban Treaty: Preamble."
28. Trenin, "Russia's Threat Perception and Strategic Posture."

It is conceivable that these small accomplishments will ultimately lead to greater endeavors. If the threat perception between the United States and Russia is fundamentally downgraded over years of Fellowship participation, the possibility of a cooperative missile defense system then becomes feasible.[29] Cooperation on missile defense is the single diplomatic measure that is capable of generating a true "reset" of U.S.-Russian relations. The next round of New START negotiations will hinge directly upon political decisions surrounding missile defense.[30] If Russia is to follow the United States in reducing its nuclear force, it will only be because of a cooperative missile defense effort that is viewed as the ultimate guarantor of Russian security. Until such a time, modernization of Russia's nuclear arsenal and research and development into advanced technologies will continue. Of greater consequence, however, is the increasing likelihood of a return to Cold War–like tensions.

Advantages of the IAEF initiative include, but are not limited to: (1) it provides a permanent venue where nonproliferation discussions between all nuclear powers (not just the United States and Russia) will be ongoing; (2) its synergistic elements working in concert to maintain a forensics database lessens the likelihood of state-sponsored terrorism; (3) it justifies and legitimizes corrective actions against states that pursue enrichment for malevolent purposes; and 4) it effectively ends what has been dubbed the "Preemptive Strike Era" of the American military and begins what this author coins the "Cooperative Strike Era." The Fellowship would exist as a voting body that makes factual determinations of international events based upon verifiable data. No longer will a nation require unilateral military action to resolve grievances over nuclear concerns; rather, the Fellowship would foster the consensus necessary for justified, cooperative military action. The reputations of the United States and Russia would dramatically improve as both nations turn back the clock to utilizing more transnational and multilateral strategies (used before the infamous events of September 11) to combat terrorism.

There are a few necessary provisos that deserve note. The administrator of the National Nuclear Security administration (NNSA) will require Senate confirmation to hold that prestigious position because he/she will also hold the U.S. seat on the IAEF Council. This individual will report directly to the president of the United States. Additionally, IAEF representatives must be assigned to every nuclear power plant and uranium enrichment facility in the world for oversight, ongoing forensic testing, and data collection. The oversight function is to assure the world that the harvesting of weapons-grade material is not occurring from reactor cores. The forensic testing function allows the IAEF to pinpoint when and where production of any form of fissile material (LEU, highly enriched uranium, or plutonium-238) occurred and who produced it, while proper data collection provides

29. Daniel Goure, "Russian Strategic Nuclear Forces," in *The Russian Military Today and Tomorrow*, eds. Stephen J. Blank and Richard Weitz (Carlisle, PA: Strategic Studies Institute, 2010), 322; Stephen J. Blank, "Prospects for Russo-American Cooperation in Halting Nuclear Proliferation," in *Prospects for U.S.-Russian Security Cooperation*, ed. Stephen J. Blank (Carlisle, PA: Strategic Studies Institute, 2009), 258; Stephen Sestanovich, interview by Bernard Gwertzman, "The U.S.-Russia Missile Defense Impasse," Council on Foreign Relations, June 1, 2011, www.cfr.org/missile-defense/us-russia-missile-defense-impasse/p25169.

30. Dmitri Trenin, "After New START," Carnegie Endowment for International Peace, December 23, 2010, http://carnegieendowment.org/2010/12/23/after-new-start/4hc.

accountability and assurances to the world that nuclear powers are being good stewards of their nuclear materials. Lastly, the IAEF initiative should be egalitarian in nature. Nations that export their LEU should do this on an "at-cost" basis. Expenses would be compared and tracked in INFA's database. The long-term security benefits to nuclear nations represented by preventing runaway proliferation far outweigh the need for short-term profits.

Looking to the Future with Hope and Optimism

> The conditions that would ultimately permit the United States and others to give up their nuclear weapons without risking greater international instability and insecurity are very demanding. Among those conditions are success in halting the proliferation of nuclear weapons, much greater transparency into the programs and capabilities of key countries of concern . . . and ultimately the resolution of regional disputes that can motivate rival states to acquire and maintain nuclear weapons. Clearly, such conditions do not exist today.
>
> —The 2010 NPR[31]

Without an international platform for 24-7-365, ongoing transnational discussions that include nonproliferation, disarmament, verification, thwarting nuclear terrorism, import/export of fissile material, safeguards, and fuel-cycle management, the level of deep-seeded distrust necessary to achieve our nonproliferation agenda will never be abated to the point where Global Zero becomes a plausible reality. Thus, this ground-breaking international model—the likes of which this world has never known—will invoke a positive nuclear mindset among international leaders over time.

The information age has revealed exceptional technological advancements that allow for an equally unparalleled capacity for international synergy and collaboration. Increasing the opportunities for information sharing and mutual transparency will be critical during the early stages of the IAEF initiative. For example, the reinvigoration of the Joint Data Exchange Center (JDEC) might be a worthwhile initial pursuit for the Fellowship. If revived, JDEC would provide a regular exchange of launch notifications that could ease tensions between the United States and Russia by reducing the potential for false alarms due to the misinterpretation of early warning data.[32] In general, the Fellowship's objectives should address Russia's genuine concerns that the evolution of U.S. conventional capabilities is tailored to undermine the survivability of Russia's forces. Then, the United States should wait for Russia to follow suit.

Unilateral arms reductions will not promote the Global Zero dream. We must draw lessons from the nonproliferation failures of the past: do not engage in decisionmaking

31. Department of Defense, *Nuclear Posture Review*, 2010, 15.

32. Christopher Ford, "Playing for Time on the Edge of the Apocalypse: Maximizing Decision Time for Nuclear Leaders" (paper presented to Conference on Nuclear Deterrence: Its Past and Future, Hoover Institute, Washington, DC, November 11, 2010), 25–26.

independent of bilateral consensus across theater-wide extended deterrence regimes. In layman's terms, decisionmaking must include proactive talks with our allies to avoid damaging those relationships or inadvertently encouraging the pursuit of nuclear weapon programs.

Conclusion

The key to ending Cold War thinking is for the United States of America and the Russian Federation to jointly and equally participate in a historic international endeavor that draws upon our common nuclear heritages. If we are willing to abandon the old patterns of START and SORT treaty negotiations and invent a new calculus for nonproliferation discussions, we need not fear a Cold War resurgence. However, if we do things exactly as they have been done in the past, we should genuinely fear the resurgence of an arms race in the very foreseeable future. A bold step must be made toward ending once and for all the old Cold War mentalities, while at the same time addressing the most pressing issues within the nuclear enterprise.

The multifaceted challenges of an increasingly dynamic world require a new dynamism of nuclear policy. The three-pronged IAEF initiative is intended to make the impossible (i.e., Global Zero) possible. In the words of the standing president of these United States of America, this author advocates that there is but one direction to which we must be compelled: "Forward."

Societal Verification: Past and Present

Jessica Bufford[1]

Verification is one of greatest challenges to the vision of a world without nuclear weapons as laid out by President Obama in Prague in 2009. One potential solution is societal verification, or the participation of the general public in arms control verification. Though the concept was originally developed in the 1950s, societal verification remains vague and poorly understood. A survey of historical definitions reveals four key characteristics, namely that societal verification is society-wide, treaty-based, systematic, and individually driven. Though a full societal verification regime does not exist, individual participation in treaty monitoring in the form of citizen monitoring is already evident. Thanks to advances in technology, nongovernmental organizations and individual experts are able to provide insights into the implementation of certain international norms and treaties. Comparative analysis of citizen monitoring and societal verification demonstrates that there are significant gaps between the current monitoring capabilities and an official verification regime using socially generated information. Despite these gaps, there is significant potential for the public to support arms control in the future, and better understanding of how to overcome some of these gaps could be an important contribution to efforts to establish a world without nuclear weapons.

On April 9, 2009, President Barack Obama announced the U.S. commitment "to seek the peace and security of a world without nuclear weapons."[2] This landmark declaration elicited mixed reactions, as it was welcomed by advocates of global nuclear disarmament and opposed by supporters of nuclear deterrence. Regardless of how it was received, President Obama's statement provided new impetus and energy to discussions about global disarmament and the necessary steps to achieve such a vision. With President Obama's statement came two questions: what would a world without nuclear weapons look like, and how do we get there?

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2. Barack Obama, "Remarks at Hradcany Square, Prague, Czech Republic" (speech, Prague, Czech Republic, April 5, 2009), White House Office of the Press Secretary, www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered.

Working toward a world without nuclear weapons will require overcoming significant challenges. President Obama recognized the enormity of this task, quickly acknowledging in his speech that "this goal will not be reached quickly—perhaps not in my lifetime."[3] One particularly difficult challenge will be verifying a treaty banning nuclear weapons. Today, the Nuclear Nonproliferation Treaty prohibits all but five countries from possessing nuclear weapons and establishes a verification regime using safeguards implemented by the International Atomic Energy Agency. The safeguards regime, however, has proven to be imperfect, as a few states have been able to circumvent inspections to pursue nuclear weapons capabilities. Responding effectively to safeguards violations as an international community has also proven to be challenging, as demonstrated by the wide variation in state responses to Iran's safeguards violations. In a world without nuclear weapons, treaty verification will have to be close to perfect. Any violation would be seriously destabilizing; therefore, the international community would need to be extremely confident in each state's compliance with a treaty banning nuclear weapons. How to achieve that level of confidence remains unclear, but it will most certainly require new approaches to verification.

One potential approach is societal verification, or "a system of monitoring compliance with treaties, and detecting attempts to violate them, by means . . . based on the involvement of the whole community, or broad groups of it."[4] Societal verification envisions the incorporation of the general public into arms control monitoring and verification. Though it was originally developed in the 1950s, it has gained renewed interested thanks to recent changes in technology. New communication capabilities like the Internet, smartphones, and public satellites have made the world more accessible to everyone. Some of these technologies could be used to support arms control treaty monitoring and verification, but how societal verification would be implemented remains unclear.

This paper attempts to shed some light on the ambiguous concept of societal verification. In order to understand the potential of societal verification, it is important to understand the history of the concept, which will be explored in the first section. Definitions of societal verification will then be analyzed to identify its characteristics. These characteristics will be compared against current civilian monitoring activities to assess the degree to which societal verification exists today and what gaps remain. The paper concludes with thoughts on the potential future of societal verification and its role in arms control.

History of Societal Verification

The concept of societal verification was initially articulated in the 1940s by Leo Szilard in response to the development of nuclear weapons. Szilard was the first physicist to conceive of the use of a nuclear chain reaction in a weapon. Though he was instrumental in the Manhattan Project, Szilard quickly became an arms control advocate, requesting that the

3. Ibid.

4. Joseph Rotblat, "Toward a Nuclear Weapon-Free World: Societal Verification," *Security Dialogue* 23, no. 51 (1992): 52.

U.S. government not drop a nuclear weapon on Japan.[5] Szilard correctly predicted the nuclear arms race during the Cold War, noting that with the development of the nuclear weapon "the destructive power which can be accumulated by other countries as well as the United States can easily reach the level at which all the cities of the 'enemy' can be destroyed in one single sudden attack."[6]

To mitigate the risk of a "preventive" nuclear war, he advocated developing a system of controls on the production of nuclear weapons. Since the consequences of violating a ban on nuclear weapons would have significant global implications, Szilard encouraged engaging scientists and engineers as informants. He asserted:

> It would be desirable to create a situation which would permit us to appeal in various ways to physicists and engineers everywhere for information that would uncover violations of the controls. . . . It would be quite essential that the people of this country and the world be brought to understand from the start that any difficulties which any nation may place in the way of the established controls would have to be considered as tantamount to a "declaration of war."[7]

Szilard's ideas on arms control and verification were contained in a memo to President Franklin D. Roosevelt; however, the unexpected death of the president prevented the memo from being delivered. These ideas did not end there, but inspired others in the 1950s and '60s during the advent of arms control.

Early critics of arms control argued that treaties could not effectively be verified nor could they successfully detect cheating. In response, a feasibility study was conducted by a group of academics and leading thinkers on disarmament issues to assess some of the problems of implementing and enforcing disarmament agreements through inspections. Within the work *Inspection for Disarmament*, Seymour Melman,[8] among others, proposed that a disarmament verification regime include "inspection by the people." Under a disarmament treaty, any citizen of any country would have an "explicit obligation . . . to report violations to [an] international inspectorate."[9] He and Lewis Bohn advocated mobilizing members of the public to report treaty violations within their own countries. They asserted that the general public supported nuclear disarmament and could feasibly participate in arms control out of a sense of moral obligation. Broad awareness of and participation in arms control agreements were central to the early articulations of societal verification, expanding the ideas of Szilard to encompass not just the expert population but also the general public.

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5. International Panel on Fissile Materials, "Global Fissile Material Report 2009: A Path to Nuclear Disarmament," *International Panel on Fissile Materials* (2009): 114.

6. Michael Bess, *Realism, Utopia, And The Mushroom Cloud: Four Activist Intellectuals and Their Strategies for Peace, 1945–1989* (Chicago: University of Chicago Press, 1993), 48–49.

7. Leo Szilard, "Atomic Bombs and the Postwar Position of the United States in the World—1945," *Bulletin of the Atomic Scientists* 3, no. 12 (December 1947): 353.

8. Melman was a scholar at Columbia University and leading advocate for disarmament throughout the 1950s.

9. Seymour Melman, "Inspection by the People: Mobilization of Public Support," in *Excerpts from Inspection for Disarmament*, ed. Seymour Melman (New York: Columbia University Press, 1958), 39.

Another important aspect of inspection by the people was the creation of reliable communication channels between governments, international governmental organizations, and the general public. Grenville Clark[10] and Louis Sohn[11] proposed the creation of a UN inspection service that would be accessible to the public for reporting of violations.[12] They thus laid out the principles for citizen reporting in an annex as:

> Any person having any information concerning any violation of this Annex or any law or regulation enacted thereunder shall immediately report all such information to the United Nations Inspection Service. The General Assembly shall enact regulations governing the granting of rewards to persons supplying the Inspection Service with such information, and the provision of asylum to them and their families. . . . No nation shall penalise directly or indirectly any person or public or private organisation supplying information to the United Nations with respect to any violation of this Annex.[13]

While the individual was charged with reporting violations, the international inspection service would provide the method for communicating those violations to the international community. Clark and Sohn recognized that such reporting would be dangerous, and they recommended measures to protect those whistleblowers.

As the Cold War progressed, however, support for societal verification declined. Mounting tensions between the United States and Russia rendered citizen reporting politically impossible, particularly during the era of McCarthyism in the United States. At the same time, government-owned satellite technology improved, making it possible to verify treaty compliance using national technical means. As arms control developed using national technical means and on-site inspections for verification, societal verification faded from arms control and disarmament discourse for a time.

During the 1990s societal verification gained renewed attention. Joseph Rotblat[14] picked up many of the same themes from early concepts, including the "deeply felt moral obligation" to report violations of a treaty to eliminate nuclear weapons, the need for broad participation, and the provision of legal protection for reporters.[15] He also suggested that scientists and technologists in relevant industries could act as watchdogs of both their organizations and of their colleagues. A few years later Costa Rica brought the idea of an international disarmament verification body back into debate by circulating a Model Nuclear Weapons

10. Clark was a lawyer and arms control advocate during the 1950s who served on the governing board of Harvard University during the 1930s.

11. Sohn was a Harvard law professor, a participant in the drafting of the UN Charter, and a champion of disarmament.

12. Dieter Deiseroth, "Societal verification: wave of the future?" in *Verification Yearbook 2000*, ed. Trevor Findlay (London: VERTIC, 2000), 267.

13. Deiseroth, "Societal verification: wave of the future?" 11.

14. Rotblat was a physicist on the Manhattan Project who then advocated nuclear disarmament. Founder of the Pugwash Conferences on Science and World Affairs, he received a Nobel Peace Prize in 1995 for his work on nuclear disarmament.

15. Rotblat, "Toward a Nuclear Weapon–Free World: Societal Verification," 57.

Convention at the UN in 1997. Its proposal included a verification agency to which individuals could report violations, similar to the Inspection Service suggested by Clark and Sohn.[16]

Today, interest in the challenge of verifying a world without nuclear weapons has spurred renewed attention to societal verification. New technologies and media could make societal verification a meaningful addition to traditional monitoring and verification methods. The ability of the general public to observe, document, and share information has exploded in recent years. Smartphone technology alone has created a widespread network of potential sensors connected to social media that has enabled individuals to widely share information almost instantaneously. Though there appears to be great potential in new technology to support arms control, understanding the social and political context of societal verification to support an arms control treaty remains a significant challenge.

Definitions and Characteristics

Societal verification remains a poorly defined concept, in part because it has never been used in a legally binding agreement or implemented in any country. Over time, a wide range of activities, behaviors, and principles have become associated with the term. Comparing a few leading definitions provides valuable insight into the basic characteristics of societal verification.

Joseph Rotblat defined societal verification as

> a system of monitoring compliance with treaties, and detecting attempts to violate them, by means other than technological verification . . . based on the involvement of the whole community, or broad groups of it.[17]

His definition highlights some of the differences and similarities between traditional and societal verification. Like traditional verification, societal verification is intended to support formally negotiated treaties. All verification needs to be systematic to ensure it can effectively detect any violations. Unlike traditional verification methods, however, societal verification relies upon the observations and actions of the general populace to verify compliance and detect violations rather than relying upon government intelligence services and mutual inspections performed by government inspectors.

Kirk Bansak[18] emphasizes similar points in his definition, describing societal verification as "the ways in which social actors and social activities can collectively contribute to the verification of arms control agreements."[19] Like Rotblat, Bansak identifies formal arms

16. Deiseroth, "Societal verification: wave of the future?" 270.
17. Rotblat, "Toward a Nuclear Weapon–Free World: Societal Verification," 52.
18. Bansak is a graduate student at the Fletcher School of Law and Diplomacy at Tufts University. Formerly, he was a research associate in the Chemical and Biological Weapons Nonproliferation Program at the James Martin Center for Nonproliferation Studies (CNS).
19. Kirk C. Bansak, "Trust, but socially verify," *Bulletin of the Atomic Scientists* (August 10, 2012): 2, http://thebulletin.org/trust-socially-verify.

control agreements as the context for societal verification and looks to the broad participation of the general public to enact verification. Bansak diverges from Rotblat in how he describes the role of societal verification within treaty enforcement. While Rotblat defines societal verification as independent from national verification, Bansak places societal verification within and in support of broader verification goals, describing it as a "contribution" to arms control verification.

Finally, Dieter Deiseroth[20] notes that the term "connotes the involvement of civil society in monitoring national compliance with, and overall implementation of, international treaties or agreements."[21] While the underlying assumptions about treaty-based, widespread participation in verification are the same, Deiseroth furnishes an important addition to the concept of societal verification by describing the activity of civil society as "monitoring." While verification suggests judgment of the information collected, monitoring carries a connotation of simple observation.

From the above analysis, four common characteristics of societal verification shared among these definitions become clear. According to all three authors, societal verification can be characterized as:

1. *Society-wide*: Within a country that is party to a treaty with societal verification provisions, all citizens or large portions of the population are interested, motivated, and able to participate in monitoring and verification of arms control agreements. Such a broad level of participation implies a common familiarity with the provisions of an agreement, a strong interest in ensuring that the ruling government complies, and even greater devotion to the enforcement of an international agreement than to one's own state.

2. *Treaty-based*: Verification activity supports a formal, multilateral arms control treaty, which implies that societal verification is acceptable to all parties. This has important implications for the necessary strength of societal verification. For a state to accept any kind of verification, the capability of the other party or parties to look into the activities of that state must be matched by the ability of that state to look into the activities of the other party or parties. Consequentially, the interest, incentive, and ability of citizens to report treaty violations needs to be comparable among all parties to a treaty.

3. *Systematic*: With the call for reporting from a broad constituency comes the need to collect, organize, and analyze information from the general public. The quantity of information coming from citizen reporting could be enormous. Some method for organizing, assessing, and presenting information from citizens is essential for the success of societal verification. Societal verification must also be equally applied to all states within a treaty, with standardized reporting processes and availability.

20. Deiseroth is a judge at the Court of Appeal (Administrative Law) in Muenster, Germany. He has published in the fields of constitutional law, administrative law, labor law and public international law. He is also chairman of the Marburg Institute for Lawand Responsibility for the Future in Marburg, Germany.

21. Deiseroth, "Societal verification: wave of the future?" 265.

4. *Individually driven*: Societal verification shifts monitoring from the sole domain of governments to the responsibility of individuals as well as national intelligence and verification teams. Citizens become monitors of treaty implementation, and investigations of violations are driven by their reports.

In order for societal verification to realistically be implemented, all four of these characteristics will need to be present. One of the challenges for future efforts to implement societal verification will be to bring about those conditions in support of future arms control treaties.

Societal Verification Today: Citizen Monitoring

Though societal verification has never been used in an international arms control agreement, one aspect already in place today is citizen monitoring. For the purposes of this paper, citizen monitoring is the collection and dissemination of publicly available information by civil society and individuals to monitor the implementation of treaty obligations by state parties. Like societal verification, citizen monitoring describes the participation of segments of society in treaty implementation, but it is more limited in scope and capabilities than societal verification. Citizen monitoring has emerged with the development of communication technologies. Today, organizations and individuals are able to access, analyze, and disseminate more information than ever before thanks to the Internet, enabling civil society to comment on treaty implementation with greater credibility than in the past. Some nongovernmental organizations (NGOs) have taken on unofficial monitoring and verification roles in support of specific treaties or international norms. Loose networks of experts have formed to collect, analyze, and self-verify data to provide both historical and real-time snapshots of nuclear activities within certain states. Though there are many instances of citizen monitoring across the range of international issues, several prominent examples within international security suggest ways in which civil society could participate in future verification efforts.

THE LANDMINE MONITOR

One of the best examples of the potential contribution of NGO monitoring is the Landmine Monitor. Published by the International Campaign to Ban Landmines (ICBL), it is a compilation of open-source reports and assessments that tracks implementation of the Mine Ban Treaty.[22] When the Mine Ban Treaty opened for signature in 1997, the only verification provision in the treaty was the regular submission of voluntary reports to the United Nations secretary-general. Civil society rapidly identified this weak verification mechanism as a significant gap in the treaty regime. In response, ICBL started the Landmine

22. Formally known as the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction, the Mine Ban Treaty prohibits the use, stockpiling, production, and transfer of antipersonnel mines. There are currently 161 States Parties.

Monitor to provide third-party verification of the treaty. Using publicly available data, researchers analyze trends and developments to provide a measure of progress on treaty implementation. Though not officially recognized by governments, the Landmine Monitor has published reports every year since 1998, becoming the de facto monitoring organization of the treaty and providing important information on state implementation of the Mine Ban Treaty.[23]

The Landmine Monitor demonstrates how civil society can effectively participate in treaty monitoring, even as ad hoc participants. Though they are only able to accesses publicly available information, the degree of connectivity afforded by the Internet has enabled the Landmine Monitor to provide significant insight into treaty implementation. As Michael Crowley[24] and Andreas Persbo[25] observe:

> Despite the potential weaknesses sometimes inherent in a system which incorporates the collection and analysis of open source material, Landmine Monitor has over the years succeeded in collecting a large amount of information on state compliance with the Mine Ban Convention. While this inevitably remains an imperfect monitoring system in some respects, it . . . has had an important impact on the Convention's implementation.[26]

Information that was previously inaccessible to anyone not in-country can now be found online, facilitating efforts by NGOs to monitor treaty implementation and making them more viable partners in future treaty verification efforts.

THE NATIONAL COUNCIL OF RESISTANCE OF IRAN AND THE INSTITUTE FOR SCIENCE AND INTERNATIONAL SECURITY

Citizen monitoring can also focus more narrowly on the implementation of treaty obligations by one country. In August 2002 the Natanz facility in Iran was disclosed by the National Council of Resistance of Iran (NCRI), an Iranian opposition group based in Paris.[27] Following this revelation, the Institute for Science and International Security (ISIS) requested satellite imagery for the area around Natanz in September 2002 and February 2003. Based upon those images, ISIS developed a detailed assessment of the size of buildings within the nuclear complex, the likely nature and purpose of activities within those

23. Landmine and Cluster Munition Monitor, "About Us: History," 2009, www.the-monitor.org/index.php/LM/About-Us/History.

24. Crowley is executive director of the Verification Research, Training, and Information Centre (VERTIC). He has worked for nearly 20 years on arms control, security, and human rights issues.

25. Persbo is an arms control and disarmament researcher at VERTIC. He has previously been a consultant for the British American Security Information Council and has published widely on arms control issues, with an emphasis on nuclear arms control and disarmament.

26. Michael Crowley and Andreas Persbo, "The Role of Non-Governmental Organizations in the Monitoring and Verification of International Arms Control and Disarmament Agreements," in *Thinking Outside the Box in Multilateral Disarmament and Arms Control Negotiations*, eds. John Borrie and Vanessa Martin Randin (Geneva: UN Institute for Disarmament Research, 2006), 235.

27. David Albright and Corey Hinderstein, "Iran Building Nuclear Fuel Cycle Facilities: International Transparency Needed," Institute for Science and International Security, December 12, 2002, http://isis-online.org/isis-reports/detail/iran-building-nuclear-fuel-cycle-facilities-international-transparency-need/8.

buildings, and the type of military strike that would be necessary to destroy certain facilities.[28] Since then, ISIS has provided regular analysis and monitoring of the Natanz facility through satellite imagery.

Two important aspects of citizen monitoring are evident in ISIS activities. First, technology has advanced to a point where individuals are able to monitor a wide variety of activities using high resolution imagery that was previously available only to governments. During the Cold War, the only satellites in space were controlled by the U.S. and Soviet governments. Today, commercial satellites with imagery capabilities have become so common that an individual can buy images of almost anywhere in the world, facilitating the emergence of what could be considered open-source national technical means.

The second important characteristic of NCRI and ISIS activities is that citizen monitoring occurs remotely, taking place largely outside of the state being monitored. Outside observers are free to make controversial claims or revelations because they have few concerns about government repercussions. Internal reporters would likely be detected and stopped by government forces, but outsiders are able to report without fear of reprisals from the state they are monitoring. Such observation, however, is limited to what the researchers know to investigate. Major revelations like Natanz may always require assistance from individuals or entities within the state or dissenters from the government, as was the case with the NCRI revelations. Regardless of this potential limitation, the ISIS reports demonstrate that civil society has the capacity to provide some ad hoc monitoring of treaty commitments, even if the analysts are working thousands of miles away.

EXPERT BLOGS

In addition to organizations monitoring treaty implementation, informal networks of experts that have emerged can act as whistleblowers and monitors. Today, experts in the nonproliferation and arms control community can share their ideas and observations through blogs and social media, reaching a broader audience more quickly than traditional publishing avenues can. More than just publishing information, members can pulse the community with a question and rapidly receive an informed answer. A researcher can ask her colleagues around the world to identify a picture or verify a piece of information and receive responses in minutes. Sharing ideas and analysis is also much quicker, as a post on a blog has the capability to start a lively debate within a few hours.

Blogs have become an important tool for experts to communicate their ideas rapidly and widely. Some are hosted by organizations, such as the *Nukes of Hazard*[29] and *ANS Nuclear Café*,[30] while others are maintained by individuals like *Restricted Data* and *Arms*

28. For more information, see David Albright and Corey Hinderstein, "The Iranian Gas Centrifuge Uranium Enrichment Plant at Natanz: Drawing from Commercial Satellite Images," Institute for Science and International Security, March 14, 2003, www.isis-online.org/publications/iran/natanz03_02.html.

29. Center for Arms Control & Non-Proliferation, *Nukes of Hazard* (blog), http://nukesofhazardblog.com.

30. American Nuclear Society, *ANS Nuclear Café* (blog), http://ansnuclearcafe.org.

Control Wonk.[31] *Arms Control Wonk* in particular provides useful insight into how experts are able to collect, analyze, and discuss information from a wide variety of sources, including news organizations, government publications, and media such as photos and video. Blog creator Jeffrey Lewis and other contributing authors analyze information collected from multiple sources and post it on their blog, distributing it to the community and generating discussion. This discussion can then assess the accuracy of information and identify problematic analysis. For example, in November 2011 Georgetown professor Phillip Karber asserted that China possessed 3,000 nuclear weapons hidden in a vast network of underground tunnels.[32] One week later, Jeffrey Lewis responded with a post on *Arms Control Wonk* analyzing and critiquing Karber's claims.[33] It resulted in a lively debate on the blog that ultimately led the expert community to refute the results of the Karber study.

This self-reflection suggests that although information coming from citizen reporting will need to be treated by governments judiciously, the expert network has the ability to evaluate and refine information being published and circulated, improving the quality of potential contributions to arms control efforts. The expert community has also demonstrated a willingness to sift through large amounts of data generated by the public and have the background to identify potentially significant clues. Open-source conversations could serve as first notifications to governments of treaty violations, though serious investigation by government officials would need to occur before any information could be presented in official diplomatic channels. As well-informed nongovernmental observers, the extensive network within the expert community has important potential to support future arms control.

Gap Analysis

Although citizen monitoring today represents a potential forerunner of societal verification, significant gaps remain between the ideal characteristics of societal verification and citizen monitoring. These gaps can best be understood by comparing the four characteristics of societal verification with citizen monitoring.

INDIVIDUALLY DRIVEN: INSIDER VERSUS OUTSIDER REPORTING

Individual participation is at the core of both societal verification and citizen monitoring, but the location of the participants differs significantly. Most citizen monitoring is conducted remotely by foreigners, whereas societal verification envisions citizens reporting suspicious activities within their own countries. Globalization and electronic communication technology

31. Jeffrey Lewis, *Arms Control Wonk* (blog), http://armscontrolwonk.com.

32. William Wan, "Georgetown students shed light on China's tunnel system for nuclear weapons," *Washington Post*, November 29, 2011, www.washingtonpost.com/world/national-security/georgetown-students-shed-light-on-chinas-tunnel-system-for-nuclear-weapons/2011/11/16/gIQA6AmKAO_story.html.

33. Jeffrey Lewis, "Collected Thoughts on Phil Karber," *Arms Control Wonk* (blog), December 7, 2011, http://lewis.armscontrolwonk.com/archive/4799/collected-thoughts-on-phil-karber.

have made countries more accessible to outsiders by facilitating both in-person and electronic visits. Outsiders are also more able to report on potential treaty violations because they do not face negative repercussions from the government being monitored. As Ronald Mitchell[34] observes:

> Outsiders have stronger net incentives to monitor and provide information, although they may have more limited capacities, since the risk from the suspect government is far less. Indeed, most governments would consider any effort to retaliate against their citizens for helping to reveal clandestine nuclear activity as warranting severe sanctions. Thus, these actors face far less risk of retaliation, assuming they are outside the suspect country at the time the information becomes public.[35]

Outside reporting may bring attention to events that would not be reported from inside a country; however it is more susceptible to inaccuracies because the reporting is done from a distance. Behavior that a local would recognize as not in violation or irrelevant to an arms control treaty may appear suspicious to an outsider. Remote observation may also miss important activity that cannot be easily tracked remotely, such as human interactions. Citizen monitoring has been greatly facilitated by modern technology, and outsiders are now able to report with relatively high confidence about certain activities within a state, but it is still a far cry from the mobilization envisioned by societal verification.

Internal mobilization and reporting remains a serious hurdle for the implementation of societal verification. The first articulations of societal verification relied on the creation of a loyalty among all people to the global cause of disarmament that would supersede national loyalty. Supranational loyalty has yet to develop, and today those leaking sensitive government information are still tried for treason and espionage. Internal mobilization is one of the toughest challenges for societal verification. Developing loyalty to an abstract idea rather than a particular country would be difficult and could have unforeseen consequences. It also may not be possible without a significant change in the international system and the development of a governance system outside of states. Although citizen monitoring demonstrates that individuals can identify, analyze, and distribute treaty-relevant information even from afar, systematic voluntary reporting on one's own state has not yet emerged.

SYSTEMATIC AND SOCIETY WIDE: INFORMAL NETWORKS VERSUS GLOBAL ORGANIZATION

Societal verification was envisioned as an organized and systematic activity, coordinated through a global verification agency. Citizen monitoring is conducted informally, coordinated

34. Mitchell is a professor of political science at the University of Oregon and has written extensively on nuclear proliferation and international safeguards.

35. Ronald P. Mitchell, "Identifying Undeclared Nuclear Sites: Contributions from Nontraditional Sources" (proceedings, Second Workshop on Science and Modern Technology for Safeguards, Albuquerque, NM, September 21–24, 1998), 66.

through a patchwork of individuals and organizations. Without a dedicated organization to manage data flow, citizen monitoring falls short of the societal verification standard. Citizen monitoring may miss important information coming out of states secretly violating treaty obligations. Only information deemed interesting by experts and nongovernmental organizations circulates repeatedly through the citizen monitoring community. As a result, there is a real potential that some indications of treaty violations may not be recognized and circulated. A systematic approach to open-source data management would be able to mitigate that risk, though no system will be able to perfectly screen all information available. False information may also be picked up and circulated as credible. Although citizen monitoring has proven its ability to correct some errors, it is not clear that all false information is caught. Without careful data authentication by an overarching organization, data coming out of citizen monitoring may not be credible, limiting its ability to contribute to arms control verification.

Citizen monitoring also has a limited scope compared to societal verification. Because citizen monitoring is informal in nature, only areas that are of interest to those participating in monitoring are covered. This is evident today in the number of blogs and discussions focused on Iran and North Korea, while other regions of the world are not discussed. Societal verification, however, would apply a similar baseline of attention to all parties to an arms control regime. Citizen monitoring is also limited in scope because of its limited participation. Many organizations and individuals who conduct citizen monitoring are from North America or Europe. There is a dearth of monitors reporting out of other areas of the world, potentially both biasing information and leaving dangerous gaps in monitoring activities. For societal verification to be truly systematic and society-wide, the degree of scrutiny and reporting out of any state should be similar to all other states. Without systematic and society-wide reporting, citizen monitoring has several serious gaps. To be used in a treaty, societal verification will need to bridge those gaps and assure participating governments that its verification system is effective and reliable.

TREATY-BASED: AD HOC VERSUS LEGAL FOUNDATION

Citizen monitoring is different from societal verification in part because it exists as an ad hoc activity and lacks any legal basis that societal verification would possess. Because it is being conducted by citizens outside of any formal treaty, information from citizen monitoring has no standing in interstate relations. Without a legal basis, citizen monitoring is limited to commenting on observed behavior, activities, and events. While it is unclear to what degree citizen monitoring provides new information or simply duplicates national intelligence, it is clear that in the future, societal verification would need to be recognized by all governments as an effective component of any arms control agreement. To be included in formal treaty negotiations, all parties would need to believe that societal verification provided meaningful and accurate information. Providing trusted information will be an important and necessary condition for societal verification, but citizen monitoring has clearly not yet crossed that threshold.

Societal Verification, Citizen Monitoring, and Future Arms Control

A world without nuclear weapons, as outlined by President Obama, will require a strong verification regime, stronger than any negotiated to date. Societal verification has the potential to contribute to strengthened verification regimes. Initially developed to support the first arms control agreements and to prove that arms control was possible, today societal verification plays a similar role in the discussion about the global elimination of nuclear weapons. An early form of societal verification has emerged in the development of citizen monitoring capabilities. There are still significant gaps to overcome, however, before societal verification could be applied in the context of a treaty.

Some of these gaps may be impossible to bridge, in part because of the connotation of the term "verification." Within an arms control context, verification implies not just collection and analysis of information but also judgments on state compliance with treaty obligations. Treaties are complex legal agreements that require extensive knowledge of the issues to assess and evaluate implementation. It is unrealistic to expect that the general public will understand arms control treaties well enough to provide a meaningful compliance assessment that could be used to confront a state government. Additionally, any allegation of noncompliance will require very strong evidence, and it is extremely unlikely that states will accept the judgment of the general public.

Despite the semantic problems with "societal verification," the term encapsulates useful ideas regarding public involvement in arms control efforts in the future. As demonstrated with the study of citizen monitoring, at least some portion of the public has the potential to provide valuable information about possible treaty violations. "Societal monitoring" could be a more appropriate term, recognizing that publicly available and collected information could be incorporated into formal verification regimes in the future to serve as supplemental information to already existing national verification activities.

Establishing a credible method for collecting, analyzing, and disseminating information from the public on treaty implementation and overcoming current limitations within citizen monitoring will require further study. There is significant potential for the public to contribute to arms control, however. Understanding how the public could contribute to future arms control verification efforts might be an important contribution to efforts to establish a world without nuclear weapons.

Climate Change and the Middle East: A Security Perspective

Nilsu Goren[1]

> Over the next 20 years and more, certain pressures—population, resource, energy, climate, economic, and environmental—could combine with rapid cultural, social, and technological change to produce new sources of deprivation, rage, and instability.[2]
>
> —Robert M. Gates, former U.S. Secretary of Defense

Analyzing the linkage between nuclear and climate risks in the Middle East can shed light on critical implications for the strategic security environment in the region. On the global scale, there is a time disconnect between states' response to global warming and fossil fuel depletion. Some states have attempted to slow fossil fuel depletion by extending nuclear energy generation, but the transition to nuclear energy is difficult and expensive and will require a long time. Yet, at the regional level in the Middle East, the security and military implications of climate change will take place much sooner than in other parts of the world due to geographical conditions, and several countries are already seeking assistance from nuclear states to develop nuclear plants to address their energy needs. The main environmental concerns in the region will be desertification and availability of water, which will trigger demand for the energy necessary to desalinate seawater. The environmental conditions implicate both safety and security of nuclear facilities and pose the potential for political conflicts among and within states. Potential security challenges include civil violence, disruptions in energy supply, water disputes, and humanitarian crises. The solution lies with multilateral efforts to prevent and mitigate potential conflicts, integrated into development assistance programs in order to preempt future environmental crises. International and

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2. Robert Gates, "U.S. Global Leadership Campaign" (speech, Washington, DC, July 15, 2008), U.S. Department of Defense Office of the Assistant Secretary of Defense (Public Affairs), www.defense.gov/speeches/speech.aspx?speechid=1262.

regional cooperation to detect and monitor security implications of climate change in the Middle East should garner as much attention as the political and societal developments in the aftermath of the Arab Spring.

Introduction

Climate change is considered to be a threat multiplier of instability in volatile regions that could destabilize every aspect of human life. States have a common interest in controlling climate change through collaboration and mutually protective regulations. In the upcoming decades, the shift from fossil fuel dependency to extended nuclear power generation will necessitate a fundamental transformation of security relationships, undermining legacy policies (i.e., the traditional relations and institutional settings among nuclear states and nonnuclear states) and enabling technology transfers and effective monitoring of fissile materials. There is a need for high-level commitment now to address the new security problems arising from the long-term military and strategic consequences of the shift from fossil fuel to nuclear energy in the upcoming decades.

The near-term consequence of climate change in the Middle East is desertification. The energy deficit in the region is expected to be addressed by nuclear energy generation, which will create new safety and security concerns. The Middle East has seismic activity, the region is prone to terrorist attacks, and proliferation-resistant nuclear plant designs are not commercially attractive to centrally directed states.

Meanwhile, the Middle East is undergoing fundamental change. The Arab awakening has seen public opinion overthrow authoritarian governments, paved the way for the success of Islamist parties, and left state security structures weakened. Regional security concerns regarding proliferation of weapons of mass destruction, terrorism, energy supplies, and human rights could be left in the hands of radicalizing forces such as Hezbollah, Hamas, and al Qaeda, which might try to benefit from the uncertain strategic implications of the tumult. There are two immediate concerns: civil violence in Syria and a nuclear Iran. As the current civil war in Syria has proven, the region constitutes an arena for proxy conflicts along sectarian and ethnic lines. Iran's nuclear program shadows the transformation of the region's security landscape. The potential ramifications of a crisis surrounding Iran's controversial nuclear program include a possible U.S. or Israeli military strike to halt Iran from acquiring nuclear weapons or, alternatively, cascade proliferation in response to Iran's achievement of a breakout capability.

This article will explore the security impacts of global warming on a regional scale in the Middle East. The region is highly varied in topography by mountain ranges, arid to semi-arid areas, and inland seas. It is evident that scarcity of water resources and rapid population growth pose the biggest threats to stability in the Middle East. Strengthening ecological security in the region can contribute to human security.

Background

Climate change refers to substantial changes in climatic measures lasting for decades, while global warming is an average increase of surface temperatures in the lowest layer of the atmosphere.[3]

As no state is immune to impacts of climate change, there is common interest in preventing and managing the consequences of global warming rather than creating national confrontation over resources. The solutions depend on the establishment of global legal standards. Although the following international arrangements are in the process of establishing the climatic rule of law, the institutional transformation is far from complete:

- In 1988, the United Nations (UN) and World Meteorological Organization set up the Intergovernmental Panel on Climate Change (IPCC) to assess scientific and socioeconomic information related to human-induced climate change.
- In September 2003, Kofi Annan created the UN High-Level Panel on Threats, Challenges, and Change to effectively address transnational threats in the twenty-first century (i.e., poverty, infectious diseases, and civil violence due to environmental degradation.)[4]
- On February 16, 2005, the Kyoto Protocol entered into force to monitor greenhouse gas emission targets, but it remains ineffective, as the United States is not a signatory.
- In December 2007, the UN Framework Convention on Climate Change in Bali stated a roadmap for industrialized nations to commit to "measurable, reportable, verifiable" mitigation or actions.[5]

Problems

According to the International Energy Agency, energy consumption will increase by 55 percent and emissions by 57 percent between 2005 and 2030, paving the way for an increase in global temperatures of 6° Celsius (C).[6] The immediate environmental concerns are the rapid degeneration of polar ice formations with corresponding sea rise, the shutdown of the thermohaline cycle—the Gulf Stream—and surging release of frozen gas hydrates that might accelerate the warming effect.[7]

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3. Environmental Protection Agency, "Climate Change: Basic Information," September 9, 2013, www.epa.gov/climatechange/basics/.
4. Secretary General's High-Level Panel on Threats, Challenges and Change, "A More Secure World: Our Shared Responsibility," United Nations, December 2004, www.un.org/secureworld/.
5. Christiane Callsen, "Climate Change and Security Policy," *CSS Analyses in Security Policy* 2, no. 26 (December 2007), 1–3.
6. Ibid.
7. Ibid.

IPCC's assessment of climate change concludes that several species and ecosystems will be impacted. The likelihood of drought will increase due to the decline in water supplies provided by glaciers and snow covers. The environmental stress on the world population is likely to trigger cascade effects through floods, severe storms, droughts, and heat waves. Food and water scarcity, along with spread of current and new diseases, might lead to civil strife and armed conflicts. Food insecurity may lead to forced migration and create spill-over effects that destabilize surrounding regions.[8]

The German Advisory Council on Global Change report projects that by 2020, Africa will be exposed to climate-induced water stress affecting 75–250 million people.[9] Water scarcity will undermine human security.

More than 850 million people are malnourished worldwide, and climate change is likely to trigger a decrease in crop productivity.[10] Even a global warming of 2–4°C would bring desertification and soil salinization, especially in parts of the Middle East, Central Asia, and Northern Africa.[11] Global warming will exacerbate the living standards in these regions, leading to mass migrations and border tensions.

The UN High Commissioner for Refugees estimated that in 2006, there were 8 million registered refugees and 23.7 million internally displaced people.[12] Climate change could trigger an increase in these numbers due to economic migrants or refugees. For example, this scenario might create a potential conflict between Russia and China in a warming climate, as the Chinese population may need to resettle from flooded coastal cities and arid regions into Russia.

Under continued rapid greenhouse gas emissions growth, the Middle East is likely to see large decreases in precipitation by the mid- to late-2030s.[13] The largest change expected is a decline in precipitation in the Eastern Mediterranean, including Turkey, Syria, northern Iraq, northeastern Iran, and the Caucasus.[14] A decrease of 170,000 square kilometers is expected in viable rain-fed agricultural fields in Israel, Lebanon, Syria, Iraq, and Iran.[15] In southeastern Turkey, the expected decrease in precipitation is larger than 125 millimeters and 25 percent of the current precipitation.[16] Over the Middle East, the expected decline in cyclonic activity—large-scale atmospheric wind and pressure activities—is 18 percent of current levels by the late twenty-first century.[17] A significant decline in

8. Jurgen Scheffran, "Climate Change and Security," *Bulletin of the Atomic Scientists* 64, no. 2 (May/June 2008): 19–25.
9. Ibid.
10. Ibid.
11. Ibid.
12. UNHCR, "2006 Global Trends: Refugees, Asylum-Seekers, Returnees, Internally Displaced and Stateless Persons," July 16, 2007, www.unhcr.org/4676a71d4.html.
13. Filippo Giorgi and Xunqiang Bi, "Time of Emergence (TOE) of GHG-Forced Precipitation Change Hot-Spots," *Geophysical Research Letters* 36 (2009), 1–5.
14. Jason P. Evans, "21st century climate change in the Middle East," *Climatic Change* 92 (2009): 417–32.
15. Ibid.
16. Ibid.
17. Ibid.

precipitation impacts agriculture and food production by altering the soil moisture, supply of water, length of the dry season, and grazing period for animals.

Security Challenges

Ecological security refers to ecosystem changes turning into security threats. Environmental degradation could lead to disruption of social coherence due to violent resource competition. Climate change is not a particular enemy that eradicates select targets. Global warming and concentration of carbon dioxide emissions pose a threat on a planetary scale. While global warming is unlikely to be an immediate cause of conflicts, it threatens to accentuate existing threats and security risks. Environmental problems intensify transnational security concerns due to increased human mobility and interaction within globalization.

For example, studies have pointed to the rapid decline in summer sea-ice cover in the past decade and correlated growth in Arctic states' military capabilities, as impacted states need to operate under new principles of survival with declined territory in the Arctic. This militarization could lead to future security scenarios in the Northern Hemisphere, involving such big players as the United States and Russia, and new foreign and defense policies as climatic events lead to population movements.[18]

Trans-nationalization of threats necessitates "intermestic security," that is, a combination of domestic and international security by aggregation of capabilities.[19] Security impacts of climate change are not perfectly quantifiable, but they require multinational and multiagency cooperation to prevent disaster scenarios. Yet, existing security relationships among major global actors do not provide a sustainable basis for the required transformation in energy production without the transformation of deterrent force operations and nuclear management. Thus, global warming can be a catalyst to alter security policy in the following areas.

NUCLEAR ENERGY GENERATION

Several governments have put the use of nuclear energy forward as a solution to fossil fuel dependence and climate change. The main factors for this change are the increase in energy demands and the economics of nuclear power for electricity. Yet, this nuclear "renaissance" could contribute to the risk of nuclear proliferation. The distinction between civilian and military nuclear technology, nuclear energy generation, and nuclear weapons development relies solely on production and processing of weapons-grade materials. Hence, the replacement of aging nuclear power plants needs to be proliferation-resistant.

18. Rob Huebert, Heather Exner-Pirot, Adam Lajeunesse, and Jay Gulledge, "Climate Change & International Security: The Arctic as a Bellwether," Center for Climate and Energy Solutions, May 2012, www.c2es.org/publications/climate-change-international-arctic-security.

19. Victor D. Cha, "Globalization and the Study of International Security," *Journal of Peace Research* 37, no. 3 (2000): 391–403.

In the Middle East, emerging nuclear power countries include Iran, Turkey, Saudi Arabia, Qatar, Kuwait, and Yemen. Jordan and Egypt have stated interest in nuclear energy for the power necessary for desalinization, as these countries have to import a huge portion of their energy needs.

Jurgen Scheffran and Janpeter Schilling, professors heading the Research Group Climate Change and Security at the University of Hamburg, call for a "double zero"[20] of nuclear weapons and carbon dioxide emissions. They argue that regional approaches can trigger global solutions. There are technologies to deal with global warming and replacement of fossil fuels, including wind, solar, biomass, nuclear fission, and carbon sequestration.[21] Climate change is most likely to be addressed by the expansion of nuclear power generation to ensure sufficient energy production. Growth in nuclear energy production to contain atmospheric carbon gas concentrations will accentuate the need to control the fuel cycle, due to nuclear proliferation concerns.

Both nuclear and climate risks pose planetary-scale existential threats and require a global response.[22] The earthquake and the Fukushima Daiichi disaster in Japan have shown the world that major seismic events can disable reactor cooling systems and cause nuclear meltdown and contamination.

The U.S. Energy Information Administration predicts that nuclear power generation will increase by 2040, especially in countries outside the Organization for Economic Cooperation and Development (OECD).[23] Changes in the political economy of energy to reduce emissions from fossil fuels will bring a nuclear reconnaissance. New reactor designs will enable the expansion in production. However, increased reliance on nuclear energy might trigger nuclear proliferation and belligerent behavior by new actors or through terrorist acquisition.

The solution is to enhance global accounting and international management of the fuel cycle. Yet, controlling unauthorized access to fissionable materials requires extensive revision of legacy deterrent practices—the division between nuclear weapons states and nonnuclear weapon states under the Non-Proliferation Treaty regime that is used to define managerial control of fissile materials.

POLITICAL INSTABILITY AND CIVIL CONFLICT

The proposition that the Middle East is prone to conflict and that political discussion will always be dominated by ethnic, tribal, and religious clashes originates from the fact that

20. Ibid.

21. John Steinbruner and Tim Gulden, "The Security Implications of Global Warming," *Public Policy: Current Thinking on Critical Issues* (Winter 2008), 2–3.

22. Jurgen Scheffran, *Climate Change, Nuclear Risks, and Nuclear Disarmament: From Security Threats to Sustainable Peace* (Hamburg: World Future Council, November 2011), www.worldfuturecouncil.org/fileadmin/user_upload/PDF/110517_WFC_Scheffran_Report.pdf.

23. Energy Information Administration (EIA), *International Energy Outlook 2011* (Washington, DC: EIA, September 2011), www.eia.gov/forecasts/archive/ieo11/.

the region is a microcosm of potentially threatening effects of globalization in terms of inequitable patterns of economic growth, climate change, and population dynamics. Territorial integrity and coercive intrusion are still valid threats in the region. The volatility of social, political, and economic conditions in the aftermath of the Arab Spring exacerbates the conditions that create civil conflict.

Climate change undermines human security by reducing access to natural resources to sustain livelihood. It is likely to overshadow the capacity of states to provide services to its citizens, generating stress factors fostering political instability. The concentration of wealth among the rich due to globalization can also lead to disruptions in social coherence and trigger civil violence and terrorism.[24] Civil violence contributes to cyclical patterns of poverty, humanitarian disasters, global lawlessness, and regional instabilities.[25] Rule of law is a global, fundamental interest, and sustained instances of civil conflict are manifestations of the breakdown of international legal order. In the aftermath of the Cold War, there has been a drastic drop in the number of interstate conflicts and a sharp increase in internal conflicts of localized violence. Contributing factors include resource depletion, increased unemployment, and economic disparities along cultural, ethnic, and religious lines.[26] Violence is both a cause and a consequence of economic disparities.[27] The inequitable pattern of economic growth threatens a surge of violence, especially in the Middle East, where unemployment among youth has skyrocketed. Increased civil violence might have spillover effects such as trade disruptions and terrorist development in the region.

Climate change impacts energy security for all countries, including OECD states, as resource shortage might lead to violent conflict and necessitate disaster relief.[28] Hence, the European Security Strategy highlights effective multilateralism as a preventive security policy tool against economic damage to critical infrastructure, tensions over energy supplies, and pressures on the international security architecture.[29]

Further research is required to determine the vulnerability of regions and livelihoods to climate change. *The Assessment of Impacts and Adaptations to Climate Change,* a 2007 global initiative by the UN Environment Program, was an initial attempt to understand the

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24. John Steinbruner, "Security Policy and the Question of Fundamental Change," CISSM Working Paper, Center for International and Security Studies at Maryland, November 2010, www.cissm.umd.edu/papers/display.php?id=448.

25. Michael Kniss, "Intertwined Inequities: Micro-Level Economic Determinants of Civil Conflict," CISSM Working Paper, Center for International and Security Studies at Maryland, November 2009, www.cissm.umd.edu/papers/display.php?id=480.

26. Carnegie Commission on Preventing Deadly Conflict, *Preventing Deadly Conflict: Final Report* (Washington, DC: Carnegie Commission on Preventing Deadly Conflict, 1997), www.dtic.mil/dtic/tr/fulltext/u2/a372860.pdf. See especially chapter 2, "When Prevention Fails: How and Why Deadly Conflict Occurs."

27. By Western standards, 77 percent of the world population is poor, 7 percent is middle class, and 16 percent is rich. See Branko Milanovic, *Worlds Apart: Measuring International and Global Inequality* (Princeton, NJ: Princeton University Press, 2005), 101–27.

28. Christiane Callsen, "Climate Change and Security Policy."

29. High Representative and the European Commission to the European Council, "Climate Change and International Security," March 14, 2008, www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/reports/99387.pdf.

connections between ecosystem degradation, failed governance, and economic decline. This is a project that needs further research.

ENERGY SECURITY

The uprisings in the Arab world have proven that major disruptions in the geostrategic balance in the Middle East will continue to impact global oil prices drastically, as evidenced by the loss of petroleum exports from Libya.[30] The impacts of environmental issues such as climate change, high reliance on fossil fuels, globalization of energy demand, and cyber-vulnerability of critical infrastructures exacerbate concerns over the security of energy supply.[31] For instance, the Iranian nuclear program could potentially upset the balance of power in the Persian Gulf, where 60 percent of the conventional oil reserves are located.[32]

Pulitzer Prize–winning energy expert Daniel Yergin argues that innovation across the energy spectrum is critical to conservation and efficiency, as the demand for energy will grow and transportation will remain as a key sector in energy. This impacts the low elasticity of demand in the short run—as the necessity for energy is high, the price change does not impact the demand immediately.[33] He states that the Arab Spring across the Middle East and North Africa has irreversibly transformed the politics of the region, and political volatility has been reflected by oil prices, as the concentration of energy resources in the region generates concerns about vulnerability of energy supplies. Global energy consumption is estimated to grow by 35–40 percent of today's consumption by 2030.[34] Given the high concentration of energy resources in the region, the Middle East will continue to be the hub of emerging issues of energy security.

Climate Predictions for the Middle East

Scientists expect the gravest impact of climate change in the Middle East to be on water vulnerability and security, due to changes in rainfall and flow of major rivers, such as the Nile, Euphrates, Tigris, and Jordan.[35] The rise in sea level affects aquifers in coastal areas, such as Gaza and the West Bank, and increases the risk of conflict in unstable areas that are unable to "respond, adapt, and recover."[36] These "hydrological shocks" can further destabilize the water-stressed region, where water policies are considered to be sensitive national information.[37] Based on different levels of climate change, the focus should be on

30. Daniel Yergin, *The Quest: Energy, Security, and the Remaking of the Modern World* (New York: Penguin Press, 2011).
31. Ibid.
32. Ibid.
33. Ibid.
34. Ibid., 714–15.
35. Jon Martin Trondalen, *Changes, Water Security and Possible Remedies for the Middle East*, UN World Water Assessment Program Scientific Paper (Paris: UNESCO, 2009), http://unesdoc.unesco.org/images/0018/001818/181886e.pdf.
36. Ibid.
37. Ibid.

Table 1. Multimodel Ensemble Mean Change in Annual Temperature and Precipitation in the Middle East

	Temperature (K)		*Precipitation (mm)*	
	2050–2005	*2095–2005*	*2050–2005*	*2095–2005*
Mean Change	1.41	3.95	–8.42	–25.45
SD	0.32	0.73	16.08	28.66

Source: Jason P. Evans, "21st Century Climate Change in the Middle East," *Climatic Change* 92 (2009): 417–32, http://web.science.unsw.edu.au/~jasone/publications/evans2009.pdf.
Note: K = Kelvin, mm = millimeters, SD = standard deviation.

the underlying social, economic, and political factors that would create political tensions between nations.

The starting point for each scenario involves a plausible assumption about the global average temperature change over a period of several decades in the future, from which climate scientists calculate environmental impacts. These impacts include melting of polar ice sheets and global rise in sea levels, flooding, changes in agriculture, scarcity of water and food, large-scale migrations, spread of disease, and severe storms. The type and severity of impact depends on the size of the temperature change.

To begin, climate scientists must predict the most probable temperature change by using computer-based mathematical modeling of the expected carbon loading of the earth's atmosphere from industrial activities. Based on the IPCC Fourth Assessment Report's 18 global climate models, overall temperatures will increase approximately 1.4 Kelvin mid-century (2045–2054) and approximately 4 Kelvin late century (2090–2099).[38] The other scenarios have larger temperature changes in the range of about 2–5°C or greater.

Rising temperatures can cause rising tensions. The climate becomes less predictable, and less rainfall impacts water management and agriculture. The shrinking of the Euphrates and Jordan Rivers causes water scarcity. Food insecurity and scarcity of resources due to reduced yields in agriculture impact erratic economic growth in the Levant, where social instability and poverty are followed by high unemployment, crime, and social breakdown. Destruction of social order and infrastructure pave the way to further militarization.[39]

Oli Brown and Alex Crawford of the International Institute for Sustainable Development argue that there will be a global rise in sea levels of 0.1 to 0.3 meters by 2050.[40] The

38. Jason P. Evans, "21st century climate change in the Middle East."
39. Ibid.
40. Oli Brown and Alex Crawford, *Rising Temperatures, Rising Tensions: Climate Change and the Risk of Violent Conflict in the Middle East* (Winnipeg, Manitoba: International Institute for Sustainable Development, 2009), www.iisd.org/publications/pub.aspx?pno=1130.

distribution of rainfall becomes unpredictable and, due to reduced flow of the rivers, groundwater aquifers will not recharge at natural rates.[41] The demand for water skyrockets, and increased saltwater intrusion starts to impact the coastal aquifers such as the Gazan coastal aquifer that provides drinking water to Palestinians.[42]

Water scarcity leads to state action for large-scale desalinization, international transfers of water, and reliance on groundwater and manufactured water.[43] Transborder water disputes between Turkey and Syria and Israel and Jordan intensify. Governments unwilling to work with each other will pursue national-level, expensive water projects.

In order to address regional concerns, the role of institutions in management of security problems arising from ecosystem failure should be determined.[44] Industries should mitigate controllable effects and execute a plan to prevent destabilizing effects that could potentially lead to global instability. Militaries should enhance operational capability by acquiring innovative technologies that reduce fuel demand.[45] A solution to be considered could be investing in thorium reactors that could be used to desalinate water.

Conclusion

Drastic changes in climate, such as changes in precipitation and a rise in temperatures, will make the Middle East prone to water scarcity, civil conflict, and transborder aggression. The short-term impacts of these changes have already started to shape the energy policies of countries in the region such as Egypt and Jordan by causing them to consider nuclear power to meet increasing energy demands and address energy dependency. States should enhance international cooperation on detection and monitoring of security threats related to climate change, especially on prevention, preparedness, mitigation, and response capacities.[46] Regional security scenarios at different levels of climate change should be created. State leaders should commit to global partnerships to help vulnerable countries build resilient capacity. Vulnerability-based research should engage local stakeholders. Adaptive capacity building should be integrated into development assistance.[47] Governments should fully integrate the security consequences of climate change into national security strategies and enhance managerial control of nuclear energy production.

41. Ibid.
42. Ibid.
43. Ibid.
44. Jon Barnett and W. Neil Adger, "Climate Change, Human Security, and Violent Conflict," *Political Geography*, 26 (2007): 639–55.
45. CAN Corporation, *National Security and the Threat of Climate Change* (Alexandria, VA: CNA Corporation, 2007), www.cna.org/sites/default/files/news/FlipBooks/Climate%20Change%20web/flipviewerxpress.html.
46. High Representative and the European Commission to the European Council, "Climate Change and International Security."
47. Oli Brown and Robert McLeman, "A Recurring Anarchy? The Emergence of Climate Change as a Threat to International Peace and Security," *Conflict, Security & Development* 9, no. 3 (October 2009), www.iisd.org/pdf/2009/recurring_anarchy_climate.pdf.

Russian Strategic Nuclear Modernization (1991–2013): Capabilities and Motivations

Jana Honkova[1]

> We should not tempt anyone by allowing ourselves to be weak. We will, under no circumstances, surrender our strategic deterrent capability. Indeed, we will strengthen it.
>
> —Vladimir Putin, "Being Strong. Why Russia Needs to Rebuild Its Military," Foreign Policy, February 21, 2012.

Since its formation, the Russian Federation has been continuously modernizing its strategic nuclear forces. This paper attempts to answer the question of Russia's motivation to do so. First, it describes Russia's modernization of ground-launched intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), strategic ballistic missile submarines (SSBNs), strategic aircraft, and long-range air-launched cruise missiles (ALCMs) from December 1991 to June 2013. After summarizing the main trends within Russia's strategic nuclear modernization, the first part of the paper identifies three periods of this process, observing that in the current period (2009–2013) Russia for the first time since the end of the Cold War is simultaneously modernizing all three legs of its triad. The second part of the paper builds on the developments described in the first part, concluding that the underlying drivers of Russia's strategic nuclear modernization are the country's great-power identity with messianic elements and its militarized strategic culture.

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Introduction

After the collapse of the Soviet Union, nearly a quarter of its ground-based strategic nuclear triad leg and almost half of its bomber fleet fell outside Russian control.[2] In spite of that, the Russian Federation, as the Soviet Union's successor, inherited a large nuclear arsenal. From its formation until today, the Russian Federation has been continuously modernizing its strategic nuclear forces.

This paper attempts to answer the question of Russia's motivation to modernize its strategic nuclear forces. For the purposes of this paper, modernization is understood as the development and deployment of new weapons systems. The findings of this paper rest on open-source research whose results are summarized in the first section, which tracks Russia's strategic nuclear modernization from December 1991 until June 2013. At the end of this section, summaries of trends found within each leg of the Russian nuclear triad as well as an overview of trends permeating all three legs' modernization are included. In the second section, the author summarizes findings of various scholars who dealt with the question of why Russia retained its nuclear arsenal after the Cold War, and suggests an explanation of Russia's modernization based on the study of the country's strategic culture and identity.

Modernization of Russia's ICBM Force: Topol-M, Yars, Rubezh, and Rail-Mobile ICBMs Revival

The intercontinental ballistic missile (ICBM) force has always been considered as the mainstay of both Soviet and Russian nuclear forces.

In December 1997,[3] Russia deployed its first domestically produced ICBM (without any participation of the member countries of the Commonwealth of Independent States or Ukraine, as was common previously), the silo-based RS-12M2 Topol-M.[4] Although initially planned as a multiple independently targetable reentry vehicle (MIRV), the RS-12M2 was finally designed as a single-warhead missile due to the expected arms control limitations of the Strategic Arms Reduction Treaty II[5] (START II).[6] The missile's more survivable counterpart, designated the RS-12M1, followed in December 2006 (a road-mobile version

2. Steven J. Zaloga, *The Kremlin's Nuclear Sword: The Rise and Fall of Russia's Strategic Nuclear Forces, 1945–2000* (Washington, DC: Smithsonian Institution Press, 2002), 215.

3. In 1997, only two Topol-M missiles were deployed in modified SS-19 silos. The deployment of the first silo-based Topol-M regiment followed in 1998. Given that the system was not fully accepted for service until April 2000, the 1997 deployment could be classified as just "for show." Zaloga, *The Kremlin's Nuclear Sword*, 223.

4. "RT-2UTTH-—Topol-M SS-27," *Nuclear Information Project* (Washington, DC: Federation of American Scientists, July 29, 2000), 27, www.fas.org/programs/ssp/nukes/nuclearweapons/russia_nukescurrent/ss27.html.

5. Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms (START II) (Moscow, January 3, 1993), www.fas.org/nuke/control/start2/text/index.html.

6. "Topol-M | RT-2PM2 | 15Zh65 | RS-12M2 | SS-X-27," *Russian Space Web*, www.russianspaceweb.com/topolm.html.

using the Transporter-Erector-Launcher [TEL][7] equipped with a new concealment technology[8]). Russia labeled the RS-12M1/2 "the missile defense penetrator," a nickname that later became associated with almost every new ICBM. The Topol-M earned the label mainly due to the large number of penetration aids that it carries, the missile's special protective coating that defends it from possible laser-gun attacks,[9] and a hypersonic warhead[10] that can reportedly maneuver during the boost and final phase of flight.[11]

After a new legal environment emerged in December 2009,[12] Russia deployed the RS-24 Yars ICBM in January 2010. Although loosely based on the RS-12M1/2, Russian military and defense-industrial representatives insisted that the mobile MIRVed RS-24 was a "genuine new missile."[13] The RS-24, "a hypersonic weapon" allegedly equipped with six warheads,[14] was praised for its penetration capabilities. According to former chief of staff of Russian Strategic Rocket Forces Viktor Yesin, both the RS-24 and the RS-12M1/2 will get through any existing ballistic missile defense system and any system developed in the next two to three decades.[15]

In late 2009, reports revealed Russia's plans for another new ICBM. While the State Armament Program for 2011–20 included the promise of a new heavy ICBM entering service before 2020,[16] it turned out that Russia was actually working on two new ICBMs, one

7. For the details about the launcher, see Gennadiy Miranovich, "On Eight Axles," *Krasnaya Zvezda*, May 4, 2007.

8. "Russian Ballistic Missiles to Cover Tracks," *RIA Novosti*, June 1, 2012, http://en.rian.ru/mlitary_news/20120601/173787154.html.

9. "Russia Improving 'Structure and Composition' of Its Nuclear Missile Force - Commander," *Interfax-AVN*, December 1, 2008.

10. Dmitriy Litovkin, "Shield Fashioned From Topol and Yars. Russia Proceeding With Rearmament of Strategic Nuclear Forces," *Izvestiya*, November 30, 2010.

11. "Russia Works on 100-Ton Monster Ballistic Missile," *Pravda.ru*, December 19, 2011, http://english.pravda.ru/russia/politics/19-12-2011/120016-russia_monster_ballistic_missile-0/; "SS-27."

12. START I prohibited the United States and Russia from increasing the number of warheads on existing missile types. See Nikolai Sokov, "Modernization Of Strategic Nuclear Weapons In Russia: The Emerging New Posture," *Program on New Approaches to Russian Security,* Working Paper no. 6 (Monterey, CA: Monterey Institute for International Studies, May 1998), www.armscontrol.ru/start/publications/ns9812b.htm#modern. Therefore, MIRVing the RS-12M1/2 Topol-M was prohibited by the treaty. Furthermore, although the START II was not yet effective then, according to the 1969 Vienna Convention on the Law of Treaties, Russia was forbidden from undertaking steps contravening the treaty during the period between its signing and its entry into force. Given that START II called for the elimination of the so-called heavy intercontinental ballistic missiles and other multiple-warhead intercontinental ballistic missiles, there were at least two legal obligations that prevented Russia from the RS-24 Yars' (legal) deployment. Eventually, both were removed. In June 2002, just one day after the United States withdrew from the ABM Treaty, Russia declared it would not be bound by the START II any more. The START I expired in December 2009, and no follow-on treaty had been in force, or agreed to as of yet. As a consequence of those events, all Russian commitments with regard to MIRVed ballistic missiles ceased to exist.

13. Charles P. Vick, "RS-24 / SS-29/ Yars-M," *GlobalSecurity.org*, October 10, 2013, www.globalsecurity.org/wmd/world/russia/rs-24.htm.

14. Pavel Podvig, "Parsing the New START Data," *Russian Strategic Nuclear Forces*, April 12, 2012, http://russianforces.org/blog/2012/04/parsing_the_new_start_data.shtml; Hans M. Kristensen and Robert S. Norris, "Russian Nuclear Forces, 2012," *Bulletin of the Atomic Scientists* 68, no. 2 (March 1, 2012): 87–97; Vladimir Temnyy, "New Strategic Missile to Enter Combat Duty in 2011," *Grani.ru*, January 15, 2010.

15. Yuriy Gavrilov and Sergey Ptichkin, "The Missile Can't Be Caught: They Are Reequipping the Strategic Troops with New Complexes," *Rossiyskaya Gazeta*, November 28, 2011.

16. "Russia to Develop New Heavy ICBM by 2020," *RIA Novosti*, December 20, 2010, http://en.ria.ru/russia/20101220/161856876.html.

liquid-fueled and the other solid-fueled. Quite plausibly, the clashes between the *pro*-solid-propellant and the pro-liquid-propellant branches in Moscow[17] that followed the Defense Ministry's December 2009 call for proposals for a new ICBM[18] contributed to Moscow's decision to launch not one but two ICBM projects.

The new liquid-fueled missile was reported to be silo-based with a launch weight of about 100 tons and to have the same dimensions as R-36 Voyevoda (SS-18 Satan) overall.[19] It is expected to be ready by 2022,[20] which seems credible given that according to the defense industry, it will take a decade to develop a new liquid-propellant silo-based ICBM. "If the country has not done it for 30 years, then difficulties are inevitable," the deputy head of the NPO Mashinostroyeniya, Andrei Goryaev, said.[21] Interestingly, in December 2012, the commander of Strategic Missile Troops (*Raketnye voyska strategicheskogo naznacheniya*, RVSN), Col. Gen. Sergei Karakayev, suggested that Russia might develop a conventional warhead for the new ICBM and thus create "a strategic high-accuracy weapons system" with practically global reach "if the United States does not pull back from its program for creating such missile systems."[22]

Rumors about a new solid-propellant ICBM began to spread after an unsuccessful ICBM test launch on September 27, 2011.[23] Three successful tests followed, with the last one conducted on June 6, 2013. Recent observations[24] disprove initial speculations about the new missile being a small one and launched from a mobile platform,[25] and rather tend to support Mark Schneider's assessment from 2011 that the missile's payload will be 10–15 warheads.[26] After the June test, Col. Gen. Vladimir Zarudnitsky, the chief of the General Staff's Main Operations Department, disclosed that the new missile is MIRVed and named Rubezh. Zarudnitsky said that Russia is currently creating the infrastructure for the new Rubezh ICBM and training personnel; Rubezh will be put on combat duty before the end of 2013, while the first regiment will be deployed in

17. These are represented within the defense industry by the Moscow Institute of Thermal Technology (MITT) and NPO Mashinostroyeniya, together with the Makeyev State Rocketry Center. See Pavel Podvig, "Closure of Kozelsk Base and the Future of UR-100NUTTH/SS-19," *Russian Strategic Nuclear Forces*, September 8, 2007, http://russianforces.org/blog/2007/09/closure_of_kozelsk_base_and_th.shtml.

18. Pavel Podvig, "Russia to Spend $70 Billion on Strategic Forces by 2020," *Russian Strategic Nuclear Forces*, February 24, 2011, http://russianforces.org/blog/2011/02/russia_to_spend_70_billion_on.shtml.

19. Aleksey Nikolskiy, "Avangard Enigma," *Vedomosti*, September 29, 2011; "Russia to Build 100-ton ICBM to Penetrate US Missile Defenses," *RIA Novosti*, December 16, 2011, http://en.ria.ru/mlitary_news/20111216/170301667.html.

20. "Russia to Adopt New Liquid Heavy ICBM after 2022—Expert," *RIA Novosti*, May 8, 2012, http://en.ria.ru/mlitary_news/20120508/173310124.html.

21. Ibid.

22. "Russia to Develop Precision Conventional ICBM Option," *RIA Novosti*, December 14, 2012, http://en.rian.ru/military_news/20121214/178154441.html.

23. "Russia Test Fires AMD-piercing Strategic Missile," *TV-Novosti: Channel RT TV*, May 23, 2012, http://rt.com/news/new-strategic-missile-test-970/.

24. Pavel Podvig, "Russia Continues Tests of New ICBM, Named Rubezh," *Russian Strategic Nuclear Forces*, June 6, 2013, http://russianforces.org/blog/2013/06/russia_continues_tests_of_new.shtml?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+russianforces+%28RussianForces.org+Blog%29.

25. Nikolskiy, "Avangard Enigma."

26. Mark Schneider, "New START's Dangerous Legacy," *Defense Dossier*, no. 1 (Washington, DC: American Foreign Policy Council, December 2011), 6, www.afpc.org/files/december2011.pdf.

2014.[27] That is a year before the originally announced deployment date of 2015[28] and much sooner than the expected deployment of the Rubezh's liquid-fueled peer, whose development started earlier.

Many reports advertise the "new" solid propellant used by the Rubezh ICBM.[29] However, the propellant's producer, the Soyuz Federal Dual-Technology Center, refused to call it a breakthrough. The much better characteristics of this fuel as compared to the composite fuel used in RS-12M1/2 and RS-24 were said to be a consequence of improved quality of the substances used, rather than a significant change in the fuel's composition.[30] Nevertheless, Russia said that the "new" propellant will shorten the missile's boost phase, and will allow it to carry between 10 and 15 warheads. So far, the only missile capable of carrying as many reentry vehicles has been the Soviet/Russian liquid-propellant R-36 Voyevoda.[31]

In addition to the new above-mentioned ICBMs, Russia started a research and development (R&D) program to develop a new rail-mobile ICBM "to counter global threats."[32] While in April 2013 Deputy Defense Minister Yury Borisov did not provide the time frame for the rail-mobile missile's deployment and said that its total cost had yet to be determined by the Defense Ministry, Russia's Defense Ministry stated in December 2012 that a prototype could be deployed by 2020. The Defense Ministry also disclosed that the new ICBM will be about half the weight of the previous Russian/Soviet rail-mobile missiles and will fit into a railcar.[33]

Modernization of Russia's SLBM Force: Sineva, Bulava, and Layner

The first submarine-launched ballistic missile (SLBM) that Russia introduced was a modernized version of the Soviet R-29RM (SS-N-23 Skiff) designated RSM-54 (SS-N-23 M1 Sineva). The RSM-54 is a MIRVed (4 to 10 reentry vehicles depending on the respective modification[34]) SLBM that set a world range record for its class when it flew 11,547 km

27. "Deployment of First Rubezh Strategic Missile Regiment to Begin in 2014—Gen. Staff," *Russia & CIS Military Newswire*, June 7, 2013.

28. Pavel Podvig, "Deployment of New Solid-propellant ICBM Expected in 2015," *Russian Strategic Nuclear Forces*, November 1, 2012, http://russianforces.org/blog/2012/11/deployment_of_new_solid-propel.shtml.

29. See, for example: "Russia Tests New Missile with Previously Unachievable Performance," *Pravda.ru*, May 24, 2012, http://english.pravda.ru/russia/politics/24-05-2012/121218-russia_missile_tests-0/.

30. Denis Telmanov, "New Unnamed Missile Will Replace Yars and Ground-Launched Topol-M: Russia Tested a Ballistic Missile With New Propellant," *Izvestiya*, May 23, 2012.

31. "Russia Tests New Missile with Previously Unachievable Performance," *Pravda.ru*, May 24, 2012.

32. "Russia to Develop New Rail-Mobile ICBM System," *Progressive Media—Company News*, April 25, 2013.

33. "Russia Launches Rail-Mobile ICBM Project," *RIA Novosti*, April 23, 2013, http://en.rian.ru/military_news/20130423/180797933/Russia-Launches-Rail-Mobile-ICBM-Project.html.

34. "The RSM-54 Sineva Submarine-Launched Ballistic Missile (SLBM)," *RIA Novosti*, March 10, 2010, http://en.rian.ru/infographics/20100310/158148536.html. See various information about the number of warheads in Robert S. Norris and Hans M. Kristensen, "Russian Nuclear Forces, 2008," *Bulletin of the Atomic Scientists* 64, no. 2 (2008): 54–57; David C. Isby, "Sineva SLBM Enters Service," *Jane's Defence Weekly*, August 29, 2007; and "US Media Reports on Secret Russian Nuclear Tests Denied," *Izvestiya*, June 19, 2001.

during the Stabilnost exercises in 2008.[35] The RSM-54 was originally scheduled to enter service in 2002 but was not deployed until July 2007.[36]

Russia restarted the production of Skiff/Sineva in November 1999, three years after it was halted.[37] Several factors influenced the 1999 decision: first, largely due to financial constraints, Russia stopped work on an upgraded version of the R-29RM SLBM known as Variant/Sineva in the early 1990s in favor of the continuing development of the R-39 Bark program. Russia chose to do so even after the R-39's production cost increased because of the need to move the production from Ukraine to the Russian Federation after the USSR's dissolution. Likely, the decisive reason was that the R-39M Bark was supposed to equip not only the Typhoon (Project 941) submarines, but also the first submarine of the new Borey class, Yuri Dolgorukiy. Nonetheless, the R-39 Bark program ended when the Security Council of the Russian Federation decided to stop it after four[38] unsuccessful test launches held between 1996 and 1997. The cancellation of the R-39 Bark program, at a stage where the missile was said to be "nearly ready,"[39] set back Russia's strategic naval modernization by a decade.[40] Furthermore, it had serious consequences for the number of Russia's SLBMs in operation. Without the new R-39 missiles, there were no successors to the old R-39s that had already reached the end of their service lives. The anticipated decommission of some of the Typhoons and the suspension of Yuri Dolgorukiy (as a consequence of the R-39's cancellation) made the six Delta IV (Project 667BDRM) submarines the backbone of Russia's strategic fleet. In order to keep the number of SLBMs at acceptable levels, Russia decided to equip the Delta IVs with modernized versions of the R-29RM; it restarted the Sineva (Variant) project, which had been canceled in the early 1990s.[41]

Second, the Russian navy reportedly preferred solid-propellant missiles[42] (the halted R-39 was a liquid-fueled missile). Third, in May 1997, Igor Sergeyev, former commander in chief of the Strategic Rocket Forces, was appointed as defense

35. Dmitriy Litovkin, "Shield Fashioned From Topol and Yars. Russia Proceeding With Rearmament of Strategic Nuclear Forces," *Izvestiya*, November 30, 2010; Nikolay Poroskov, "Rhymes With Bulava: President Announced Successful Launches of In-Service Strategic Missile," *Vremya Novostey*, July 15, 2009.

36. "Tests of Strategic Missile Sineva Successful—Russian Defense Ministry (Part 2)," *Interfax-AVN*, May 20, 2011; "R-29RMU / RSM-54 Sineva / SS-N-23 SKIFF," *Globalsecurity.org*, www.globalsecurity.org/wmd/world/russia/r29rmu.htm.

37. David Hoffman, "New Life for 'Star Wars' Response; Russians Could Revive Soviet Strategy If U.S. Decides to Deploy Missile Defense," *Washington Post*, November 22, 1999; "Current Status and Future of Russian Strategic Forces," *Center for Arms Control, Energy and Environmental Studies, MIPT*, September 10, 2002, http://armscontrol.ru/start/rsf_now.htm.

38. Some sources refer to only three, not four trials. See Howard Gethin, "Russian Fleet to Get Adapted Topol-M," *Flight International*, September 23, 1998, www.flightglobal.com/pdfarchive/view/1998/1998%20-%202636.html; versus Pavel Podvig, "Status of Russia's SLBM Programs," *Russian Strategic Nuclear Forces*, January 7, 2005, http://russianforces.org/blog/2005/01/status_of_russias_slbm_program.shtml.

39. "TV Programme Charts History of Development of Russian Sea-Based Missiles," *BBC Monitoring Former Soviet Union*, January 25, 2008.

40. Zaloga, *The Kremlin's Nuclear Sword*, 224.

41. Podvig, "Status of Russia's SLBM Programs"; "Current Status and Future of Russian Strategic Forces."

42. Podvig, "Status of Russia's SLBM Programs."

minister.[43] Sergeyev, who believed the strategic nuclear forces were indispensable for Russia's great power status, made their modernization a priority within the Defense Ministry.[44] However much of a blessing this might have been for the modernization of Russian nuclear forces as a whole, for the R-39 program it meant the opposite. Sergeyev chose to support the project of a naval modification of Topol-M (later known as the RSM-56 Bulava) instead of the failing R-39 Bark. Some sources also mention the close relationship between Sergeyev and Yuri Solomonov, the director of the Moscow Institute of Thermal Technology (MITT), as a possible intervening variable.[45] (It was Solomonov's design bureau that proposed and later conducted the modification of Topol-M into its naval variant, the RSM-56 Bulava.[46])

Around 1998, Russia decided to build a new SLBM designated the RSM-56 (NATO classification: SS-NX-30). Known as Bulava, and likely armed with six individually maneuverable warheads,[47] the RSM-56 was said to constitute the core of Russia's naval deterrent forces.[48] At the same time, it has been referred to as "the apotheosis of the military-industrial complex's crisis"[49] and the costliest military project in Russia (approximately 1 billion rubles at $31.7 million per missile[50]).[51] During six years of testing, from 2005 until 2011, 18 Bulava launches were carried out: 10 successful, 6 unsuccessful, and 2 were considered to be a partial success.[52] Reportedly, the failures were caused by the lack of control over the execution of particular operations, which used to be conducted by military acceptance offices. Since October 2010, there have been seven

43. See the comment by Pavel Felgenhauer following Sergeyev's appointment. It is an excellent example of army-related considerations present in Russia at that time (recall the ongoing budgetary crisis). Pavel Felgenhauer, "Kicking Brass to Save Army," *Moscow Times*, May 29, 1997.

44. "RANSAC Nuclear News, October 4, 2000," *Partnership For Global Security*, www.partnershipforglobalsecurity.org/projects%20and%20publications/news/nuclear%20news/2000/10_04_00.html.

45. Norman Friedman, *The Naval Institute Guide to World Naval Weapon Systems* (Annapolis, MD: Naval Institute Press, 2006), 506; Nikolai Sokov, "Nuclear Weapons in Russian National Security Strategy," 2010, 26, www.ndu.edu/inss/symposia/2010%20Russia%20Security%20Workshop/OSD_Russia_Sokov.pdf.

46. Andrew Feickert, *Missile Survey: Ballistic and Cruise Missiles of Selected Foreign Countries* (Washington, DC: Congressional Research Service, July 26, 2005), 8, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA454552; "Putin Puts Confidence in New Generation of Missiles," *Jane's Intelligence Review*, January 7, 2005, http://articles.janes.com/articles/Janes-Intelligence-Review-2005/Putin-puts-confidence-in-new-generation-of-missiles.html.

47. The RSM-56 might be capable of carrying up to 10 150-kiloton-warheads. See Maxim Pyadushkin, "Keep Away," *Defense Technology International* 6, no. 1 (January 2012): 41. However, some sources consider the payload of 10 warheads rather unlikely. For example, the latest report of the *Bulletin of the Atomic Scientists*, a respected publication on nuclear arsenals worldwide, stated that the RSM-56 Bulava is able to carry up to six 100-kiloton-warheads; Hans M. Kristensen and Robert S. Norris, "Russian Nuclear Forces, 2013," *Bulletin of the Atomic Scientists* 69, no. 3 (June 2013): 72.

48. See, for example: "Bulava Missile Could Be Modified for Ground Launches—Designer," *RIA Novosti*, December 8, 2010.

49. "The State of the Russian Military-Industrial Complex Has Become Critical: It Is Easier to Buy Weapons Abroad," *Zagolovki.Ru*, January 11, 2010.

50. "Russia Runs Out of Bulava Strategic Missiles Left for Test Launches," *Interfax-AVN*, August 10, 2012.

51. Norman Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, 506; "Russia Successfully Tests Bulava Ballistic Missile," *Associated Press*, October 28, 2011, http://cnsnews.com/news/article/russia-successfully-tests-bulava-ballistic-missile.

52. "Russia Runs Out of Bulava Strategic Missiles Left for Test Launches."

successful consecutive launches, a likely result of increased control over the production process. Initially, reports indicated some errors in the missile's design, yet these accusations were rebutted by the VPK (*Voenno-promyshlennaia komissiia*, or Military-Industrial Commission[53]).[54]

Some of the history behind the decision to produce the RSM-56 and to award the contract to MITT despite the lack of experience with SLBM construction is mentioned above. Before Bulava, the MITT designed only ground-based ICBMs. The Russian Defense Ministry liked the idea of standardized missiles, especially because of the assumed decreased production costs. However, "when 'Topol' specialists learned that a submarine-launched missile had to launch while the nuclear submarine is moving, they grabbed their heads."[55] It turned out that the technical differences between a ground-based missile and an SLBM were quite important. The Bulava missile shares about 70 percent of the Topol-M's design, and its cost proved the argument of a cheap standardized missile invalid.[56]

Russia's quest to cut expenses supposedly led to other mistakes as well. During the testing phase of the RSM-56, the usual preliminary trials (the so-called "pop-up tests") fell out. Thus, several phases of testing were skipped.[57] Instead of economizing the process, this decision likely resulted in the prolonged testing period of the missile system. Besides increased costs, Bulava's failures caused the MITT General Director Yuri Solomonov to resign; still, Solomonov retained his position as the MITT chief designer of ballistic missiles.[58]

The RSM-56 completed its sea trials in December 2011. In January 2012, then defense minister Anatoly Serdyukov said that Russia had ordered mass production of the RSM-56,[59] but according to First Deputy Defense Minister Aleksandr Sukhorukov's statement made in June 2012, the legal documents regarding Bulava's entering into service had not been

53. In 2006 the VPK, which was created during the Cold War, transformed into the Military-Industrial Commission of the Russian Federation. Its task is to ensure coordination between the defense industry, the Defense Ministry of the Russian Federation, and the Armed Forces of the Russian Federation. See "Military-Industrial Commission of the Russian Government," *Agentura.ru*, www.agentura.ru/english/dossier/komissia/; and "Military Industrial Commission," *Russian and Soviet Nuclear Forces*, www.fas.org/nuke/guide/russia/agency/vpk.htm.

54. "Heavy ICBM, New Warhead, Bulava—Russian Missile Designer Solomonov's Interview," *Interfax-AVN*, January 27, 2011; Dmitry Gorenburg, "A New Push for Nuclear Submarine Development," *Russian Military Reform*, March 6, 2012, https://russiamil.wordpress.com/2012/03/06/a-new-push-for-nuclear-submarine-development/; Dmitry Gorenburg, "The Modernization of Russia's Nuclear Submarine Forces," *Russian Military Reform*, April 25, 2013, http://russiamil.wordpress.com/2013/04/25/the-modernization-of-russias-nuclear-submarine-forces/.

55. Oleg Veniaminovich Burtsev, "Chernavin on Bulava Design and Testing Problems," *Russian Defense Policy*, July 18, 2010, https://russiandefpolicy.wordpress.com/2010/07/18/chernavin-on-bulava-design-and-testing-problems/.

56. Norman Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, 506.

57. Burtsev, "Chernavin on Bulava Design and Testing Problems."

58. "Russian Bulava Missile Designer Quits after Failed Tests," *RIA Novosti*, July 22, 2009, http://en.rian.ru/mlitary_news/20090722/155584015.html; "Russian Website Says New Strategic Missile to Enter Combat Duty in 2011," *Grani.ru*, January 15, 2010.

59. "Bulava Enters Hasty Production," *StrategyPage.com*, January 30, 2012, www.strategypage.com/htmw/hticbm/articles/20120130.aspx.

signed yet. Interestingly, in September 2012, Rudolf Kuzin, the chief engineer of the joint-stock company Votkinsk Plant, revealed that "it is not the first year we have produced Bulava serially, we have been producing this product for three years, even four."[60]

Although serially produced, the Bulava SLBM remains nondeployed. The last test was scheduled for October 2012 but moved to July 2013 due to continuing troubles with automated control systems for the launch mechanism.[61] The first Borey class submarine that started deployment in January 2013, which was supposed to be armed with the RSM-54 Bulava, was therefore launched with empty missile containers.[62]

The latest development in Russia's strategic naval modernization is the Layner/Liner MIRVed SLBM. Although many reports suggested that the Layner was a new missile, in November 2012 a source from the General Staff of Russia's Armed Forces said the Layner "is in fact a Sineva. Only the warhead is new. Novelty lies in greater missile defense penetration capabilities, achieved owing to, among other things, a greater number of re-entry vehicles in the warhead."[63] The Layner's defense-industrial designation (R-29RMU2.1) also suggests close resemblance to the RSM-54 (the R-29RMU).[64] In the fall 2011, a Makeyev State Rocketry Center's report about the Layner leaked. According to the report, which for unknown reasons was later removed from the design bureau's website, the Layner's payload exceeds the RSM-56's by a factor of 1.5–2.0, which means that it should be able to carry up to 12 warheads.[65] The report also stated that the Layner could be deployed with a mix of warheads with various yields, namely, it could carry "up to ten low-yield warheads with missile defense penetration aids, or eight low-yield warheads with additional penetration aids, or four medium-yield warheads with penetration aids."[66] This information was later published in *Natsionalnaya Oborona* as well.[67]

Reportedly, Russia started working on the Layner missile in 2007 and the design documentation was ready in 2010.[68] The missile has only been tested twice, in May and September of 2011. Commander in Chief Vladimir Vysotskiy said that this because "it doesn't need to go through the process of being accepted for operational service because it is an existing missile that is undergoing modernization while in service."[69] In February 2012, the director of the Makeyev State Rocketry Center said the Layner's design documentation was

60. "Russia's Bulava ICBM 'Serially' Produced for Years—Official," *RIA Novosti*, September 27, 2012.
61. Gorenburg, "The Modernization of Russia's Nuclear Submarine Forces."
62. Ibid.
63. "No New Missile for Russian Strategic Missile Troops," *Interfax-AVN*, November 21, 2012.
64. Pavel Podvig, "Liner SLBM Explained," *Russian Strategic Nuclear Forces*, October 4, 2011, http://russianforces.org/blog/2011/10/liner_slbm_explained.shtml; Vladimir Degtyar, "Missiles of the State Missile Center Named after Makeev for Defense of the Country and Conquering of Outer Space," *Natsionalnaya Oborona* no. 12 (2012): 44–46.
65. "Russian Defense Minister Reports Successful Launch of New Ballistic Missile (adds)," *ITAR-TASS*, September 29, 2011, www.itar-tass.com/en/c32/236647.html.
66. Podvig, "Liner SLBM Explained."
67. Degtyar, "Missiles of the State Missile Center Named after Makeev for Defense of the Country and Conquering of Outer Space."
68. "Russia's Liner Ballistic Missile Better than Sineva—Source," *Interfax-AVN*, May 25, 2011.
69. "Russian Navy CO on Plans for Submarines, ICBMs and Aircraft Carriers," *RIA Novosti*, February 9, 2012.

complete and that the state commission recommended launching its serial production.[70] So far, there have been no reports about the Layner's deployment.

Given the extraordinarily smooth progress of the liquid-propellant Layner's development and the rather unhappy record of the solid-propellant RSM-56, as well as multiple public statements suggesting Layner's superiority to the overpriced Bulava, the speculations about the Defense Ministry having used Layner to force the MITT to reduce Bulava's cost did not seem completely unfounded. The relationship between the MITT and the Defense Ministry was further cooled by the company's chief designer's statements: Yuri Solomonov repeatedly criticized the Defense Ministry for delayed payments and the disruptive effects this had on the fulfillment of the State Defense Order for 2011 and, thus, Bulava's development as well. This reportedly instigated an intervention by then president Dmitriy Medvedev and then premier Vladimir Putin themselves.[71] Medvedev was reported to have ordered Defense Minister Anatoliy Serdyukov to "get rid of any officials that are responsible"[72] and even recalled the Stalin-era practice of shooting.[73]

Even more likely were the rumors about the pressure exerted by the pro–liquid fuel factions within the Ministry of Defense exercised on MITT.[74] In the Russian defense community the debate about the advantages and disadvantages of solid- vs. liquid-propellant missiles still remains unresolved. Besides the strategic-military positives and negatives of solid versus liquid propulsion,[75] there is also the economic factor to consider. Consequences of ending the missiles' production at one of the "huge city-forming enterprises" were said to be "incomprehensible."[76]

Modernization of Russia's SSBNs: Borey and Borey A

Russia currently operates a fleet of three Delta III (Project-667BDR) and six Delta IV (Project-667BDRM) strategic ballistic missile submarines (SSBNs), each equipped with 16 SLBMs. The Delta III and Delta IV submarines entered service in the late 1970s and mid-1980s respectively. The Delta IIIs are scheduled to be retired in 2019–2025, while the Delta IVs are being overhauled and might remain in service until at least 2030.[77] Besides the Deltas, Russia uses one Typhoon (Project-941) submarine, the TK-208 *Dmitriy Donskoy*, as a test bed for the Bulava

70. "Russia Completes Development Work on SLBM Liner," *Naval Today*, February 27, 2012, http://navaltoday.com/2012/02/27/russia-completes-development-work-on-slbm-liner/.

71. Daniel Vajdic, "Russia's Ballistic Missile Politics," *Center for Defense Studies*, August 11, 2011, www.defensestudies.org/cds/russias-ballistic-missile-politics/; Sergey Smirnov, "Layner Threatens Bulava: In Russia the New Layner Ballistic Missiles Successfully Passed the Tests," *Gazeta.ru*, August 9, 2011.

72. Vajdic, "Russia's Ballistic Missile Politics."

73. Smirnov, "Layner Threatens Bulava."

74. Vajdic, "Russia's Ballistic Missile Politics."

75. Matthew Fargo, "Ballistic Missile Technology 101—Rocket Fuel," *PONI Debates the Issues* blog, August 8, 2012, http://csis.org/blog/ballistic-missile-technology-101-rocket-fuel.

76. Smirnov, "Layner Threatens Bulava."

77. Gorenburg, "The Modernization of Russia's Nuclear Submarine Forces"; "New Submarine Supermissile Can Pierce ABM Shield," *Russia Today*, August 10, 2011, http://rt.com/news/new-nuclear-submarine-missile/.

SLBM. The Typhoons were the largest submarines ever built. The last two of them, the *Severstal* and the *Arkhangelsk*, were said to be withdrawn from the navy by the end of this year and to be scrapped between 2018 and 2020.[78]

In November 1996 after nearly a 10-year break in SSBN construction,[79] Russia laid down the keel of the first next-generation SSBN, designated K-535 and named *Yuri Dolgorukiy*. The new class (Project 955) was named "Borey" after the icy-cold north wind, which causes heavy snowstorms, especially in Russian steppes, and is "difficult to predict and impossible to fight against."[80] Although the plan was to launch *Yuri Dolgorukiy* in five years, the project suffered major delays due to underfunding and the 1998 cancellation of the R-39M Bark, which resulted in the need to redesign the submarine to accommodate a different missile, the RSM-54 Bulava. The submarine was finally launched in April 2004, and after a large number of postponements, its deployment started in January 2013. *Yuri Dolgorukiy* is slotted to become operational in January 2014.[81] It was planned to be armed with 16 Bulava SLBMs, but because the missile was (and is) not ready yet, the submarine's missile containers remain empty.

In March 2004, Russia began construction of the second Borey-class submarine, the K-550 named *Aleksandr Nevskiy*. Although work on *Aleksandr Nevskiy* began eight years later than on *Yuri Dolgorukiy*, *Aleksandr Nevskiy* was launched only three years after its predecessor in December 2010. The last condition of the *Aleksandr Nevskiy*'s acceptance into service was said to be a successful launch of the RSM-56 Bulava missile, which was scheduled for November 2012. It was the only launch of Bulava planned for 2012[82] and the first to be done from *Aleksandr Nevskiy*.[83] Due to problems with the Bulava's software of the automatic control firing system,[84] the November launch was rescheduled for July 2013. Compared to *Yuri Dolgorukiy*, *Aleksandr Nevskiy*'s development proceeds quickly. Since the RSM-54 was meant to arm the submarine from the beginning, there has been no need for redesigning. The shortening of the construction period might also have played a role in Vladimir Putin's statement that completion of a new atomic submarine in Russia should not take more than four or five years.[85]

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78. "Russia to Scrap World's Biggest Nuclear Subs," *RIA Novosti*, May 21, 2013, http://en.rian.ru/military_news/20130521/181272846/Russia-to-Scrap-Worlds-Biggest-Nuclear-Subs.html.

79. Nikolai Sokov, "Modernization of Strategic Nuclear Weapons in Russia: The Emerging New Posture," *Program on New Approaches to Russian Security,* Working Paper no. 6 (Monterey, CA: Monterey Institute for International Studies, May 1998), www.armscontrol.ru/start/publications/ns9812b.htm#modern.

80. "Bad Weather Delays Keel-Laying of New Strategic Missile Submarine," *Rossiyskaya Gazeta*, October 29, 1996; "Project 955 Borei—Nomenclature," *GlobalSecurity.com*, www.globalsecurity.org/wmd/world/russia/935-borei.htm.

81. "Transcript of the Videoconference with Defence Minister Sergei Shoigu Reporting from the Nuclear-powered Missile Cruiser Yury Dolgoruky," *Official Site of the President of Russia*, January 10, 2013, http://eng.kremlin.ru/transcripts/4853.

82. "Russia to Test Bulava ICBM in November, to Commission Latest Sub in September," *RIA Novosti*, August 17, 2012.

83. "Date for Next Bulava Firing Not Set yet Due to Tech Problems (adds)," *ITAR-TASS*, September 21, 2012.

84. Ibid.

85. "Nevsky and Novomoskovsk: Two Submarines for Putin," *RIA Novosti*, December 15, 2010, http://en.rian.ru/analysis/20101215/161784522.html.

Construction on the third Borey-class submarine, named *Vladimir Monomakh,* began in March 2006. It is expected to start trials in the White Sea shortly and enter service in 2014.[86]

Yuri Dolgorukiy, *Aleksandr Nevskiy*, and *Vladimir Monomakh* were each built with 16 launchers for the Bulava SLBM, designed at the Rubin Central Design Bureau for Marine Engineering, and constructed by the biggest shipbuilding complex in Russia, the Northern Machine-Building Production Association (*Severnoye Mashinostroitelnoye Predpriyatie*), which is generally referred to as "Sevmash."[87] The Borey SSBNs were all allegedly underfunded, leading to delays. All three also commanded the presence of senior high-ranking officials, including the Russian premier and/or the president at their keel-laying ceremonies,[88] and all were named after great Russian governors in the middle ages: Yuri Dolgorukiy (1099–1157), the founder of Moscow; Aleksandr Nevskiy (1220–1263), a warrior who is venerated as a saint in today's Russia; and Vladimir Monomakh (1053–1125), the Grand Prince of Kievan Rus'.[89]

After three years of postponements,[90] Russian officials formally inaugurated the construction of the first Borey A (Project 955A, also known as the Project 955 II) class submarine in July 2012, named *Knyaz Vladimir* (although originally the submarine's name was *Svyatitel Nikolay*[91]) to honor the memory of Knyaz Vladimir (960–1015), the Grand Prince of Kiev and ruler of Kievan Rus'[92] and, in President Putin's words, "the unifier and defender of Russian lands."[93] *Knyaz Vladimir* is the fourth Russian submarine to be built. The preparatory work on the hulls for the fifth and sixth SSBNs, named *Alexander Suvorov* and *Mikhail Kutuzov,* were said to have started at Sevmash in 2011.[94] As of the time of this writing, their keel-laying ceremonies [were] planned for July and November 2013.[95] Alexander Suvorov was a Russian general under Catherine II who is believed to have never lost a battle. Mikhail Kutuzov was one of Suvorov's officers during Russia's wars with the

86. "Russia's Third Borey-Class Sub Blessed for Sea Trials," *RIA Novosti*, June 10, 2013, http://en.rian.ru/military_news/20130610/181601631/Russias-Third-Borey-Class-Sub-Blessed-for-Sea-Trials.html.

87. Pavel Podvig, "Strategic Fleet," *Russian Strategic Nuclear Forces*, May 2012, http://russianforces.org/navy/; "Sevmash JSCo," *Setcorp.ru*, August 10, 2013, www.setcorp.ru/exb/index.phtml?ID=1909&language=english.

88. "Bad Weather Delays Keel-Laying of New Strategic Missile Submarine"; Trude Pettersen, "Putin Attends Nuclear Sub Ceremony," *Barents Observer*, July 31, 2012, http://barentsobserver.com/en/security/putin-attends-nuclear-sub-ceremony-31-07; "Russian Defence Minister to Attend Keel Laying of Nuclear Submarine," *Interfax-AVN*, March 13, 2006.

89. "Project 955 Borei," *GlobalSecurity.org*, www.globalsecurity.org/wmd/world/russia/935.htm.; Pettersen, "Putin Attends Nuclear Sub Ceremony."

90. Pavel Podvig, "Construction of First Project 955A Submarine Formally Inaugurated," *Russian Strategic Nuclear Forces*, July 30, 2012, http://russianforces.org/blog/2012/07/construction_of_first_project.shtml.

91. Hans M. Kristensen and Robert S. Norris, "Russian Nuclear Forces, 2012," *Bulletin of the Atomic Scientists* 68, no. 2 (March 2012): 94; Pavel Podvig, "Project 955 Saint Nicholas," August 23, 2009, http://russianforces.org/blog/2009/08/project_955_saint_nicholas.shtml.

92. Pettersen, "Putin Attends Nuclear Sub Ceremony."

93. "Russian Navy to Get 51 Modern Warships & 24 Subs before 2020," *ITAR-TASS*, July 30, 2012, www.itar-tass.com/en/c154/484475.html.

94. "Six Borey-Class Nuclear Ballistic Missile Submarines Under Construction—Source," *RIA Novosti*, June 1, 2012.

95. "Russia to Lay Down Two Improved Borey Class Subs in 2013," *RIA Novosti*, January 14, 2013, http://en.rian.ru/military_news/20130114/178766923.html.

Ottoman Empire and later became an iconic general, praised for his victory over Napoleon in the Patriotic War of 1812.[96]

The Borey A class has the same designer, constructor, and number of launchers as its predecessor; although initially, Borey A was supposed to carry 20 Bulava launchers.[97] According to a source in the defense industry, at least 50 percent of the Borey A SSBNs' systems "will be completely new. Consequently, its technical characteristics and combat capabilities will go up by tens of percentage points."[98]

In total, Russia plans to have eight new submarines in its arsenal by the end of the decade: five Borey As and three Borey SSBNs. Although Russia has reiterated this plan on many occasions, recent media reports about underpriced submarine contracts resulting in additional costs, as well as Putin's call for a speed-up of (delayed) naval deliveries, suggest that the modernization plans might end up following the Russian tradition of postponements.[99] Nevertheless, Andrei Vernigora, director of the Defense Ministry's state defense contracts department, was optimistic and said that there will be "no delays" with the *Alexander Nevsky* and *Vladimir Monomakh*.[100] Regarding funding, in July 2012 President Putin announced that Russia will spend 4.44 trillion rubles ($1.36 billion) on naval technology through the year 2020. Putin added that "one of the absolute priorities is to create balanced naval groups equipped with long-range precision weapons."[101]

Russian modernization plans indicate the state's desire to retain and strengthen its status as a great naval power. This is supported also by the February 2012 promise to renew *continuous* deterrent patrolling of Russia's nuclear SSBNs made by Vladimir Vysotskiy, the commander in chief of the Russian navy.[102] Furthermore, in June 2013, a source at the General Staff of the Armed Forces revealed that from 2014, Russia plans to expand combat patrol zones of its SSBNs to include southern latitudes, for example in areas where Russia has been absent since the USSR's collapse.[103] In order to keep these promises, however, Russia would need to increase the number of patrols significantly. As Hans Kristensen recently reported on the Federation of American Scientists' blog, the number of the Russian navy's deterrent patrols has been declining since 2008, repeating the trend from

96. "Russia to Start Building 2 Nuclear Borei Super-subs in 2013," *Russia Today*, January 12, 2013, http://rt.com/news/borei-nuclear-submarines-2013-852/.

97. "Later Borey Class Subs to Carry Only 16 Missiles—Source," *RIA Novosti*, February 20, 2013, http://en.rian.ru/military_news/20130220/179588098.html.

98. "Russia to Start Building First Project 955A Sub, While Design Work Continues," *ITAR-TASS AVN*, July 25, 2012.

99. "Putin Calls on Shipbuilder to Speed Up Naval Deliveries," *RIA Novosti*, May 21, 2013, http://en.rian.ru/military_news/20130521/181273882/Putin-Calls-on-Shipbuilder-to-Speed-Up-Naval-Deliveries.html; "Russian Nuclear Submarine Contracts 'Underpriced,'" *RIA Novosti*, June 7, 2013, http://en.rian.ru/military_news/20130607/181563795/Russian-Nuclear-Submarine-Contracts-Underpriced.html.

100. "3 Nuclear Subs to Join Russian Navy by Yearend," *Philippines News Agency*, April 23, 2013.

101. Nicholas de Larrinaga, "Russia Celebrates Start of Project 955A SSBN Build Programme," *Jane's Defence Industry*, July 31, 2013.

102. "Russian Strategic Subs to Resume Routine World Patrols," *RIA Novosti*, February 4, 2012, http://en.rian.ru/military_news/20120204/171127327.html.

103. "Upon Receiving Boreys RF's Navy to Resume Strategic Submarines Patrol in Southern Latitudes," *ITAR-TASS*, June 1, 2013, http://pda.itar-tass.com/en/c/756891.html.

1984 until 2002. During 2012, Russia conducted only five deterrent patrols, "barely enough to maintain one missile submarine on patrol at any given time." Kristensen also noted that such a low number of patrols means that "each submarine crew cannot be certain to get out of port even once a year."[104]

Modernization of Russia's Strategic Nuclear-Capable Bombers: Bear-H, Blackjack, and PAK DA

Strategic aviation has always been the weakest part of the Russian/Soviet strategic triad,[105] despite the fact that Russia considers itself to be the cradle of the strategic bomber.[106] In 1984 and 1987, the USSR deployed its last strategic bombers, the Tu-95MS "Bear" and the Tu-160 "Blackjack," respectively. Some of them were lost due to the USSR's dissolution.[107] The Tu-95MS and Tu-160 are reported to have the capability to carry a variety of systems: (1) six long-range air-launched cruise missiles (ALCMs) (Tu-95MS6 "Bear-H6"), (2) up to 16 ALCMs (Tu-95MS16 "Bear-H16"), (3) up to 12 ALCMs (Tu-160), or (4) the Kh-15 (AS-16 "Kickback") short-range attack missiles (Tu-160). Both strategic bombers can carry the nuclear Kh-55 ALCM (AS-15A "Kent") and/or its conventional version designated Kh-555.[108] They can also carry free-fall bombs, although generally, they do not (the Tu-22M3 bomber is the bombs' strategic carrier).[109] The Soviet Tu-95MS and Tu-160, of which Russia is reported to operate 59 or 58[110] and 13 aircraft, respectively have remained the mainstay of Russian nuclear aviation to date.[111] Russia also operates the Tu-22M3, a long-range mid-heavy

104. Hans M. Kristensen, "Russian SSBN Fleet: Modernizing but Not Sailing Much," *FAS Strategic Security Blog*, May 3, 2013, http://blogs.fas.org/security/2013/05/russianssbns/.

105. Marc V. Schanz, "Out of Hibernation," *Air Force Magazine*, February 2002, 58, www.airforce-magazine.com/MagazineArchive/Pages/2012/February%202012/0212Hibernation.aspx.

106. Michael Jasinski and Victor Mizin, "Russian Strategic Aviation: In Search of Mission," *Journal of Slavic Military Studies* 17, no. 2 (April 2004): 215.

107. Russia lost large numbers of modern aircraft that remained outside its newly established borders. Many of the aircraft were scrapped. In regard to strategic aircraft, however, Russia managed to get some of them back. In 1993, 40 Tu-95MS bombers were transferred from Kazakhstan in exchange for Russian fighter aircraft. From Ukraine, Russia acquired 3 Tu-95MS bombers together with 8 Tu-160 bombers and 575 Kh-22 and Kh-55SM long-range air-to-surface cruise missiles. Russia and Ukraine concluded the agreement after long negotiations in 1999. In exchange for the aircraft, Russia cut Ukraine's debt for natural gas by US$285 million. See Aleksandr Pikayev, "Arsenal of the 21st Century: With What Weapons Will Russia Greet the 21st Century? This Is a Vital Question That Is Determining the Fate of the Russian Defense Industry," *Novoye Vremya*, no. 39 (September 1994), www.fas.org/news/russia/1994/tac94023.htm; Stephane Lefebvre, *The Reform of the Russian Airforce* (Shrivenham, UK: Conflict Studies Research Centre, Defence Academy of the United Kingdom, July 2002), 8.

108. Hans M. Kristensen and Robert S. Norris, "Russian Nuclear Forces, 2013," *Bulletin of the Atomic Scientists* 69, no. 3 (June 2013): 72.

109. Dmitry Gorenburg, "Air Force Procurement Plans Part 2: Long Range Bombers," *Russian Military Reform*, August 16, 2011, https://russiamil.wordpress.com/2011/08/16/air-force-procurement-plans-part-2-long-range-bombers/.

110. One Tu-95MS was lost to a fire in early April 2013. It is not clear if the satellite images that Hans Kristensen and Robert Norris used to determine the number of Russian strategic bombers reflect this incident. See Pavel Podvig, "Tu-95MS Bomber Lost to a Fire," *Russian Strategic Nuclear Forces*, April 6, 2013, http://russianforces.org/blog/2013/04/tu-95ms_bomber_lost_to_a_fire.shtml.

111. Kristensen and Norris, "Russian Nuclear Forces, 2013," 72.

supersonic bomber, that is nuclear-capable but is reported to be only conventionally armed.[112]

In contrast to the sea-based and ground-based legs of the triad, no plans for a new strategic aircraft materialized in Russia during the 1990s. Although several design bureaus were working on competing strategic bomber designs (dubbed "Tu-180"), they were never completed. This was due to the low probability of government funding and rumored internal intrigues within the Russian aviation industry, and possibly as a consequence of the departure of Petr Deynekin, the commander in chief of the Air Force, a strong, new heavy-bomber advocate and a friend of the new defense minister, Igor Sergeyev. In September 2000, plans for a replacement of Tu-95MS and Tu-160 were officially suspended by the Russian Defense Ministry because of the absence of available funding.[113]

Therefore, instead of producing new strategic aircraft that would allow withdrawing the already obsolete bombers from service, Russia proceeded with modernization in the sense of upgrading current systems.[114] According to Russia's rearmament plan for the period of 1999–2005,[115] its long-range aviation was to modernize in two phases.[116] The first phase focused on the extension of the bomber service life through 2035. It did not significantly increase the bomber's performance qualities, but it improved reliability and maintainability. The second phase, in contrast, was aimed at upgrading the bombers' combat potential, navigation systems, precision guidance, fire-control accuracy, penetration, and countermeasures.[117] The Russian military establishment agreed on the benefits of precision-strike systems and long-range bombers also carrying out non-nuclear missions.[118] Upgrades in this direction have been time-consuming, particularly because after the Cold War the only heavy bomber fitted for a conventional payload was the long-range bomber Tu-22M.[119]

Russia's strategic nuclear aviation modernization has proceeded gradually (the current reported rate is about five Tu-95MS bombers and two to three Tu-160 bombers annually[120]); not all strategic bombers have gone through both of the above-mentioned phases yet.

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112. Dmitry Gorenburg, "Air Force Procurement Plans Part 2: Long Range Bombers."

113. Nikolai Sokov, "Modernization Of Strategic Nuclear Weapons In Russia: The Emerging New Posture"; Michael Jasinski and Victor Mizin, "Russian Strategic Aviation: In Search of Mission," 225–26.

114. It should be also noted that President Yeltsin announced a unilateral moratorium on Tu-95MS's and Tu-160's production in January 1992. See Boris Yeltsin, "Address to the Nation on Russia's Policy in the Field of Arms Limitation and Reduction," January 29, 1992. English translation available in Brian Alexander and Alistair Millar, *Tactical Nuclear Weapons: Emergent Threats in an Evolving Security Environment* (Dulles, VA: Potomac Books, 2003), 175–81.

115. R. F. Staar, "Funding Russia's Rearmament," *Perspective* 10, no. 1 (October 1999): 1, http://dcommon.bu.edu/xmlui/handle/2144/3568.

116. Michal Fiszer and Jerzy Gruszczynski, "Russian Unveils Bomber-Modernization Program," *Journal of Electronic Defense* 26, no. 2 (February 2003): 29.

117. Ibid., 29–30.

118. Ilya Kramnik, "New Russian Bomber: Needless Expenditure or Future Necessity?" *Voice of Russia*, July 30, 2012, http://english.ruvr.ru/2012_07_30/New-Russian-bomber-needless-expenditure-or-future-necessity/.

119. Michael Jasinski and Victor Mizin, "Russian Strategic Aviation: In Search of Mission," 224.

120. Dmitry Gorenburg, "Air Force Procurement Plans Part 2: Long Range Bombers," *Russian Military Reform*, August 16, 2011, https://russiamil.wordpress.com/2011/08/16/air-force-procurement-plans-part-2-long-range-bombers/.

Further delay might be caused by a belated delivery of the new NK-32 engines, built for the Tu-160. Russia plans to upgrade the current aircraft to the "Tu-160M" version, which should be twice as combat effective as the original Tu-160.[121] However, it seems that the initial plan to begin with reequipment in 2013 will be delayed. [122] The Kuznetsov plant will not be able to present the new NK-32 engines before 2017. The delay was said to be caused by the need to develop the engine from scratch. A representative of the Kuznetsov plant said: "Nearly 100 enterprises produced parts for the engines during the Soviet era. Now, half of them are either located beyond the territory of Russia or no longer exist. Consequently, we must master the skills of producing our own parts and units."[123] The lifespan of the Tu-160 engines should reportedly suffice until 2017.[124] The overall deep modernization of the bombers should be completed by 2020.[125]

The pervasive and persistent lack of funding in the Russian military has slowed modernization and had a profound effect on combat readiness and pilot proficiency. For example, in 2000 only 80 percent of the aircraft were reported to be combat ready.[126] To cut expenses, the military reduced flight times. Consequently, Russian pilots achieved the number of flight hours required for top qualifications at a much later age, sometimes close to retirement.[127] This changed in 2007 when Russia decided to resume regular strategic training flights.[128] After 14 years of being "virtually inactive,"[129] Russian strategic aviation started to conduct flight patrols on a "permanent" and "regular" basis in both transatlantic and Pacific theaters.[130] Not surprisingly, Russia's neighbors have not welcomed this change. Russian bombers and fighter jets are regularly accused of violating other states' sovereign airspace.[131] Besides recent Finnish complaints,[132] it is worth noting that during the last year, Russian strategic bombers flew unusually close to U.S. missile defense sites on three occasions: in June 2012, July 2012, and February 2013 they were intercepted near Alaska, California, and Guam respectively.[133]

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121. "Deep Modernization of Russian Air Forces' Tu-22M3 and Tu-160 Bombers Has Begun," *Union of Aviation Industrialists*, February 9, 2012, http://www.aviationunion.org/news_second.php?new=93.

122. Gorenburg, "Air Force Procurement Plans Part 2: Long Range Bombers."

123. Denis Telmanov, "Tu-160 Modernization Stuck on Engines - New Engines for Russia's Only Supersonic Strategic Bomber Will Come Out After 2016," *Izvestiya*, February 8, 2012.

124. Ibid.

125. "Deep Modernization of Russian Air Forces' Tu-22M3 and Tu-160 Bombers Has Begun."

126. Stephane Lefebvre, *The Reform of the Russian Airforce,* 8.

127. Jasinski and Mizin, "Russian Strategic Aviation," 216.

128. The durability of that change was confirmed by the newly released figures in *Red Star*, the official publication of the Russian defense ministry, according to which Russia's long-range aircraft are flying considerably more than in the previous years. See Vladimir Karnozov, "Russia Develops Requirements for Future Long-Range Bomber," *Air Defense Perspective*, August 24, 2012, www.ainonline.com/aviation-news/ain-defense-perspective/2012-08-24/russia-develops-requirements-future-long-range-bomber.

129. Gorenburg, "Air Force Procurement Plans Part 2: Long Range Bombers."

130. Russia's then president Vladimir Putin quoted from Marc V. Schanz, "Out of Hibernation," *Air Force Magazine*, February 2002, 57, www.airforce-magazine.com/MagazineArchive/Pages/2012/February%202012/0212Hibernation.aspx.

131. Ibid., 59.

132. "Finland Accuses Russia of Airspace Violation," *RIA Novosti*, June 12, 2013, http://en.rian.ru/world/20130612/181627853/Finland-Accuses-Russia-of-Airspace-Violation.html.

133. Bill Gertz, "Bear Bombers Over Guam: Russian Nuclear Bombers Circle Guam," *Washington Free Beacon*, February 15, 2013, http://freebeacon.com/bear-bombers-over-guam/.

In 2009, Russia announced plans to acquire a new strategic bomber during the 2025–30 timeframe.[134] Later it was shortened to 2020, when the new bomber's serial production is supposed to start.[135] The Russian Air Force approved its design in early March 2013.[136]

The new strategic bomber, known as the Advanced Aviation Complex for Long-Range Aviation (PAK DA), is expected to supplement and partially replace Tu-95MS and Tu-160 strategic bombers and Tu-22M3 long-range bombers.[137] It is most likely that work on PAK DA did not start from scratch but is a continuation of the suspended Tu-180 project mentioned above. Reportedly, the new bomber would be based on the Tu-160 but would differ externally. It was also reported to be equipped with entirely new navigation, communications, reconnaissance, and electronic-warfare systems.[138] The PAK DA might also use the so-called plasma technologies: the liquid-propellant jet engine would create a plasma cloud around the bomber's airframe, thus creating a shield that would make the bomber invisible to radars.[139]

Although, it has been reported the new bomber would be flying at a hypersonic speed of about 4,000–5,000 m/s,[140] and Russian Deputy Prime Minister Dmitry Rogozin reiterated this information in February 2013, it is known now that the PAK DA will be a subsonic aircraft. The tender was won by the Tupolev design bureau, and, like the United States, Russia gave preference to stealth capabilities over hypersonic speed.[141]

Unsurprisingly, the PAK DA will be equipped with nuclear-tipped long-range cruise missiles and a number of high-precision conventional weapons.[142]

Although the anticipated qualities of the PAK DA sound impressive, the Russian establishment did not seem fully unified in regard to its development. A clear proponent of the PAK DA has been Vladimir Putin, who proclaimed that Russia needed to proceed with the work on the next-generation strategic bomber in spite of the project's high technological and financial demands; otherwise, Russia might be left behind.[143] Dmitry Rogozin expressed doubts about the need for a new bomber and reminded his colleagues of the advances in

134. "Russia to Commission New Stealth Bomber in 2025–2030," *RIA Novosti*, December 22, 2009, http://en.rian.ru/mlitary_news/20091222/157324925.html.

135. "Russian Air Force Approves New Bomber Design—Commander," *RIA Novosti*, April 11, 2013, http://en.rian.ru/military_news/20130411/180586959.html.

136. "Tupolev Design Bureau to Develop an Advanced Long-range Bomber," *SKRIN Market & Corporate News*, March 7, 2013.

137. Vladimir Karnozov, "Russia Develops Requirements for Future Long-Range Bomber," *Air Defense Perspective*, August 24, 2012, www.ainonline.com/aviation-news/ain-defense-perspective/2012-08-24/russia-develops-requirements-future-long-range-bomber.

138. Yuriy Gavrilov and Sergey Ptichkin, "VVS To Get Unusual Airplanes: Military Aviation Will Get a New Missile Carrier and a Flying Truck," *Rossiyskaya Gazeta*, June 13, 2012.

139. Ibid.

140. Ibid.

141. "Tupolev Design Bureau to Develop an Advanced Long-range Bomber."

142. "Russian Air Force Approves New Bomber Design—Commander."

143. "Putin Says Russia Needs New Strategic Bomber," *Associated Press*, June 14, 2012, www.businessweek.com/ap/2012-06/D9VD11A80.htm; Robert Beckhusen, "Putin Wants New Long-Range Bombers and a Gazillion Drones," *Wired*, June 14, 2012, www.wired.com/dangerroom/2012/06/putin-bombers/.

anti-aircraft and anti-missile defenses. According to Rogozin, "all these planes will never get near their targets."[144] Rogozin's arguments were later rebutted by the First Russian Air Force commander in chief, Petr Deynekin, who pointed out that, among other factors, there is no need for strategic aviation to penetrate defenses. Deynekin explained: "The missiles that are on board modern strategic aircraft are capable of penetrating any air defenses because they fly not in space, but low over ground and have such high intelligence that they can fly under any program and even converse among themselves for an exchange of information."[145] Interestingly, later in August 2012, Rogozin changed his mind. He called for the development of a new hypersonic bomber, arguing that otherwise, Russia would fall behind the United States.[146]

Modernization of Russia's Air-Launched Cruise Missiles: The Kh-555 and the Kh-101/102

In January 1992, President Boris Yeltsin announced a unilateral moratorium on the production of all existing long-range air-launched and sea-launched nuclear cruise missiles (ALCMs and SLCMs).[147] Six years later, Russia even suggested a ban on new types of nuclear ALCMs to the United States. However, this vain proposal was not mirrored in Russia's modernization plans agreed to earlier in 1998. Those contained a new nuclear ALCM as well as a new heavy bomber (recall plans for the Tu-180). Given that any aircraft carrying nuclear ALCMs was counted as a heavy bomber under the START I rules,[148] it seemed unlikely that Russia would have deployed strategic bombers with ALCMs other than the nuclear ones. Vice versa, the banning of new types of ALCMs would have rendered Russia's bomber force with no prospects for upgraded nuclear capability.[149]

At the same time, Russia appeared to have devoted its primary attention to non-nuclear ALCMs development during the 1990s, likely as a consequence of their demonstrated utility during the 1991 Desert Storm operation. According to some reports, Russia first flight-tested its first conventional ALCM in late 1990s after it had been developed for a still undisclosed period of time.[150] Finally in November 2004, the Kh-555 (NATO designation: AS-15C

144. "Russia Developing New Strategic Bomber," *Interfax*, August 10, 2012, http://rbth.ru/articles/2012/08/10/russia_developing_new_strategic_bomber_17218.html.

145. "'The Bomber of the Future Has To Have a Minimum of Two Pilots'; Petr Deynekin, First Russian Air Force Commander in Chief, Has Settled the Dispute of Makarov and Rogozin," *Izvestiya*, July 16, 2012.

146. "Deputy PM Repeats Call For Hypersonic Bomber," *RIA Novosti*, August 27, 2012, http://en.beta.rian.ru/mlitary_news/20120827/175461736.html.

147. President Boris Yeltsin, "Address to the Nation on Russia's Policy in the Field of Arms Limitation and Reduction," January 29, 1992. English translation available in Brian Alexander and Alistair Millar, *Tactical Nuclear Weapons*, 175–81.

148. Treaty Between the United States of America and the Union of Soviet Socialist Republics on Strategic Offensive Reductions (START I) (Moscow, July 31, 1991), www.state.gov/www/global/arms/starthtm/start/start1.html.

149. Nikolai Sokov, *Russian Strategic Modernization: The Past and Future* (Lanham: Rowman & Littlefield, 2000), 143.

150. "Kh-555," *GlobalSecurity.org*, www.globalsecurity.org/military/world/russia/kh-555.htm; "Russia to Test Long-Range Non-nuclear Cruise Missile," *Nezavisimaya Gazeta*, January 12, 2000.

Kent) formally entered service with the Russian Air Force and brought the U.S. monopoly on conventional long-range ALCMs to an end.[151] The design of Russia's first non-nuclear long-range ALCM was based on the Kh-55, so far the only operational nuclear long-range ALCM in Russia's arsenal. The non-nuclear Kh-555 has a homing warhead that allows it to deliver precision strikes from long distances. Its range is 2,500–3,000 km, which is not much less than the range of its nuclear predecessor Kh-55 (3,000–3,500 km).[152] It uses inertial and satellite guidance and was said to be capable of penetrating ballistic missile defense and air defense systems.[153]

In 2013, Russia is expected to deploy two new ALCMs: the conventional Kh-101 and its nuclear-tipped counterpart designated the Kh-102.[154] As with other Russian ALCMs, the details about the Kh-101/102's development and specifications have been veiled in secrecy. Russian officials often do not refer to the yet-to-be-deployed ALCMs by their designations and leave it to the observers to decide to what particular ALCM they have been referring. In August 2012, First Deputy Defense Minister Aleksandr Sukhorukov said that Russia's latest long-range ALCM may enter service in 2013, after two more flight tests slated for the same year.[155] Although he did not mention the missile's designation, a source in Russian Air Force later confirmed various analysts' conclusions that Sukhorukov was referring to Kh-101.[156]

Reportedly, the Russian Raduga design bureau conceived the Kh-101/102 initial design in the late 1980s.[157] The decision to begin production of the non-nuclear Kh-101 was made in the late 1990s,[158] and as early as 1998, reports emerged stating that the Kh-101 was nearing completion[159]; some even indicated its deployment.[160] There has been considerably less information and attention dedicated to the Kh-102, which seems to be indicative of Russia's interest in conventional versus nuclear ALCMs.

The Kh-101's range is reported to be up to 10,000 km, which is twice the distance of its nuclear counterpart, the Kh-102, whose range is reported to be 5,000–5,500 km.[161] This officially unconfirmed information regarding the Kh-101's ultra-long range is supported by the missile's length, which suggests considerably larger fuel capacity compared with

151. "Air-to-Surface Missiles—Stand-Off and Cruise, Russian Federation: Kh-55/RKV-500A, Kh-55SM/RKV-500B, Kh-555 and Kh-65SE (AS-15 'Kent')," *Jane's Air-Launched Weapons*, April 30, 2013.

152. "Kh-555"; "Russia to Test Long-range Non-nuclear Cruise Missile."

153. James Dunnigan, "Russian Mystery Missile," *StrategyPage*, April 12, 2012, www.strategypage.com/dls/articles/Russian-Mystery-Missile-4-12-2012.asp.

154. "Russian Air Force to Get New Cruise Missile in 2013," *RIA Novosti*, September 26, 2012, www.defencetalk.com/russian-air-force-to-get-new-cruise-missile-in-2013-44769/.

155. "Kh-101, Kh-102," *Jane's Air-Launched Weapons*, April 30, 2013.

156. "Russian Air Force to Get New Cruise Missile in 2013."

157. Barrie Douglas, "Nuclear Reaction; Russia Advances New Air-Launched Deterrent as Glimpses of Design Emerge," *Aviation Week & Space Technology*, December 3, 2007.

158. "Russia to Test New Cruise Missiles at End of November," *Nezavisimaya Gazeta*, November 10, 1999.

159. Barrie Douglas, "Russia to Overhaul Nuclear Weapons Arsenal," *Flight International*, July 15, 1998; Mikhail Lukin and Vladimir Savvin, "All Russian Aviation," *Kommersant-Vlast*, August 25, 2008.

160. Thomas Withington, "Decline and Fall," *Flight International*, April 2002; Vladimir Karnozov, "Tu-160 Returns to Skies After Probe," *Flight International*, November 11, 2003.

161. Gorenburg, "Air Force Procurement Plans Part 2: Long Range Bombers."

Kh-55.[162] Its reported accuracy (10 m and about two to three times better circular error probable (CEP) than the Kh-555) denotes it as a high-precision-strike weapon.[163] Its nuclear counterpart, the Kh-102, was reported to have an accuracy of 20 m.[164] Leaked photos of the Kh-101/102 test version suggest that stealth is one of the missile's central characteristics.[165] The Kh-101 missile flies at subsonic speeds[166] and uses the GLONASS satellite navigation system, while also utilizing inertial guidance as a backup.[167]

Trends within Russia's Strategic Nuclear Modernization

TRENDS WITHIN ICBM MODERNIZATION

The ICBM force has always been considered the mainstay of the Soviet/Russian nuclear forces. The course of its modernization from the early 1990s to the present confirms that such a view remains valid even in the third decade following the end of the Cold War.

Despite financial and political complications following the USSR's dissolution, Russia managed to sustain production of new ICBMs de facto without a break. So far, Russia has introduced two new ICBMs (one of them in two basing modes), announced deployment of a new Rubezh ICBM for 2014 and of a silo-based SS-18 Satan's replacement for ~2022, and launched an R&D program for a new rail-mobile ICBM.

Unequivocally, a major trend in Russia's ICBM modernization is maximizing missile penetration capability, for example, the capability to reach the missile's target. All post–Cold War ICBMs, including those currently still in research and development, are reported to have abbreviated boost phase and extensive maneuvering capability to complicate satellite detection, tracking, and interceptor engagement, and to be equipped with a large number of penetration aids. With the exception of the single-warhead Topol-M, Russia has been introducing and working only on MIRVed ICBMs and keeps increasing the number of reentry vehicles they can carry.

The trend toward increased survivability can be identified as well. Russia has been deploying mainly mobile ICBMs and keeps improving the concealment technology of its launchers.

Elements of both the first-strike and a retaliatory force structure can be found. Increased accuracy of the introduced missiles, MIRVing, and lowering of the warheads' yield enhance Russia's war-fighting and counterforce capability. Yet, at the same time, Russia

162. Douglas, "Nuclear Reaction; Russia Advances New Air-Launched Deterrent as Glimpses of Design Emerge."
163. "Russian Air Force to Get New Cruise Missile in 2013."
164. Gorenburg, "Air Force Procurement Plans Part 2: Long Range Bombers."
165. Douglas, "Nuclear Reaction."
166. Withington, "Decline and Fall."
167. "Russian Air Force to Get New Cruise Missile in 2013."

has been working on mobile ICBMs, the primary utility of which is seen as the second strike force. Given Russia's fear of a fifth and sixth deployment phase of the U.S. ballistic missile defense system, Russia's emphasis on penetration capability can be assigned to both the first and the second strike missions.

TRENDS WITHIN STRATEGIC NAVAL MODERNIZATION

Strategic naval forces have typically taken second priority in the Soviet/Russian strategic triad. Russia has been persistently upgrading and working on new designs for both its SLBMs and its SSBNs. The level of intensity and the pace of development have nevertheless been lower than in the ICBMs sector.

During the 1990s, development programs suffered from underfunding that eventually contributed to the cancellation of programs focused on a new SLBM. Although design work and testing on a new SLBM has taken place since the end of the 1980s, the final decision to build an analogue to the ground-based RS-12M1/2 Topol-M instead of a new SLBM based on previous Soviet liquid-fueled models postponed the whole modernization time frame and led to the decision to resume production of an upgraded version of the Soviet R-29RM Skiff. Although the record provided above suggests that the reasons behind the decision to begin work on the RSM-56 Bulava missile were rather nonstrategic (recall the friendship between Solomonov and Defense Minister Sergeyev, and the liquid-versus-solid fuel debate in Russia), the decision to produce the RSM-54 Sineva apparently had a strategic-military rationale, namely, strategic parity with the United States. The perceived necessity to at least approximately maintain the levels of warheads at that time led not only to the resumption of Soviet missile production (although upgraded) but also to the extension of the service lives of Soviet-era strategic submarines.

The trends of Russia's SLBM and ICBM modernization do not substantially differ. Russia has been working on MIRVed missiles with improved accuracy and the ability to maneuver, allegedly at hypersonic speed. Considering the reported improved capability to employ various ballistic missile defense countermeasures (advertised as one of the RSM-54 Sineva's advantages), the emphasis on penetration capability can be clearly seen. The increasing accuracy of the systems, together with more flexible options of employment achieved by the possibility of mounting various mixes of warheads on a missile body (Layner SLBM) and lower yields, suggest a first-strike purpose of the enhanced penetration capability. At the same time, however, it should be noted that sea-launched missiles are generally considered to be retaliatory in nature, given their enhanced survivability due to the technical challenges of detecting SSBNs.

Modernization of Russia's strategic submarines began in 1996, after a 10-year break and, in terms of deployment, proceeded very slowly. On the other hand, starting in 2004, Russia clearly accelerated its efforts in submarine development (four keel-lying ceremonies since then; two more are envisaged for July and November 2013). Russia also attempts to make its strategic naval might more visible through the promises of renewed continuous patrolling in the world oceans, including in southern latitudes.

Last but not least, Russia's strategic naval modernization represents an interesting example of the role and influence of financial considerations, personal relationships, and established practices within Russia's defense industry and the government on strategic systems' development (recall, for example, the instrumental use of the Layner missile testing against MITT, and the involvement of Russia's highest governmental officials in dispute settlement).

TRENDS WITHIN THE MODERNIZATION OF STRATEGIC AVIATION

During the 1990s, modernization of Russia's strategic aviation complex took place on drawing boards of design bureaus rather than in their production facilities. The production of existing types of the heavy bombers was halted as part of the 1992 Presidential Nuclear Initiatives, and the slowdown of new bomber research, development, and production can be partially explained by pure financial and logistical-technical reasons. The overall financial shortage affected Russian strategic aviation even more than the other legs of the triad because, consistent with the Soviet approach, Russia did not consider nuclear-capable bombers to be the highest priority. Logistical and technical obstacles to strategic bomber production and development were a consequence of the breakup of the USSR. Several important production facilities remained outside Russian borders.

New weapon systems were not introduced until 2004 (Kh-555) and later (Kh-101/102, PAK DA), although research had already been conducted in the 1990s. Overall, the strategic bomber force was neglected during the 1990s, especially when compared to the efforts put into the modernization of the other legs of the triad. Although qualitative upgrades of Soviet-era bombers proceeded, the pace has not been particularly impressive and still remains incomplete. The deterioration of Russian pilots' abilities as a consequence of the radically lessened number of flight hours was not reversed until 2007 when regular flight patrols resumed.

In the late 2000s, Russian strategic aviation has seemingly begun its resurrection. A new strategic bomber is now on the way, and a conventional as well as a nuclear-tipped ALCM is expected to enter service in 2013. Prognoses from the 1990s about Russia choosing a dyad are therefore unlikely to materialize, although their economic rationale still applies.[168]

Modernization of both strategic bombers and long-range ALCMs improved in the areas of reliability, accuracy, and reach. There has also been an increased emphasis on conventional missions as the conflicts in the 1990s showed the inadequacy of Cold War bomber forces for new-era contingencies. At the same time, however, due to Russian conventional weakness, the same events have been interpreted as reasons for continuing reliance on nuclear weapons.[169]

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168. Russia's Ministry of Finance usually protests against increases in defense spending. In 2011, after openly disagreeing with the amount of defense expenditures, Finance Minister Alexei Kudrin was asked to resign from his position by then president Dmitriy Medvedev. See "Russia's Rearmament Remains on Schedule—Econ Minister," *RIA Novosti*, July 7, 2012, http://en.rian.ru/mlitary_news/20120702/174362353.html.

169. Sokov, *Russian Strategic Modernization: The Past and Future.*

Through qualitative improvements, which were largely needed due to the obsolescence of the bombers' technology, Russia gained more flexibility for strategic aviation planning and employment. As a result, not only were Russian war-fighting capabilities improved, but also Russian deterrence posture was strengthened. Russian threats to employ its strategic bomber force seemed more credible given that not only the taboo options (nuclear) were on the table. Similarly, enhanced penetration potential bolstered the guarantee of the punishment's delivery in case deterrence failed.

Apart from the possible psychological motivation for retaining the full triad and the argument of flexibility, the quest for high penetration ability itself seems to lie behind the strategic aviation's modernization. The U.S. ballistic missile defense system could be overwhelmed by Russian long-range cruise missiles flying on a low trajectory from relatively long distances.

The argument that Russia needs to maintain parity with the United States can also be used as an explanation for the modernization of strategic aviation that intensified as START I expiration approached. The mainly Russian-driven evolution of arms control counting rules with regard to strategic bombers and their weapons[170] resulted in the option to produce and deploy long-range nuclear cruise missiles without the need to worry about exceeding any limit and without any obligation to provide information about those systems. An absence of a link between Russia's arms control efforts and increased ALCMs and bomber development does not seem very plausible.

Finally, it cannot be discounted that personal ties and preferences caused certain developments (recall Petr Deynekin's possible role in the Tu-180's development).

Modernization of Russia's Strategic Nuclear Arsenal (1991–2013): Summary of Trends

Three phases of Russia's strategic nuclear modernization (1991–2013) can be identified. During the first phase (1991–1998), Russia concentrated its efforts on only one leg of the strategic triad: ground-launched intercontinental ballistic missiles. Although several modernization programs were under way (recall the programs for the RS-12M1/2 Topol-M ICBM, the R-39 Bark SLBM, the R-29RM Sineva/Variant SLBM, the Borey class SSBNs, the Tu-180 bomber, and long-range ALCMs), only one of them (the RS-12M1/2 Topol-M ICBM) led to a successful and timely deployment. It appears that the main reason for the termination of many modernization programs was the lack of available funding together with the personal preferences within Russia's military elite (recall the relationship between Sergeyev and Solomonov, the cancellation of the R-39 Bark program in favor of the RSM-56

170. According to the New START, strategic bombers are counted as only one warhead, regardless of the number of warheads or bombs actually deployed on them. See Article III in Treaty Between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (signed in Prague, U.S. Government Printing Office, April 8, 2010), www.state.gov/documents/organization/140035.pdf.

Bulava development and the relationship between Sergeyev and Petr Deynekin, and the termination of the Tu-180 program). Certainly, the difficulties stemming from Russia's political and economic transition contributed to the slow pace of modernization in this period. The same applies to the intensity of strategic nuclear modernization, which was low, especially in terms of new systems' development and deployment. In regard to new systems' research and initial design work, the intensity was higher and should thus be described as medium.

The second phase of Russia's modernization (1999–2008) marked the transition toward more aggressive modernization of not one but two strategic triad legs. Although the pace slowed down considerably as a consequence of the 1998 financial crisis (recall zero deployments from 1998 to 2004 [the Kh-555], or 2006 [the RS-12M1 Topol-M]), at the end of this period, Russia had already deployed a new SLBM (the RSM-54 Sineva in 2007), begun testing of another new SLBM (the RSM-56 Bulava, first flight-tested in 2005), announced plans for development and early deployment of its third SLBM (the Layner, in 2007), and deployed a new ICBM (the RS-12M1 Topol-M, in 2006). The effort to upgrade the Soviet-era strategic bombers accelerated as well (no plans for a new strategic bomber had been introduced yet). The pace as well as the intensity of the modernization began to increase in the second half of the 2000s. The overall economic recovery and rising oil prices surely allowed for such developments.

The acceleration of Russia's modernization efforts that began in the mid-2000s continued and increased in the third phase (2009–2013). During the period from 2009 to 2013, Russia's strategic modernization, defined here as the development and deployment of new systems, concerned all three triad legs. One new ICBM (the RS-24 Yars) was deployed in 2010, the Rubezh ICBM is expected in 2014, another new ICBM by 2022, and R&D of a new rail-mobile ICBM started. Both the Bulava and the Layner SLBMs appear to be almost ready for deployment, but their actual status remains secret, especially in the Layner's case. The first Borey class SSBN, *Yuri Dolgorukiy*, became operational in January 2013 (although with empty Bulava launchers), *Aleksandr Nevskiy* might be entering service in late 2013, to be followed by *Vladimir Monomakh* in 2014. In the second half of 2013, two keel-laying ceremonies for Borey A submarines were planned. In 2009, Russia announced plans to develop a new strategic bomber expected to be serially produced by 2020. In 2013, the bomber's design was approved. The Kh-101 is likely to enter Russia's arsenal later this year, and it might be followed by its nuclear-tipped counterpart, the Kh-102. In short, during the last four years, Russia's strategic nuclear modernization visibly intensified, and regardless of the global financial crisis, it seems to continue without major delay or change.

These three phases show the dynamic of Russia's strategic nuclear modernization. It has been a continuing activity of the Russian Federation that has gradually intensified in both its pace and scope. Yet, its progression has not followed the lines of the systems' technological age and prowess. Instead of starting with the technologically obsolete strategic bomber force, Russia began its modernization with the relatively current ICBMs. It appears

that modernization was driven by the systems' warranty periods rather than by their technological level. The service life of the latest Soviet ICBM, the RS-12M Topol, was 10 to 15 years, whereas the service life of the bombers was up to 30 years. The service life of the Soviet SSBNs was 25 to 30 years.[171] Nevertheless, to argue that Russia's modernization was driven solely by the systems' aging would be insufficient. The intensity of Russia's modernization efforts clearly exceeded the level of pure maintenance-style modernization.

Measured by Soviet standards, the pace and scope of Russia's strategic modernization in all three phases remains limited. Nevertheless, the fact that Russia is simultaneously modernizing all three legs of its triad bears some resemblance to the Soviet paradigm.

Despite the visible differences in intensity of the new systems' development and deployment, the three phases of Russia's strategic modernization overlap in the main characteristic of the procured and planned weapon systems: enhanced missile defense penetration capability. Major effort has been put into the exploration and integration of stealth capabilities, MIRVing and maneuvering, increased throw-weight of the missiles, shortened boost phase, and hypersonic speed.

Otherwise, modernization trends go in multiple directions. They indicate both the first strike and the second strike posture. Besides the characteristics providing better penetration capability mentioned above, the new systems have improved accuracy, lower yields, strengthened protection against physical disturbances and electromagnetic pulse, and various modes of deployment (silo-based and mobile ICBMs, SLBMs, bombers). Although the strategic-military rationale certainly influences Russia's choices with regard to specifications of its strategic systems, it cannot be stated with certainty that it determines them. Institutional and personal preferences have played an important role, as the previous sections demonstrated. An example is Russia's ICBM modernization program. The current development of two ICBMs, one solid-propellant and the other liquid-propellant, suggests that the battle between the solid-versus-liquid fuel factions within Russia's military-industrial establishment has not ended yet, and if it has, it ended in a draw.

The study of similarities and differences between Russian and Soviet strategic nuclear modernization was not the aim of this paper. However, as far as its results can be used for that purpose, it can be said that recent Russian pursuits resemble the Soviet modernization in the second half of the 1970s and in the 1980s in the scope of modernization (all three legs); the intensity in the sense of simultaneous research, development, and deployment of new systems (although the new stealth bomber is yet to be deployed); the emphasis placed on individual triad legs; and ICBM modernization considered top priority, SLBM modernization second, and the bomber force bearing the least importance. With regard to specifications, Russian and Soviet modernization coincide in the production of missiles with longer ranges, lower yields, better precision (CEP), penetration aids, and MIRVed warheads.[172]

171. Sokov, *Russian Strategic Modernization: The Past and Future*, 126.
172. Compare previous sections with: Zaloga, *The Kremlin's Nuclear Sword*, 235–48.

Drivers of Russia's Strategic Nuclear Modernization

The previous sections demonstrated that Russia's strategic nuclear modernization has been a continuous and gradually accelerating effort since the early 1990s. The obvious question is: *why*? Why has Russia not only maintained but modernized its strategic nuclear forces?

When looking for the reason behind Russia's strategic nuclear modernization, it is useful to begin with the reasons Russia has for the preservation of its nuclear arsenal as such. Scholars[173] usually refer to the continuing reliance or validity of nuclear deterrence and the threat of mutually ensured destruction (especially vis-á-vis the United States); the need for prestige stemming from the mere possession of nuclear weapons that demonstrate the country's scientific and technological prowess as well as its vastly destructive military power; the "nuclear condition" of the respect for Russia's national interests; the symbolic value of a nuclear arsenal that is (supposed to be) a source of pride for the Russian nation and thus a contributor to the country's internal unity and, as a consequence, stability; the military value of nuclear strikes in cases where conventional capabilities might not be sufficient; and the desire for prestige coming from nuclear arms control, especially if conducted on a bilateral level with the world's only superpower.[174] Several other more or less researched and acknowledged motivations could be identified, such as the need to keep the nuclear defense industry alive for economic (including employment) reasons; the desire to prevent the exodus or deterioration of domestic nuclear expertise; organizational and bureaucratic pressures reinforcing the status quo conditions; and the influence of personal interests, ties, and corruption on governmental decisions.

If interpreted in a suitable manner, all the above-mentioned reasons can be identified as motivations for Russia's strategic nuclear modernization. However, the author argues that the real motivation, "the driver" of Russia's modernization pursuits, is not the result of the interpretation but the kind of interpretation itself. In other words, to understand Russia's modernization, we need to comprehend the lens through which Russia views the world and itself. This is possible through the study of Russia's strategic culture and identity.[175]

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173. See and compare different chapters in Stephen J. Blank, ed., *Russian Nuclear Weapons: Past, Present, and Future* (Carlisle, PA: Strategic Studies Institute, 2011).

174. Olga Oliker et al., *Russian Foreign Policy: Sources and Implications* (Washington, DC: Rand Corporation, 2009), 170.

175. The term "strategic culture" was first coined by Jack L. Snyder in his 1977 RAND Corporation study on the implications of Soviet strategic culture for the U.S. strategy of limited nuclear operations. Snyder defined strategic culture as "the sum total of ideas, conditioned emotional responses, and patterns of habitual behavior that members of a national strategic community have acquired through instruction or imitation and share with each other with regard to nuclear strategy." See Jack L. Snyder, *The Soviet Strategic Culture: Implications for Limited Nuclear Operations* (Santa Monica, CA: RAND Corporation, 1977), 8, www.rand.org/pubs/reports/R2154. A more elaborate definition was later provided by Alastair I. Johnston, who referred to strategic culture as "an integrated system of symbols (e.g., argumentation structures, languages, analogies, metaphors) which acts to establish pervasive and long-lasting strategic preferences by formulating concepts of the role and efficacy of military force in interstate political affairs, and by clothing these conceptions with such an aura of factuality that the strategic preferences seem uniquely realistic and efficacious." See Alastair I. Johnston, "Thinking About Strategic Culture," *International Security* 19, no. 4 (1995): 46. In his book about Chinese

Both Russia's strategic culture and its identity developed under conditions of almost constant warfare and a seemingly eternal struggle for recognition and security. Russia experienced multiple invasions and abasement from the West as well as from the East. This historical experience led to the militarization[176] of Russia's strategic culture, the constant presupposition of threat (in other words: fear) in Russian minds, and an extreme emphasis on power. Russia has also always perceived itself as a unique power (expressed in the Russian *Samobytnost'*) whose innate characteristics and qualities predetermine it for a leading position in the world. The messianic element of Russia's identity projects itself in the belief that within the right world order, Russia will be followed by others, and not the other way around.[177] The contrast between Russia's expectations in the international situation, both in the past and today, is obvious. An inevitable result of Russia's desires' not being satisfied has been frustration.

Russia's worldview is dominated by fear for which there is only one cure: military power. Military power is perceived as guaranteeing Russia's security, sovereignty, and respect for its interests abroad. Because of the militarization of its strategic culture, Russia also perceives military power as ensuring the country's prestige—the need for which stems from Russia's identity-based desire to be admired. Objectively, Russia did not need to modernize its strategic arsenal to achieve superiority or to react to external events. Russia's strategic nuclear arsenal was already one of the two most impressive arsenals in the world, and it could not be defeated by any of the planned phases of the U.S. ballistic missile defense system. Yet, Russia needed to modernize its nuclear stockpile to maintain, or maybe even regain, the respect stemming from the possession of state-of-the-art nuclear weapons. With a robust, though obsolete, nuclear arsenal, Russia would have been feared as a big nuclear power capable of inflicting devastating damage even with a retaliatory strike. With a robust and highly sophisticated nuclear arsenal, Russia expects to be not only feared but also admired for its military-technological prowess.

Russia's quest for admiration and superiority in the military sphere (as a cure for its fear and at the same time a means to satisfy its desire to lead) explains the trends in the evolution of Russia's capabilities as they were described in the first part of this paper. So far, with the exception of the United States, no other nation has mastered MIRV technology to the extent Russia has. Similarly, the ranges, duration of the boost phase, CEP, penetration aids, and maneuvering capabilities of Russia's strategic weapon systems are superior characteristics that cannot be seen elsewhere in the world—with the exception of the United States. Although Russia might perceive an actual need for a new strategic bomber

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strategic culture, Johnston defines strategic culture in a more modest way as an "ideational milieu that limits behavioral choices" from which "one could derive specific predictions about strategic choice." See Alastair I. Johnston, *Cultural Realism: Strategic Culture and Grand Strategy in Chinese History* (Princeton, NJ: Princeton University Press, 1998), 36.

176. Fritz W. Ermarth, "Russian Strategic Culture in Flux: Back to the Future?" in *Strategic Culture and Weapons of Mass Destruction*, eds. Kerry M. Kartchner, Jeffrey A. Larsen, and Jeannie L. Johnson (New York: Palgrave Macmillan, 2009), 86.

177. For more about Russian messianism, see Peter J. S. Duncan, *Russian Messianism: Third Rome, Revolution, Communism and After* (London: Routledge, 2000); Kerstin Bouveng, "The Role of Messianism in Contemporary Russian Identity and Statecraft" (Ph.D. diss., Durham University, 2010), http://etheses.dur.ac.uk/438/.

to be employed in not so distant future scenarios (in contrast to the actual use of ICBMs, for instance), the fact that Russia's main competitor, the United States, is still the only[178] country operating a stealth strategic bomber (the B-2 Spirit) is likely to be at least one of the motivating factors of PAK DA development.

While Russia's fear of being invaded and humiliated—again—is a strong driving force, that fear is neither paralyzing nor does it translate into passivity. Russia has historically interpreted its doctrine and actions as defensive, a characterization that many other nations would deny[179]; however, an important component of Russia's strategic mindset is the notion of "security through expansion," mainly the result of Russia's historical experience and geographic position. When combined with Russia's identity and its identity's geographic component that transcends the present boundaries of the Russian Federation, the likelihood of another Georgia-style war or the emergence of more Belarus-like states is not small at all. Because the West is averse to an escalation leading to the use of nuclear weapons, the modernization of Russia's strategic nuclear arsenal for war-fighting has strengthened Russia's position in many scenarios.

Last but not least, the argument that Russia strives to have the most sophisticated nuclear forces and that it desires the number-one status in the military-technological arena (which should generate domestic as well as international admiration) must not be confused with a fixation on nuclear weapons as such. The above-described rationale suggests that as soon as weapons "better" than the nuclear ones will be developed, Russia will develop them (too). While today, this scenario might seem to be purely hypothetical, it has not been entirely dismissed in Russia. In February 2012, Vladimir Putin wrote: "In the more distant future, weapons systems based on new principles (beam, geophysical, wave, genetic, psychophysical, and other technology) will be developed. . . . It is already clear that nuclear deterrence will retain its leading role and importance in the structure of the Russian armed forces, *at least until we develop new types of weapons*, new-generation assault systems, including high precision weapons" (italics added).[180] This simultaneously means that as long as nuclear weapons are regarded as the ultimate and, in a sense, the most effective weapons, Russia will not reduce its arsenal to total zero. It also follows that as long as other nations are producing new systems that have (however slight) implications for Russia's position in the strategic nuclear sphere (such as increasingly sophisticated ballistic missiles of other states, or ballistic missile defense), Russia will not suspend its strategic nuclear modernization programs.

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178. To learn more about Chinese efforts to build a stealth strategic aircraft, see, for example: John Reed, "Is This China's New Design for a Stealth Bomber?" *Foreign Policy*, June 11, 2013, www.foreignpolicy.com/articles/2013/06/11/is_this_chinas_new_design_for_a_stealth_bomber.

179. Condoleeza Rice aptly described Soviet strategy and doctrine as one of a dichotomy. She wrote: "Soviet political doctrine is explicitly defensive, but Soviet military strategy is undeniably offensive, even preemptive in character." This dichotomy seems to apply to the strategy and doctrine of the Russian Federation as well. See Condoleeza Rice, "The Making of Soviet Strategy," in *Makers of Modern Strategy from Machiavelli to the Nuclear Age*, eds. Peter Paret, Gordon A. Craig, and Felix Gilbert (Oxford: Oxford University Press, 1986), 658.

180. Vladimir Putin, "Being Strong: National Security Guarantees for Russia," *Rossiiskaya Gazeta*, February 20, 2012, http://archive.premier.gov.ru/eng/events/news/18185/; see also "Russia Eyes Development of Futuristic Weaponry," *RIA Novosti*, March 22, 2012, http://en.rian.ru/military_news/20120322/172332421.html.

Conclusion

This paper identified three periods of Russia's strategic nuclear modernization. However, those should not be perceived as entirely separate and distinct phases but rather as a single, uninterrupted, and intensifying process that resulted in a full-fledged modernization concerning all three legs of the triad. In simplified terms, it can be said that in the first period (1991–1998) Russia modernized only one leg of the triad (ICBMs), and in the second period (1999–2008) two legs (ICBMs and SLBMs together with SSBNs). The present period of Russia's modernization therefore represents the first time since the end of the Cold War when Russia is modernizing *all three* legs of its strategic triad *simultaneously*.

All modernization phases witnessed the predomination of ICBM force modernization. Stephen Zaloga's suggestion to call Russia's strategic nuclear triad a tricycle remains valid.[181] While a triad implies equality among the legs, in Russia's case the ICBMs clearly represent the leading and bearing wheel. Needless to say, Russia's tricycle would likely have a hard time riding straight given that the strategic aviation wheel seems to be smaller than the strategic naval one.

The major limit to the scope and pace of Russia's efforts appears to be its financial situation. It yet remains to be seen if the global financial crisis will slow down Russia's economy to such an extent that its government decides to cancel or postpone some of its modernization plans.

As the last section of this paper demonstrated, various reasons can be identified for the preservation of Russia's strategic nuclear arsenal. With regard to its modernization, however, the underlying motivation is to be found in Russia's strategic culture and identity. It is the power-based and militarized strategic culture of Russia, the country's centuries-old identity as a one-of-a-kind great power that has always been meant to lead, and the ubiquitous fear of invasion and subordination that drive Russia's modernization of those weapons that are perceived as the ultimate means of the current and future military as well as political struggle. As long as nuclear weapons remain unsurpassed and Russia's strategic culture and identity unchanged, an honest and long-lasting break in Russia's strategic modernization should not be expected.

181. Zaloga, *The Kremlin's Nuclear Sword*, 59.

Failure to Ignite: The Absence of Cascading Nuclear Proliferation

Graham W. Jenkins[1]

Before North Korea ever detonated a nuclear device, it was feared that should its nuclear program bear fruit, it would inevitably lead to regional nuclear proliferation. The nightmare scenario envisioned a successful nuclear explosion followed by a South Korean crash program to develop its own nuclear weapons, followed by Japan and other nations with a latent nuclear capability. But despite a 2006 test with dubious results and two more successful tests in 2009 and 2013, regional powers have unequivocally refrained from developing nuclear weapons of their own. This paper will explore the technical, institutional, and political restraints that might explain why South Korea and Japan have thus far refrained from developing nuclear weapons, and in what way this precedent might apply to Turkey and Saudi Arabia should Iran test a nuclear weapon. It will explain why extended deterrence and global integration are key to preventing proliferation and suggest policy options to ensure that the current absence of cascading proliferation continues.

Before North Korea ever detonated a nuclear device, it was feared that should its nuclear program bear fruit, it would inevitably lead to regional nuclear proliferation. The nightmare scenario envisioned a successful nuclear explosion followed by a South Korean crash program to develop their own nuclear weapons, followed by Japan and other nations with a latent nuclear capability. But despite a 2006 test with dubious results and two more successful tests in 2009 and 2013, regional powers have unequivocally refrained from developing nuclear weapons of their own. Why is this? And what lessons might this offer for Iran's nuclear program, which often raises the same fear of regional proliferation in the Middle East?

Linking the two regions and their respective pariah states is not a far-fetched association. The National Intelligence Council (NIC) makes a similar comparison in *Global*

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Trends 2030: Alternative Worlds, in which it warns that "the future of nuclear proliferation hinges on the outcome of North Korean and Iranian efforts to develop nuclear weapons. Iran's success, especially, could trigger an arms race in the Middle East, undermining the nonproliferation regime."[2] Eight years and two editions of *Global Trends* prior, the NIC emphasized that "countries without nuclear weapons, especially in the Middle East and Northeast Asia, may decide to seek them as it becomes clear that their neighbors and regional rivals already are doing so."[3] Past performance does not guarantee future results, and so it is clear that the potential for regional proliferation is worth exploring.

North Korea and the Region

The balance of power in East Asia is dominated by China and, to a lesser extent, Japan and South Korea, which both possess economic power and military prowess. A true regional economic framework exists in the form of the Association of South East Asian Nations (ASEAN). Mostly consisting of smaller countries, the ASEAN+3 is the variant that also includes Japan, China, and South Korea. The organization has promoted strong economic ties between Asian countries and is making progress toward the creation of a free trade zone in East Asia and much of the Pacific.

But the rosy Asian economic picture is clouded by "the hermit kingdom": the Democratic People's Republic of Korea, more commonly known as North Korea. Since the armistice ending the Korean War was signed in 1953, North Korea has consistently flouted international norms and laws while pursuing multiple pathways in pursuit of weapons of mass destruction (WMD). International actors have enacted policies to counter North Korea's conventional military power, to bribe its ailing economy, and to pressure the ruling Kim regime to reform, but no country has yet developed a deterrent specifically to meet the North Korean threat. The international community is determined to reverse North Korea's nuclear progress, but in the meantime has charted a course intended to deter North Korea from ever actually *using* a nuclear weapon.

U.S. policy toward North Korea's nuclear weapons program has oscillated between bribery and threats for many years. At various times, the United States assigned different priorities to reunification: curtailing Pyongyang's nuclear, biological, and chemical programs; checking North Korea's conventional military threat; encouraging trilateral talks; and many other issues affecting the peninsula. Beginning with a 1999 policy review, however, the United States announced that it was going to take a different approach that focused on "priority concerns over [North Korea's] nuclear weapon- and missile-related activities," and involved a "new, comprehensive, and integrated approach to our negotiations

2. National Intelligence Council, *Global Trends 2030: Alternative Worlds*, NIC 2012-001, Office of the Director of National Intelligence, December 2012, 57.

3. National Intelligence Council, *Mapping the Global Future: Report of the National Intelligence Council's 2020 Project*, NIC 2004–13, Office of the Director of National Intelligence, December 2004, 15.

with [North Korea]."[4] The review also indicated a preference for using the Agreed Framework[5] to achieve the goals of negotiations.

However, the Agreed Framework had stalled by 2002, and in 2003 North Korea announced its withdrawal from the Non-Proliferation Treaty (NPT). Despite the failure of the Agreed Framework to halt the North Korean weapons program, dire predictions of cascading proliferation also failed to materialize. The 1999 policy review had warned that "acquisition of [nuclear] weapons by North Korea could also spark an arms race in the region and would surely do grave damage to the global nonproliferation regimes covering nuclear weapons and ballistic missiles."[6] Fortunately, those regimes still stand relatively intact for now.

In 2005 Pyongyang declared its possession of a nuclear weapon and tested the first weapon at Punggye-ri the next year. International outcry was swift and fierce. Within five days of the test, the United Nations Security Council (UNSC) had passed Resolution 1718, which placed heavy sanctions on military and luxury goods shipped into North Korea and demanded that North Korea cease missile and nuclear testing as well as immediately return to the Six-Party talks.[7] Of note, though, is the fact that South Korea successfully opposed any language in the resolution that would suggest military action against North Korea as punishment for the test.[8] This could be considered the first instance of successful deterrence by the North Korean nuclear arsenal.

North Korea tested a second nuclear device in 2006, and a third in February 2013. Following the third test, U.S. rhetoric became increasingly sharp. "North Korea's WMD, ballistic missile, conventional arms, and proliferation activities constitute a serious and unacceptable threat to U.S. national security, to say nothing of the integrity of the global nonproliferation regime." The United States also clarified that its policy was to promote the Six-Party Talks while vigorously enforcing sanctions as authorized by UNSC Resolution 1718, but that "the United States will not engage in talks for the sake of talks." The United States also unequivocally declared that it would not accept North Korea as a nuclear state.[9]

Other regional powers had condemned Pyongyang's actions in similar terms. Japan, hours before banning most trade with North Korea, called the test "a grave threat that will not be tolerated at all." This was "in lockstep" with South Korean opinion, according to

4. William J. Perry, *Review of United States Policy toward North Korea: Findings and Recommendations* (Washington, DC: U.S. Department of State, October 12, 1999), 8.

5. The Agreed Framework was a 1994 agreement between the United States and North Korea that laid out a plan for halting North Korea's nuclear program and normalizing relations between the two countries.

6. Perry, *Review of United States Policy Toward North Korea*, 3–4.

7. United Nations Security Council, 5551st Meeting, "Resolution 1718 (2006) [Non-proliferation/Democratic People's Republic of Korea]" (S/RES/1718), October 14, 2006, http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N06/572/07/PDF/N0657207.pdf?OpenElement.

8. Raviprasad Narayanan, "South Korean Response to the North Korean Nuclear Test," *Strategic Analysis* 30, no. 4 (October 2006), Institute for Defence Studies and Analyses, www.idsa.in/strategicanalysis/SouthKoreanResponsetotheNorthKoreanNuclearTest_rnarayanan_1006.

9. Glyn Davies, "Testimony Before the Senate Committee on Foreign Relations," March 7, 2013, www.state.gov/p/eap/rls/rm/2013/03/205691.htm.

Japanese Prime Minister Shinzo Abe.[10] After the third test in 2013, Abe characterized it again as a "grave threat."[11] South Korea has used the nuclear tests as opportunities to call for more sanctions and a halt to North Korean missile and nuclear programs, and to warn Pyongyang of possible military responses. The South Korean Foreign Ministry reminded North Korea that "the ROK Government will also accelerate expanding its military capability, including deploying at an early stage its extended-range missiles, currently being developed, which cover all of North Korea."[12]

In brief, North Korea is a volatile actor that has provoked widespread condemnation and spurred both Japan and South Korea into reinforcing their anti-ballistic missile (ABM) capabilities. With the threat of a nuclear-armed neighbor, it would make logical sense to develop nuclear capabilities of their own in order to establish deterrence equilibrium. But so far, despite three North Korean tests in eight years and decades of civilian nuclear experience, neither Japan nor South Korea has taken steps to develop credible nuclear deterrence capabilities of their own. Why is this? To answer the question, the two traditional proliferation drivers—capability and intent—must be examined.

Potential Proliferator: South Korea

Determining potential proliferation pathways involves a twofold analysis: capability and intent. With regard to the former, South Korea possesses a latent nuclear capability in spades. The South Korean civilian nuclear industry currently supplies a large amount of the country's energy needs—33 percent, or 20.7 gigawatts, as of 2011. Current plans would increase the number of nuclear plants in the country from 23 to 40 by 2030, providing 43 gigawatts, or 59 percent of all of its energy. South Korea's fuel cycle is open, lacking reprocessing or enrichment capabilities (these are provided by the United States).[13]

Despite the limited fuel cycle, South Korea has engaged in—and been censured for—several clandestine enrichment activities at various times between 1980 and 2000. The Korea Atomic Energy Research Institute (KAERI) performed a plutonium separation experiment in 1981, producing roughly 0.7 grams of plutonium-239 by irradiating a mini-assembly in a Seoul-based reactor; the processing facility was later dismantled in 1987. Traces of plutonium were not discovered until 1997, and in 2004 South Korea admitted to the International Atomic Energy Agency (IAEA) that it had performed the experiments.[14] This came on the heels of two other South Korean NPT violation

10. David Pilling, "Japan PM Calls Test a 'Serious Threat,'" *Financial Times*, October 9, 2006, www.ft.com/intl/cms/s/0/6818aaee-576b-11db-833b-0000779e2340.html#axzz2aPCohxww

11. David Chance and Jack Kim, "North Korean Nuclear Test Draws Anger, Including from China," Reuters.*com*, February 12, 2013, www.reuters.com/article/2013/02/12/us-korea-north-idUSBRE91B04820130212.

12. Spokesperson's Office, "Statement by the Government of the Republic of Korea on North Korea's Third Nuclear Test," Ministry of Foreign Affairs, Republic of Korea, February 12, 2013, www.mofat.go.kr/ENG/press/ministrynews/20130212/1_47598.jsp?menu=m_10_10.

13. World Nuclear Association, "Nuclear Power in South Korea," June 2013, www.world-nuclear.org/info/Country-Profiles/Countries-O-S/South-Korea/#.UfG3O23Pbms.

14. Director General, International Atomic Energy Agency, *Implementation of the NPT Safeguards Agreement in the Republic of Korea*, GOV/2004/84, November 11, 2004, 5–6.

disclosures to the IAEA, to which Seoul admitted only after their Additional Protocol entered into force.

South Korea has engaged in conversion activities. These include the conversion of uranium tetrafluoride to uranium metal and the production of 154 kilograms of natural uranium metal. The IAEA found evidence of depleted uranium's presence in samples of yellowcake uranium found at a KAERI milling plant in Daejon, and all the laboratories participating in these processes were consequently dismantled in 1994.[15]

Finally, in 2004 South Korea's additional protocol entered into force, permitting IAEA inspectors to enter the KAERI Laser Technology Research and Development Centre in Daejon. This center is home to South Korea's atomic vapor laser isotope separation capabilities, and had enriched 200 milligrams of uranium-235 at 77 percent (originating from 3.5 kilograms of natural uranium metal—presumably some of that produced before 1994). This facility was dismantled and declared only after the entry into force of the additional protocol.[16]

Put simply, South Korea now possesses the full set of skills and experience necessary to develop fissile materials suitable for a nuclear weapon, as well as significant portions of the fuel cycle. South Korean capabilities imply an existing capacity to produce very significant quantities of further refined fissile products, as well as the ability to rapidly increase that capacity. Obtaining raw materials like uranium ore would pose a challenge, as they are currently supplied from the United States under a "123 agreement."[17] However, South Korea is seeking to change its status and close the fuel cycle in the 2014 renewal of the 123 agreement currently being negotiated between Washington and Seoul.[18]

Additionally, South Korea has a fledgling space program under way and possesses advanced missile technology. In 2012 Washington and Seoul reached an agreement that nullifies a 1979 memorandum of understanding between the two, allowing South Korea—as a member of the Missile Technology Control Regime (MTCR)—to construct and deploy ballistic missiles with a range of up to 800km (500 miles), up from the previous limitation of 300km (186 miles).[19] Thus, delivering nuclear weapons (following miniaturization) would not be a barrier to potential South Korean nuclear capabilities.

In sum, South Korea possesses the requisite capabilities to develop and deliver nuclear weapons. What about the intent? What intent, if any, does South Korea have to develop

15. Ibid., 4–5.
16. Ibid., 2–3.
17. A "123 Agreement" is named for Section 123 of the 1954 Atomic Energy Act, which requires that two countries enter into an agreement before any nuclear technology or materials are transferred to another country.
18. Scott Stearns, "Washington, Seoul Seek to Extend Nuclear Partnership," *Voice of America*, April 26, 2013, http://blogs.voanews.com/state-department-news/2013/04/26/washington-seoul-seek-to-extend-nuclear-partnership/.
19. Sung-won Shim, "U.S., South Korea Agree on Longer Range Ballistic Missiles," Reuters.com, October 7, 2012, www.reuters.com/article/2012/10/07/us-korea-usa-missile-idUSBRE89602J20121007.

nuclear weapons, and why have they not done so in the wake of North Korean nuclear testing? Public sentiment has been significantly in favor of either developing an indigenous nuclear weapons capability or reintroducing nonstrategic U.S. nuclear weapons to the Korean Peninsula. This popular opinion grew especially strong following the third North Korean nuclear test in February 2013. The Asan Institute conducted a poll shortly after that test in which 66 percent of the South Korean public supported the development of nuclear weapons in their country.[20] And this number is not an especially high outlier. Support since 2010 has *averaged* around 63 percent.[21] South Korean support for developing nuclear weapons has become, in essence, a mainstream position.

Perhaps this explains Seoul's desire to finally close the fuel cycle, and perhaps that open fuel cycle explains the lack of South Korean proliferation to date—it may actually be a case of lack of capability and not one of intent. The IAEA's investigations into Korean enrichment have no doubt played a role as well in retarding, if not halting altogether, any current progress toward permanent enrichment capabilities. With this recent round of revelations, the accession of South Korea to the Additional Protocol can be seen as a diplomatic coup and one without which South Korea may have very well possessed sufficient stocks of fissile material to produce a nuclear arsenal.

Perhaps the most compelling, if unheralded explanation for why South Korea has not developed a nuclear weapons capability is the extension of the U.S. nuclear umbrella over South Korea. Indeed, not a few analysts believe that U.S. extended deterrence, which encompasses both South Korea and Japan, is the primary reason that the ROK has never fully committed to pursuing nuclear weapons.[22] But decades of verbal assurances were not enough to assuage Seoul. It was only in 2009 that the deterrence guarantee was *written* and made explicit by President Barack Obama, at the urging of South Korean President Lee Myung-Bak at a nuclear summit in Washington, DC.[23] Interestingly, only 48 percent of the South Korean public believes that the United States would actually consider using a nuclear weapon in South Korea's defense (and that proportion has *decreased* since the signing of the written nuclear guarantee).[24] The continued strength and reaffirmation of the Mutual Defense Treaty Between the United States and the Republic of Korea and the lack of a South Korean nuclear program are certainly positive signs, but even these may not last forever. A clear disconnect exists between elite South Korean opinion and that of the general

20. Kim Jiyoon, Karl Freidhoff, and Kang Chungku, "The Fallout: South Korean Public Opinion Following North Korea's Third Nuclear Test," Issue Brief No. 46, Asan Institute for Policy Studies, February 25, 2013, 9–10.

21. Ibid.

22. See, for example, Lewis A. Dunn, "Deterrence Today: Roles, Challenges, and Responsibilities," *Proliferation Papers* series (Paris: Ifri Security Studies Centre, 2007), www.ifri.org/downloads/Deterrence_Today_Dunn_2007.pdf; Jonathan Pollack and Mitchell B. Reiss, "South Korea: The Tyranny of Geography and the Vexations of History," in Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss, eds., *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices* (Washington, DC: Brookings Institution Press, 2004), 254–92; and Brad Roberts, "Nonproliferation: Challenges Old and New," *The Counterproliferation Papers*, Future Warfare Series No. 24, USAF Counterproliferation Center (Maxwell AFB, AL: Air University, 2004), http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA446152.

23. "Flournoy to Follow Up S. Korea Summit," *United Press International*, June 20, 2009, www.upi.com/Top_News/2009/06/20/Flournoy-to-follow-up-S-Korea-summit/UPI-72421245525336/.

24. Jiyoon et al., "The Fallout: South Korean Public Opinion," 6–7.

public—a fortunate thing for the time being. With each North Korean test chipping away at South Korean resolve, it may only be a matter of time before it erodes altogether.

What this means for South Korean nuclear aspirations is that Seoul's commitment to the NPT and the global nonproliferation regime is perhaps weaker than previously thought. Hopefully U.S. assurances and guarantees—as well as the threat of international opprobrium and economic disaster—will be enough to continue to maintain the status quo. However, if Pyongyang continues to test nuclear weapons with impunity and further develop its nuclear capabilities, Seoul may decide that it has no choice but to forge its *own* nuclear path.[25] But one thing is clear: bilateral and multilateral and international pressure must be applied to potential proliferators well in advance.

Potential Proliferator: Japan

It is often said that Japan possesses a latent, "turnkey" nuclear weapons capability.[26] That is to say, were Japan to suddenly reverse its long-standing prohibition on nuclear weapons, it has the material, facilities, and knowledge base to develop nuclear weapons within several years. Japan's nuclear industry is very mature, dating back to Prime Minster Yasushiro Nakasone's desire to harness the atom for Japanese uses since the moment of the Hiroshima detonation in 1945.[27] Institutional momentum for preserving a nuclear industry is solid, weathering even the crisis at the Fukushima-Daiichi plant in the wake of the 2011 earthquake and tsunami. The first reactor went operational in 1966, and Japan now has 50 reactors in operation, with another 15 planned or already under construction. Together these provide 44.4 gigawatts, or around 30 percent of the country's energy needs.[28]

As a matter of national policy, Japan has a full and closed fuel cycle. Plutonium is reprocessed from spent civilian fuel rods and is then used to fuel other reactors. Currently, much of the reprocessing is performed abroad, as the opening of the Rokkasho plant—planned to host reprocessing operations—has been repeatedly delayed, and the existing Tokai Reprocessing Plant only processed around 90 tons of spent fuel per year until 2006, when it was shuttered.[29] Much of Japan's plutonium is in the hands of private industry, something unique among the major nuclear powers. And for decades, spent fuel has been reprocessed in France and the United Kingdom (by choice of the Japanese nuclear industry). Most of Japan's plutonium stockpile is thus stored abroad, and of the 44 tons of plutonium that

25. And with operational control of U.S. forces in South Korea due to be handed back to the South Korean military in 2015, Seoul may soon feel even more isolated.

26. See, for instance, Jeffrey Lewis, "How Long for Japan to Build a Deterrent?" *Arms Control Wonk*, December 28, 2006, http://lewis.armscontrolwonk.com/archive/1339/japans-nuclear-status.

27. Jacques E. C. Hymans, "Veto Players, Nuclear Energy, and Nonproliferation: Domestic Institutional Issues to a Japanese Bomb," *International Security* 36, no. 2 (Fall 2011), 162.

28. World Nuclear Association, "Nuclear Power in Japan," July 23, 2013, www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Japan/.

29. Jay Solomon and Miho Inada, "Japan's Nuclear Plan Unsettles U.S.," *Wall Street Journal*, May 1, 2013, http://online.wsj.com/article/SB10001424127887324582004578456943867189804.html.

Japanese companies own, only nine are actually on the Japanese Home Islands.[30] Furthermore, as Jacques E. C. Hymans points out, with the nuclear industry holding an oversight role over that plutonium, "the prime minister is not well-positioned to order the sudden militarization of that portion of the stockpile."[31] Until Rokkasho begins operations,[32] Japan's domestic closed fuel cycle exists in name only, complicating any designs for a nuclear breakout.

Like South Korea, Japan also has a space development program and antiballistic missile capabilities. U.S. Forces Japan and the Japanese Self-Defense Forces maintain a joint ABM capability in the form of midcourse defense Aegis-capable cruisers. In addition, Japan operates batteries of terminal-phase defense Patriot Advanced Capability-3 missiles. Similar to its turnkey nuclear power status, Japan's space program is advanced to the point where its launch vehicles could be converted into ballistic missiles. The M-5 rocket, in particular, could easily become a delivery system equivalent to the US MX Peacekeeper system.[33] Japan's development of ballistic missile defense can been viewed as a response to North Korean Taepo Dong ICBM testing. It would not be unreasonable to expect a similar reaction to North Korean nuclear testing.

Japan is perhaps the single most technologically advanced nation, in terms of both nuclear energy and military hardware, to have refrained from developing nuclear weapons. It is the only non-nuclear weapons state with a full fuel cycle. That status owes something to the vision of Nakasone at the birth of the Japanese nuclear program. As Hymans argues, "It is clear that he wanted to at least build both a technology base and an institutional framework that would permit a future Japanese prime minister to make a quick and irrevocable decision for a military nuclear breakout."[34] And that is where Japan remains today.

So why has Tokyo, even with the threat of a nuclear-armed North Korea brimming with ballistic missiles capable of reaching Japan, declined to pursue a nuclear path? The traditional explanation highlights Japan's "three non-nuclear principles": to neither possess nor manufacture nor permit the introduction of nuclear weapons into Japan.[35] This has been a traditional guide for Japanese policy; cabinet secretaries have been ousted for even appearing to question Japan's policy of no nuclear weapons (interestingly, Shinzo Abe was one such minister who was *not* censured, and he later became prime minister). At a more fundamental level lie what have been described as the three nuclear taboos: Hiroshima, Nagasaki, and a national "nuclear allergy."[36] The taboos, however, may well be losing their importance. Indeed, one former senior official with the National Nuclear Security

30. Daniel Horner, "Strains Seen in Japan's Plutonium Policy," *Arms Control Today*, November 2012, www.armscontrol.org/act/2012_11/Strains-Seen-in-Japans-Plutonium-Policy.

31. Hymans, "Veto Players, Nuclear Energy, and Nonproliferation," 170.

32. As of this writing, scheduled for autumn 2013.

33. James Martin Center for Nonproliferation Studies, "Country Profiles: Japan; Missiles," Nuclear Threat Initiative, May 2013, www.nti.org/country-profiles/japan/delivery-systems/.

34. Hymans, "Veto Players, Nuclear Energy, and Nonproliferation," 163.

35. Kurt M. Campbell and Tsuyoshi Sunohara, "Japan: Thinking the Unthinkable," in Campbell et al., *The Nuclear Tipping Point*, 223.

36. Ibid., 222.

Administration has estimated that within 20 years, Japan may lose the allergy altogether and begin debating the development and possession of nuclear weapons.[37]

As Hymans argues, the structure of Japanese politics and policy also appears to play a large role in precluding any sudden breakout. Put simply, there are too many vested interests among the Diet, Tokyo Electric Power Company, the Ministry of International Trade and Industry, the heavy equipment manufacturers, and the prime minister's office that serve to block any new or otherwise different consensus beyond that of the status quo. Japanese politics lends itself to inertia; it would require a huge shift in momentum to alter the trajectory of the state.

Despite this, the very fact that external parties can engage in a conversation about Japan's willingness to "go nuclear" is telling. The deterrent capabilities of even a turnkey nuclear arsenal are, it seems, at least somewhat close to possessing actual nuclear weapons. And the U.S. nuclear umbrella serves to fill in any perceived gaps in that strategy.

Iran and the Middle East

The collection of nations that form the Middle East are far more disparate than those of East Asia in their economic and political ties to the larger global community. The schism between Sunni and Shia Islam still threatens to tear the region asunder, and aside from some commodities-based groups such as the Organization of Petroleum Exporting Countries, there is little in the way of a regional economic community.

Also unlike East Asia, the Middle East has no single authoritative center of gravity or especially dominating influence similar to the role China plays in its region. Instead, various nations of the Middle East compete for varying influences. Sectarian rivalries and religious tensions underscore relations between Middle Eastern states. Cairo has traditionally been the home of Arab intellectualism. Ankara has, until recently, played a secularizing role. Tehran is the home of revolutionary Shia Islam, while Riyadh lays claim to "true" Islam with its curatorship of Mecca and Medina. Underlying the tension throughout the region is the ongoing Israel-Palestine crisis and general enmity toward Israel.

Where the Middle East *does* more strongly resemble East Asia is in the existence of an internationally isolated nation with strong grievances and a probable clandestine nuclear weapons program. That nation, of course, is Iran. In May 2013, the IAEA found that Iran was in violation of numerous portions of its safeguards agreement pertaining to its nuclear energy industry, including issues "related to possible military dimensions to Iran's nuclear program."[38] Iran has continued to enrich uranium at its Natanz and Fordow facilities. Of major concern is the fact that over the past several years, Iranian centrifuges have been

37. Remarks given at the Center for Strategic and International Studies, Washington, DC, June 28, 2013.

38. Director General, International Atomic Energy Agency, *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, GOV/2013/27, May 22, 2013, 2–7.

employed in uranium enrichment to the 20 percent uranium-235 level, which means that they have performed 90 percent of the work required to obtain 92 percent uranium-235—better known as weapons-grade uranium. Iran also continues to work on heavy water projects, despite IAEA and UNSC resolutions requiring their suspension.[39] Many, if not most, analysts are convinced that Iran's continued enrichment and other nuclear fuel production are designed to produce significant quantities of fissile materials. And so at some point, countries in the region may well find themselves faced with the same choices as South Korea and Japan in the aftermath of a nuclear test. Israeli Defense Minister Ehud Barak guaranteed that "a nuclear Iran will be the end of the nonproliferation regime: Saudi Arabia will turn nuclear immediately, Turkey within several years, and probably the new Egypt will start moving to do it."[40] As the cases of South Korea and Japan have shown, however, such declarations are subject to the vagaries of reality and *realpolitik*. Does the East Asian experience so far hold any hope for the Middle East?

Potential Proliferator: Saudi Arabia

Saudi Arabia—often cited as the primary proliferation risk in the Middle East after Iran—has no domestic nuclear energy capability or experience with a nuclear fuel cycle. Various studies have been conducted in the past to determine the feasibility of nuclear power in Saudi Arabia, and the kingdom now plans to construct 16 nuclear reactors by 2033, with the first coming on line in 2022. To date, several contracts have been awarded and a National Atomic Regulatory Authority established, although construction has yet to begin. Virtually all components of the fuel cycle will have to be imported, and Saudi Arabia has reached agreements with France, South Korea, and Argentina for the supply of reactors and reactor technology. An agreement with China will provide fabricated nuclear fuel. Even once the industry matures, Saudi Arabia does not hold significant uranium deposits and would have to rely on imported nuclear material.[41] Saudi Arabia is a signatory to the NPT and has vowed to abide by IAEA safeguards, although it has not yet signed the Additional Protocol.

With most of Saudi Arabia's nuclear capability expected to develop over the coming decades, it will be necessary to weigh progress of their nuclear program against that of Iran. The notion that Saudi Arabia has no ability to produce its own nuclear weapons, while valid today, may need to be revisited as the industry matures. However, the future political situation of Saudi Arabia is far from guaranteed. Tight state control makes it unlikely that anything short of elite desire would spur policy changes, but this also would allow the ruling oligarchy to change that policy should it deem fit. And this assumes that the monarchy prevails indefinitely.

39. Ibid. 2–7.

40. JPost.com Staff, "'Nuclear Iran Would Trigger Middle East Arms Race,'" *Jerusalem Post*, June 21, 2012, www.jpost.com/Iranian-Threat/News/Nuclear-Iran-would-trigger-Middle-East-arms-race.

41. World Nuclear Association, "Nuclear Power in Saudi Arabia," June 2013, www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Saudi-Arabia/#.Ufanx23PYyY.

Put simply, the nuclear breakout potential of Saudi Arabia today is nil, and the long road from nuclear energy to nuclear weapons is unattractive to Riyadh from both a technical and a strategic standpoint. As a recent report from the Center for a New American Security explains, getting the bomb "could make the Kingdom's strategic predicament worse, not better. It would complicate the Kingdom's national security, risk a strategic rupture with the United States, do great damage to Saudi Arabia's international reputation, and potentially make Riyadh the target of international sanctions."[42]

Despite its lack of existing nuclear capability, Saudi Arabia is often discussed as a potential new nuclear power should Iran successfully acquire a nuclear weapon. In 2011 a former head of Saudi intelligence stated that "it is our duty toward our nation and people to consider all possible options, including the possession of these weapons."[43] Other unnamed Western intelligence officials have claimed that Riyadh essentially has "an option" of buying Pakistani nuclear weapons, by virtue of having financed as much as 60 percent of Islamabad's nuclear program.[44] If this argument is valid, then, unlike other potential proliferators, Saudi Arabia could forgo the issues and investments entailed in developing a domestic nuclear power industry and proceed straight to becoming a nuclear weapons state by borrowing or purchasing a weapon from Pakistan.

This is true for other countries, too, with or without a domestic nuclear industry. There are a number of wealthy countries that could easily afford to buy a nuclear weapon, if only such sales were forthcoming. Japan and South Korea are some the richest nations in the world, and if weapons were easily bought and sold, their nuclear latency would be a moot point when compared against their currency reserves. The problem with this argument, then, is finding a willing seller. If Pakistan does indeed represent Saudi Arabia's primary nuclear option, it is still unlikely that the result would be an outright sale and transfer of nuclear weapons.

Instead, as Gary Samore said, "I don't believe there's a deal that the Saudis already paid . . . and if I were the Saudis I wouldn't trust the Pakistanis to deliver. . . . I don't believe any such quid pro quo exists. [More likely is] that Pakistan would station troops on Saudi soil, and those could include nuclear-armed forces."[45] If Iran is the antagonist in the nuclear Saudi Arabia scenario, however, Pakistan would almost certainly be reluctant to be perceived as helping to "encircle" Iran. As a direct neighbor, Pakistan stands to lose more than almost any other nation if Iran develops nuclear weapons.

What Riyadh would probably seek, then, is a nuclear umbrella, but the question remains as to who would extend it. It is certainly possible that Pakistan might, and some

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42. Colin H. Kahl, Melissa G. Dalton, and Matthew Irvine, *Atomic Kingdom: If Iran Builds the Bomb, Will Saudi Arabia Be Next?* (Washington, DC: Center for a New American Security, February 2013), 8.

43. Associated Press, "Prince Hints Saudi Arabia May Join Nuclear Arms Race," *New York Times*, December 6, 2011, www.nytimes.com/2011/12/07/world/middleeast/saudi-arabia-may-seek-nuclear-weapons-prince-says.html.

44. Julian Borger, "Pakistan's Bomb and Saudi Arabia," Julian Border's Global Security Blog, *The Guardian*, May 11, 2010, www.guardian.co.uk/world/julian-borger-global-security-blog/2010/may/11/pakistan-saudiarabia.

45. As quoted in Thomas W. Lippman, "Saudi Arabia: The Calculations of Uncertainty," in Campbell et al., *The Nuclear Tipping Point*, 137–40.

analysts believe that *this* is in fact the Saudi-Pakistani quid pro quo for which Saudi funding was exchanged. The two nations do share close cultural and military ties, as well as a healthy skepticism of the value of their respective relationships with the United States.[46] And Riyadh may believe that the Pakistanis are willing to trade Lahore for Mecca. Americans would be more reluctant to lose Boston in the name of preserving Medina.

In the end, it is probably a U.S. nuclear umbrella that would be more appealing to Saudi Arabia, despite its qualms about the depth of the U.S. commitment to their security. Such a security guarantee could be made regardless of American distaste for whatever regime held power and would also be suitable to dissuade nuclear-armed adversaries, and need not even be overtly nuclear in order to deter state adversaries.[47] A guarantee of this kind might be prefaced with a more visible U.S. posture vis-à-vis conventional security in Saudi Arabia. Compared with Japan and South Korea, Saudi Arabia's relationship with the United States is lacking a physical and permanent commitment to the kingdom's security. The complicating nature of U.S. forces in the Holy Land has certainly discouraged such a presence, but without that mutual commitment, it is hard for Riyadh to see U.S. security "guarantees" as anything but lip service. It has been 30 years since President Ronald Reagan unequivocally declared that "an attack on Saudi Arabia would be considered an attack on the United States."[48] Perhaps it is time to renew a similar sentiment—and keep an eye on the King Abdullah City for Nuclear and Renewable Energy in the meantime.

Potential Proliferator: Turkey

Turkey is another of the most frequently suggested proliferators in response to an Iranian nuclear weapon. This suggestion is poorly thought out. Neither in capability nor intent does Turkey appear as if an Iranian bomb would spur the development of its own nuclear weapons. With regard to Iran and the West, Turkey walks a fine line, but the balancing act does not tolerate the possession of nuclear weapons by Iran *or* Turkey.

Like Saudi Arabia, Turkey has no domestic nuclear industry, although since the 1970s it has been planning to start one. These plans finally appear to be coming to fruition, with the first reactor at Akkuyu scheduled to begin construction in 2016 through an agreement with Russia's Rosatom.[49] The agreement also includes the provision of a fuel fabrication plant in Turkey; however, it doesn't mention the possibility of enrichment or reprocessing facilities. Turkey is a signatory of both the NPT and the Additional Protocol, and its facilities will be fully IAEA safeguarded.

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46. Kahl et al., *Atomic Kingdom*, 27–28.

47. Thomas Lippman makes the case that for nonstate actors, terrorist groups, and insurgency-type threats to the kingdom, the U.S. umbrella would be insufficient, but as this paper addresses the consequences of an Iranian bomb, that scenario is outside its scope. See Lippman, "Saudi Arabia," in Campbell et al., *The Nuclear Tipping Point*.

48. Lippman, "Saudi Arabia," in *The Nuclear Tipping Point*, 139.

49. World Nuclear Association, "Nuclear Power in Turkey," July 2013, http://world-nuclear.org/info/Country-Profiles/Countries-T-Z/Turkey/#.UffdBm0UN8E.

It is this long-held desire to develop a nuclear energy sector that has very much complicated Turkey's relationship with Iran and with the West. Turkey has no interest in Iran's developing a nuclear weapon, despite Western misconceptions. To Ankara, an Iranian bomb would "alter the regional balance of power and embolden Iranian hardliners to pursue a more provocative foreign policy."[50] On the other hand, Ankara *also* opposes additional European and American economic sanctions because "it believes that would only strengthen the Iranian hard-liners and disproportionately affect the Turkish economy."[51] The only sanctions Ankara supports are those approved by the UN Security Council. Turkey does, however, support the Iranian enrichment program, much to the frustration of the West.

One of the fundamental principles of Turkey's view of the international system is the primacy of international agreements and treaties. Turkey is a signatory to a dozen different arms control agreements, including the Partial and Comprehensive Test Ban Treaties and the MTCR. For Ankara, "these agreements represent real, structural elements of national security policy and an integral part of the strategy whereby Turkey grounds its security on faith in the value of Turkish solidarity with the international community."[52] This also means that Turkey is a strong supporter of Article IV of the NPT, which gives non-nuclear weapon states an inalienable right to peaceful nuclear energy. With the long-desired nuclear sector finally becoming a reality, it is more important than ever to Turkey that it avoid hypocrisy that could jeopardize its own program. Turkish Prime Minister Recep Tayyip Erdogan has thus staunchly defended Tehran's right to enrichment, while at the same time condemning the possibility of an Iranian nuclear weapon.[53]

Turkey has tried its own approach toward solving the Iran problem and, with Brazil, offered Iran a uranium swap in 2010 that would have replaced 1,200 kilograms of Iranian low-enriched uranium with 120 kilograms of 20 percent enriched uranium. But this deal was eventually jettisoned by Western powers. Even the proposal "underscore[d] the reality that the conventional powers . . . have . . . been unable to broker a solution. If an alternative framework, such as a deal among Turkey, Brazil, and Iran, could prove more effective, it would be a blow to the existing global institutions led by the United States and other conventional powers."[54] And beyond these principled stances, Turkey enjoys a thriving economic relationship with Iran and good cross-border relations. Ankara is fond of reminding observers that it has not had border conflicts with Tehran since the Qasr-i Shirin Treaty of 1639. Erdogan's quasi-Islamist Justice and Development Party has also been a factor in warming relations with Iran.

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50. Aaron Stein, "Understanding Turkey's Position on the Iranian Nuclear Program," *WMD Junction*, January 12, 2012, http://wmdjunction.com/120112_turkey_iran_nuclear.htm.

51. Sinan Ülgen, "Turkey and the Bomb," Carnegie Endowment for International Peace, February 15, 2012, 4.

52. Leon Fuerth, "Turkey: Nuclear Choices Among Dangerous Neighbors," in Campbell et al., *The Nuclear Tipping Point*, 152.

53. Ülgen, "Turkey and the Bomb," 4.

54. Nobumasa Akiyama and Kenta Horio, "Can Japan Remain Committed to Nonproliferation?" *Washington Quarterly* 36.2 (Spring 2013), 157–158.

However, Turkey occupies a unique geopolitical niche as a nation straddling the line between Europe and the Middle East, which has brought it into conflict with its own allies. Turkey's position as a gateway to Europe meant that it was brought into the North Atlantic Treaty Organization (NATO) during the Cold War. In many respects, Turkey is in an enviable position when it comes to nuclear weapons and deterrence: it already enjoys their deterrent benefits via the U.S. umbrella and the NATO alliance without having to risk a crash program. Even if Iran develops a bomb, there is little reason to fear Turkey doing the same.

Conclusion

There are far too many variables associated with a national nuclear program to cite just one as the explanation for a lack of regional proliferation. But several commonalities at least point to possible ways ahead for the Middle East (with the extremely important caveat of assuming that East Asia continues along its present trajectory).

First and foremost is the extension of the U.S. nuclear umbrella, coupled with strong security assurances and a physical commitment to the security of the country in question. The U.S. ties to Japan (U.S. Forces Japan), South Korea (U.S. Forces Korea), and Turkey (NATO) are a highly visible and reassuring sign of commitment and extended deterrence. It is telling that even in the wake of heightened tensions with North Korea, South Koreans are clamoring for the reintroduction of U.S. nonstrategic nuclear weapons on the Korean Peninsula. Such ties can help improve a country's sense of security to a point where it will feel secure even without nuclear weapons.

Second is the international nonproliferation regime. It is thanks to the diligent efforts of the IAEA and other intergovernmental organizations that clandestine nuclear programs such as Iran's—or even South Korea's—have been detected. In the case of South Korea, its earlier 1970s-era program was not halted by the IAEA because the NPT had not yet brought the agency into being. As the safeguards regime in Korea grew stronger, down went the likelihood of an undetected program. The Additional Protocol compounded that. Coupled with pressure from international stakeholders and global opinion, those programs can be halted before they develop into further proliferation. Of course, as experience with North Korea and Iran has shown, the existing safeguards regime is by no means perfect. Its chief purpose is to detect violations, not to punish them. But that is where the international community—and a shared global sense of responsibility—can come into play, through either negotiations or the application of appropriate nonproliferation measures.

Third is the international community more generally. Greater economic integration into the global system serves the practical purpose of tying a country's fortunes to that of the world at-large. The destabilizing prospect of nuclear weapons would jeopardize that economic prosperity. The United States has deep ties and close relations with South Korea, Japan, and Turkey, and is a participant in many of the same global organizations with them (e.g., NATO, the Organization for Economic Cooperation and Development, the Development Assistance Committee). Saudi Arabia, on the other hand, is relatively isolated. The only

international organization (other than the United Nations) to which all four countries and the United States belong is the Group of 20. In addition to the practical benefits, membership in these groups and participation in international trade and development serve a normalizing role, easing tensions and promoting cooperation among otherwise fiercely competitive nations. Granted, it is a small sample size, but it is telling that the two countries whose nuclear programs are assumed to be catalysts for cascading regional proliferation are absent from virtually all international forums. Those that have not embarked on crash programs have significant ties with the world at large. And the international community should ensure that other potential proliferators are just as connected.

It is a merciful reality that, seven decades after splitting the atom, only 10 nations have successfully developed nuclear weapons (with one of the 10 later renouncing its arsenal and program). The past will not determine the future, but if it is in any way a guide, it will indeed be possible to prevent most proliferation in its early stages—and avoid the dire consequences of regional nuclear arms races.

The CTBT and the Nuclear Testing Moratorium: Technical Perspectives and Political Challenges

Phyllis Ko[1]

There has been ongoing disagreement over whether or not the United States should ratify the Comprehensive Nuclear Test Ban Treaty (CTBT), a debate that has continued ever since the U.S. Senate last rejected the treaty in 1999. Despite promising that he would work to pursue ratification of the CTBT, President Barack Obama has not indicated when he will initiate the legal process for this to happen. At the time of the last debate, the main technical concerns raised regarded the United States' ability to ensure the safety and reliability of its nuclear weapons stockpile, the capabilities of the international monitoring system, and the possible advancements that other countries could make by conducting clandestine nuclear testing. In the years since the treaty was last considered, a number of studies have been published and reflect a better understanding of the main technical issues related to the treaty. This paper begins by summarizing the current status of technological capabilities related to the CTBT and the questions and issues the treaty currently faces. The next section looks back at the technical impediments that were overcome leading up to ratification of nuclear test–limiting treaties preceding the CTBT. The conclusion discusses implications for the United States under an indefinite nuclear testing moratorium. The paper does not purport to provide a policy position on whether the United States should ratify the CTBT. Rather, it provides a technical perspective and an analysis of the connections between science and policy related to the treaty.

Introduction

When the Comprehensive Nuclear Test Ban Treaty (CTBT) treaty failed to receive Senate ratification in 1999, many felt that the process leading up to the vote had been rushed. The idea of banning nuclear testing was not new. Discussions of a nuclear test ban treaty had been going on for over 50 years, but most senators at the time had limited knowledge about the CTBT and felt that too little time was devoted to the debate. The senators

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serving on national security committees at the time also shared that feeling.[2] After the Senate debate, General John Shalikashvili, Special Adviser to the President and the Secretary of state for the CTBT, commissioned a study by the National Academy of Sciences (NAS) on the main technical questions raised during the debates. The study, titled *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty*, was published in 2002. Ten years later, the U.S. NAS published an updated report that took into account the technological developments since the 2002 report. The 2012 publication was highly anticipated, and many hoped it would help get the treaty back onto the Senate floor. The purpose of the technical assessments was not to support specific policy decisions but to provide a technical perspective to inform the policymaking process and to educate the public.

Technical Analysis of the CTBT

Over the years, the NAS and other organizations such as the JASON group, an independent scientific advisory group for the U.S. government run through the MITRE Corporation, have conducted technical analyses with relevance to the CTBT. Supporters of the CTBT hoped that better understanding of capabilities and advancements in the technology for monitoring nuclear test explosions would ensure the safety and reliability of the U.S. nuclear stockpile and consequently bolster the case for the treaty. There is now extensive information on the technical aspects of (1) the ability of the United States to maintain a safe, reliable, and secure nuclear weapons stockpile, (2) monitoring capabilities for detecting nuclear explosions for treaty verification, and (3) the potential advancements a country can make if it decided to conduct nuclear testing covertly. However, opinions remain divided on whether the United States should ratify the CTBT.

THE SAFETY AND RELIABILITY OF THE NUCLEAR WEAPONS STOCKPILE UNDER A TESTING MORATORIUM

When the 1992 nuclear testing moratorium was extended indefinitely, the Department of Energy (DOE) was tasked with creating a program to ensure the preservation of nuclear weapons and intellectual and technical capabilities. The Stockpile Stewardship program (SSP) was created, and it comprised surveillance, scientific research, modeling, and simulations.[3] The surveillance program ensures the reliability of nuclear weapons by conducting a series of various nonnuclear tests, including flight tests, systems tests, and laboratory tests of the nuclear components. Experimental facilities that support the SSP include the National Ignition Facility (NIF),[4] the Dual-Axis Radiographic Hydrodynamic

2. "Statement by Senator Lugar (R-IN) in Opposition of the CTBT," U.S. Senator Richard G. Lugar press release, October 7, 1999, www.fas.org/nuke/control/ctbt/text/100799lugar.htm.

3. "Managing the Stockpile," National Nuclear Security Administration, www.nnsa.energy.gov/ourmission/managingthestockpile.

4. Located at Lawrence Livermore National Laboratory in California, NIF is designed to study the thermonuclear components of nuclear weapons. This includes boosting from the primary fission bomb and the fusion secondary.

Test Facility (DARHT),[5] the Joint Actinide Shock Physics Experimental Research Facility (JASPER),[6] and the Z-Machine.[7] The Accelerated Strategic Computing Initiative (ASCI)[8] uses advanced computers and software to model the nonnuclear experiments, which simulate various conditions of a nuclear explosion, carried out at these facilities.[9]

Currently the United States is not pursuing redesigns of its weapons, but it is refurbishing existing warheads by replacing certain components. The proposed Reliable Replacement Warhead (RRW) program would have developed an optimized warhead design to improve performance, predictability, and safety. However, this would have required new experiments and advanced computational tools that might have led to a future need to return to nuclear testing.[10,11] Because of these concerns, the RRW program was denied funding by Congress and discontinued by the Obama administration. Currently, the United States conducts Lifetime Extension Programs (LEPs) to refurbish nuclear weapons and extend their operational lives for the coming decades. The W76 and W78 warheads and the B61 strategic bomb are undergoing modernization, and the W88 is scheduled to begin in 2016.[12] Under the LEPs, weapons components are remanufactured with adherence to their original design and are used to replace their aging counterparts.

The leaders of the SSP are very confident of the safety and reliability of the United States' nuclear weapons.[13] Due to the work carried out using tools developed under the SSP, a 2009 JASON study found "no evidence that accumulation of changes incurred from aging and LEPs have increased risk to certification of today's deployed nuclear warheads."[14] The lifetime of weapons can be extended for decades, using the current approach to LEPs, without expecting significant loss of confidence over time.[15] It was concluded that the primary components of nuclear weapons systems in the stockpile and the plutonium pits have "credible minimum lifetimes" of over a century.[16] The 2012 NAS committee stated that the LEPs are "satisfactorily carried out to extend the lifetime of existing warheads

5. DARHT is located at Los Alamos National Laboratory in New Mexico and is designed to study the fission primary of nuclear weapons.

6. Operating at the Nevada National Security Site, formerly the Nevada Test Site, JASPER studies the implosion of the plutonium pit of the primary fission bomb.

7. The Z Machine, located at Sandia National Laboratories in Albuquerque, New Mexico, uses pulsed power technology in simulations to mimic the conditions created by a nuclear detonation.

8. ASCI is a network of supercomputers housed in several national laboratories.

9. A. Fitzpatrick and I. Oelrich, "The Stockpile Stewardship Program: Fifteen Years On," *Federation of American Scientists*, April 2007, 3, www.fas.org/2007/nuke/Stockpile_Stewardship_Paper.pdf.

10. Congressional Commission on the Strategic Posture of the United States, *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States* (Washington, DC: U.S. Institute of Peace Press, 2009), 41.

11. JASON Defense Advisory Panel Reports, *Reliable Replacement Warhead Executive Summary,* September 7, 2007, 4, www.fas.org/irp/agency/dod/jason/rrw.pdf.

12. "U.S. Nuclear Modernization Programs," *Arms Control Association*, August 2012, www.armscontrol.org/factsheets/USNuclearModernization.

13. Fitzpatrick and Oelrich, "The Stockpile Stewardship Program: Fifteen Years On."

14. *Lifetime Extension Program (LEP) Executive Summary*, JSR-09-334E (McLean, VA: MITRE Corporation, JASON Program Office, 2009), 2.

15. Ibid.

16. *Pit Lifetime*, JSR-06-33335 (McLean, VA: MITRE Corporation, JASON Program Office, 2007), 20.

without the need for nuclear-explosion tests."[17] Furthermore, the reuse or replacement of individual warhead components is considered a viable option for improving the safety and reliability of the weapon.[18] The stockpile surveillance program of the SSP has also judged that the current condition of the nuclear weapons stockpile is safe and reliable.

THE CAPABILITIES OF NUCLEAR TEST EXPLOSION MONITORING

The technical capability to monitor nuclear tests has also been a great concern when considering the CTBT. The international monitoring system (IMS) of the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) uses four verification technologies to monitor nuclear testing in the atmosphere, space, underwater, and underground. Established in 1996, the Preparatory Commission for the CTBT is headquartered in Vienna, Austria, and is working on developing the verification regime of the CTBT and preparing the treaty's entry into force. The IMS monitoring stations are located in 89 countries around the world and monitor for nuclear events in the oceans, the atmosphere, and underground.[19] The other sources of test monitoring data for the United States are available through National Technical Means (NTM), the classified U.S. monitoring capability, and satellite based-monitoring. Most of the IMS seismic stations are currently operating and have been certified for data quality, calibration, and robustness against data tampering and fraud.[20]

A total of 11 stations monitor the oceans for testing activity: 6 underwater hydro-acoustic stations and 5 T-phase stations on land. Hydro-acoustic stations monitor sound waves that propagate through water over long distances, and T-phase stations monitor seismic waves that occur when the underwater sound waves hit land. Hydro-acoustic monitoring is the most costly detection method since the systems need to be operated and maintained in challenging environments (in the deep ocean).[21] Infrasound stations, comprising an array of infrasound detectors and a meteorological station, measure low frequency sound waves in the atmosphere. Sixty infrasound stations around the world monitor the atmosphere for nuclear test explosions.[22] Radionuclide monitoring stations detect fission products that have become airborne and transported in the atmosphere, and they can confirm that a suspected event was a nuclear explosion. There are 80 radionuclide stations around the world, and half of them have the ability to detect specific isotopes of noble gases that are released in nuclear explosions.[23]

17. National Research Council of the National Academies, Committee on Reviewing and Updating Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (Washington, DC: National Academies Press, 2012), 28.

18. Ibid.

19. "Overview of the Verification Regime," CTBTO Preparatory Commission, www.ctbto.org/verification-regime/background/overview-of-the-verification-regime/.

20. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 38.

21. "Hydroacoustic Monitoring," CTBTO Preparatory Commission, www.ctbto.org/verification-regime/monitoring-technologies-how-they-work/hydroacoustic-monitoring/.

22. "Infrasound Monitoring," CTBTO Preparatory Commission, www.ctbto.org/verification-regime/monitoring-technologies-how-they-work/infrasound-monitoring/.

23. "Radionuclide Monitoring," CTBTO Preparatory Commission, www.ctbto.org/verification-regime/monitoring-technologies-how-they-work/radionuclide-monitoring/.

With 170 stations around the world, seismic monitoring is the most effective technique for detecting underground nuclear explosions. Nuclear explosions and earthquakes exhibit different seismic signals, which can be used to discriminate between the two kinds of events. The technical capability of seismic detectors and the ability to distinguish nuclear explosion signals from conventional explosives, earthquakes, and other phenomena has advanced over the years. Seismic monitoring also has the lowest detection threshold for nuclear testing. Seismologists can attest to being able to detect underground nuclear tests with a limit of detection of 1 kiloton, even if attempts are made to artificially suppress the signal by "muffling" the test.[24] Although extremely difficult to implement in reality, a nuclear explosion could theoretically be "decoupled" from its surroundings by conducting the test in a giant underground cavity. Alternatively, the signal could be suppressed by simultaneously detonating conventional explosives near the site of the nuclear test.[25] Concerns that another country could advance their nuclear weapons capability by conducing undetected low-yield nuclear tests persist in debates on the CTBT.

POTENTIAL ADVANCES A COUNTRY COULD MAKE BY CONDUCTING NUCLEAR EXPLOSION TESTS

Other than the United States, the countries that are currently planning to upgrade (to varying extents) their nuclear arsenals include China, North Korea, France, India, Israel, Pakistan, Russia, and the United Kingdom. According to the 2012 NAS report, "The Nuclear Weapon States have been able to maintain their nuclear weapons programs under a nuclear-explosion-test moratorium and are likely to be able to make nuclear weapons modifications that fall within the design range of their test experience without resorting to nuclear-explosion testing."[26] It is unlikely that a single test explosion will provide information on the overall condition of the country's stockpile. For example, most of the nuclear tests carried out by the United States in the decades before the testing moratorium were related to the development of new designs or understanding of weapons physics. Few of the warhead designs tested ever entered the actual stockpile. Although the U.S. testing program contributed to developing expertise and a sense that the U.S. weapons were reliable, the total number of tests carried out was too small, and was not intended, to provide a statistic basis for confidence in the overall weapons stockpile.[27] Therefore, a country could decide to test if it believed that doing so would enhance its confidence in its nuclear weapon capabilities or validate a new weapons design, but doing so would not provide statistically relevant confidence in its stockpile.

The detection capabilities of the IMS and the U.S. NTM can reduce the likelihood of countries successfully conducting evasive nuclear explosion tests and thus discourage the

24. Paul G. Richards and Wu Zhongliang, "Seismic Monitoring of Nuclear Explosions," in *Encyclopedia of Solid Earth Geophysics Series,* ed. Harsh K. Gupta (Dordrecht, The Netherlands: Springer, 2011), 1144–56, http://link.springer.com/referencework/10.1007/978-90-481-8702-7/page/1.

25. Ibid.

26. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 126.

27. National Research Council of the National Academies, Committee on Technical Issues Related to Ratification of the Comprehensive Nuclear Test Ban Treaty, *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty* (Washington, DC: National Academies Press, 2002), 21.

development and testing of new warhead designs. However, it is still possible for relatively simple lower-yield weapons to be developed without being tested. For example, the United States did not test the Little Boy design before the weapon was deployed.[28] If a country with less nuclear testing experience decided to pursue covert low-yield tests of under one kiloton, it would be able to study weapons physics and gain testing experience and confidence in its stockpile. Countries with advanced testing experience could potentially pursue modifications of existing nuclear weapons designs by testing at low yields. With the ability to test weapons with yields exceeding one kiloton, a less experienced country could develop more complex weapons designs, whereas an advanced country could develop new or modified weapons without restraint.[29] Primarily, the nuclear modernization programs of concern to the United States are those of Russia and China, since they are judged to be the states with the most testing experience and the ones most likely to carry out an evasive nuclear test explosion without being detected. (It is noted that the term *nuclear modernization*, which is sometimes used when discussing the CTBT, can be ambiguous since it often does not distinguish between modernization of different delivery systems or the warhead).[30] Some sources indicate Russia's plans to develop low-yield tactical weapons and China's plans to increase the number of warheads in its arsenal, but it is not clear if either country is definitely pursuing new, advanced weapons designs.[31] The two countries are believed to be the ones most able to benefit from undetectable low-yield tests. Other states with nuclear weapons will encounter challenges financing their testing programs and carrying out the test, and they would face a high likelihood of being detected if they are successful.[32]

Uncertainties and the Current Political Debate on the CTBT

It is widely acknowledged that considerable progress has been made in the past several years in stockpile stewardship, nuclear test monitoring, and understanding the risks of nuclear weapons modernization around the world. However, technical insights remain a necessary but insufficient condition for facilitating agreements on all the provisions of the CTBT. At the interface of science and policy for the CTBT, technical findings are often interpreted in the framework of existing political criteria. Despite the advances made since the last Senate debate, many of the underlying concerns about the CTBT still exist. Uncertainties about maintaining U.S. nuclear weapons and the limits of IMS detection capability are examples of persisting points of disagreement in the ratification debate. Many of the other arguments involve perceptions of whether ratifying the treaty would affect nonproliferation, deterrence, and assurance. Although the issues are both technical and political,

28. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 2.

29. Ibid., 100.

30. Jeffrey Lewis, "Maintaining Stable Deterrence with Russia and China: Testimony Before the Subcommittee on Strategic Forces Committee on Armed Services, U.S. House of Representatives," October 14, 2011.

31. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 96–99.

32. Ibid., 109.

positions are often based on deeply held views of the role of nuclear weapons in U.S. national security and judgments about U.S. capability to provide security to its allies.

The SSP has been deemed adequate for maintaining the safety and reliability of U.S. nuclear weapons without the need to conduct nuclear explosive testing. Yet, the technical community is divided on whether the uncertainties in the aging of weapons over time will be detrimental to the credibility of the U.S. nuclear deterrent. These concerns stem from assessments that the surveillance programs for aging warheads have not been adequate.[33] The Congressional Commission on the Strategic Posture of the United States agreed, "The Life Extension Program has to date been effective in dealing with the problem of modernizing the arsenal. But it is becoming increasingly difficult to continue within the constraints of a rigid adherence to original materials and design as the stockpile continues to age."[34] Uncertainty in our nuclear capability could have significant policy implications. Arguments over the assurance value of U.S. nuclear weapons and the ability of the United States to reliably maintain nuclear weapons for extended deterrence affect U.S. relationships with allies and adversaries alike. Assurance affects how an ally perceives the United States, and deterrence affects the decisions of an adversary, and there is a wide spectrum of conjectured outcomes. On the one hand, U.S. ratification of the CTBT could lead to a future in which countries will be compelled to develop native nuclear weapons capability, since they no longer feel that the United States can provide the necessary security. On the other hand, ratification could lead to an era of nuclear restraint in which nonproliferation is enhanced due to the ability of the United States to maintain a safe, secure, and reliable nuclear weapons stockpile without additional testing.

Another aspect of the CTBT that opponents view as problematic is treaty verification. The threshold limit of detection by the IMS is estimated to be 1 kiloton worldwide for fully coupled explosions. This is further complicated by the statistical requirement that the explosion be detected at a 90 percent confidence by enough monitoring stations to be able to estimate the location of the event.[35] Verification itself is a policy judgment, whereas monitoring is the gathering of information. Detection of a suspected event would indicate that further information is needed, which could be obtained by conducting an on-site inspection (OSI). Under the CTBT, an OSI is the final verification procedure and can only be authorized once the treaty has entered into force.[36] Critics point out that before the CTBT can enter into force, it requires the ratification of 44 specific countries, including India, Israel, Pakistan, and North Korea.[37] In addition to the treaty's having entered into force, an OSI would require 30 out of 51 member states of the executive council to approve the inspection. Under these conditions, is likely that a request to conduct on OSI could be easily

33. C. Paul Robinson, John Foster, and Thomas Scheber, "The Comprehensive Test Ban Treaty: Questions and Challenges," Lecture No. 1218, Heritage Foundation, April 10, 2012, www.heritage.org/research/lecture/2012/11/the-comprehensive-test-ban-treaty-questions-and-challenges.

34. Congressional Commission on the Strategic Posture of the United States, *America's Strategic Posture*, 45.

35. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 6.

36. "Overview of the Verification Regime," CTBTO Preparatory Commission, www.ctbto.org/verification-regime/background/overview-of-the-verification-regime/.

37. Kathleen Bailey and Thomas Scheber, *The Comprehensive Test Ban Treaty: An Assessment of the Benefits, Costs, and Risks* (Fairfax, VA: National Institute Press, 2011), 23.

blocked.[38] From a different perspective, the 30-member requirement was designed to give the states assurance that inspections would be approved as needed but also guard against possible suspect or abusive inspections by states with questionable intentions.[39]

A similar issue that has been raised is the lack of definition of "test" and the U.S. decision to abide by a zero-yield[40] policy. The CTBT, as well as the Treaty on the Non-Proliferation of Nuclear Weapons, is lacking in this language. In reality, the United States "decided at the outset of negotiations that it was unnecessary, and probably would be problematic, to seek to include a definition in the Treaty text of a 'nuclear weapon test explosion or any other nuclear explosion' for the purpose of specifying in technical terms what is prohibited by the Treaty."[41] The decision not to include a precise definition was intentional and not an oversight, and it sought to ensure that "no loopholes were created by including a highly technical and specific list of what specific activities were and were not permitted under the Treaty."[42] When the treaty was signed, the five permanent members of the UN Security Council[43] and other signatories understood it was a "zero-yield" treaty.[44] The language of the CTBT emulated the text of the Limited Test Ban Treaty (LTBT), which also did not include such precise technical definitions.

Because it is possible to conduct extremely low-yield nuclear tests undetected, there is concern that other states will be able to continue to do "experimental proof testing of their stockpiled nuclear arsenals" under the guise of compliance with the treaty. Meanwhile, the United States is restricted to surveillance tests on weapons.[45] Many are concerned that this scenario would place the United States at a disadvantage if other countries were able to attain high confidence in their nuclear weapons.

A Historical Perspective: Verification Challenges of Earlier Nuclear Test-Limiting Treaties

Nuclear test–limiting treaties of the past faced years of opposition before being ratified and entering into force. The CTBT has faced many of the same concerns and problems since the idea of a total test ban was first proposed in the 1950s. The same debates surrounded its predecessors: the 1963 LTBT, the 1990 Threshold Test Ban Treaty (TTBT), and the 1990 Peaceful Nuclear Explosions (PNE) Treaty. The LTBT is a multilateral agreement, and the TTBT and the PNE Treaty are bilateral treaties between the United States and the Soviet Union. The

38. Robinson, Foster, and Scheber, "The Comprehensive Test Ban Treaty: Questions and Challenges."
39. "Test Ban Treaty: Myths vs. Realities," *Arms Control Association* 3, no. 6 (March 30, 2012), www.armscontrol.org/issuebriefs/CTBT-Myths-vs-Realities.
40. Tests that do not go supercritical, leading to an uncontrolled fission chain reaction.
41. U.S. Department of State, "Comprehensive Nuclear Test-Ban Treaty (CTBT),"www.state.gov/t/avc/trty/16522.htm.
42. U.S. Department of State, "Scope of the CTBT," September 29, 2011, www.state.gov/t/avc/rls/173944.htm.
43. These are also the five nuclear weapons states recognized by the Treaty on the Non-Proliferation of Nuclear Weapons.
44. U.S. Department of State, "Scope of the CTBT," www.state.gov/t/avc/rls/173944.htm.
45. Robinson, Foster, and Scheber, "The Comprehensive Test Ban Treaty: Questions and Challenges."

LTBT prohibited nuclear weapons tests or explosions in the atmosphere, outer space, and underwater, but not underground.[46] The TTBT, also known as the Treaty on the Limitation of Underground Nuclear Weapon Tests, established a threshold for nuclear explosions of 150 kilotons.[47] The PNE Treaty expanded governance of nuclear explosions to locations not covered by the TTBT and set limits for nuclear tests involving multiple explosions.[48]

When considering the challenges for the CTBT, it is meaningful to look back on the experiences during previous efforts to limit nuclear test explosions. Unanimous Senate approval of the LTBT came after eight years of hard work, which involved overcoming difficult technical issues of verification and strongly held opposing views on how best to implement arms control. The treaty also had to face the divided political atmosphere and relationships of the time.[49] Originally envisioning a path to a comprehensive test ban, President John F. Kennedy was unable to negotiate such a treaty. However, many saw the resulting LTBT as an important step in this direction for slowing the U.S.-Soviet arms race. After the treaty was signed, the Kennedy administration pursued an aggressive campaign for Senate and public support and succeeded. In 1963 the treaty was ratified and signed into law.[50]

One year later, in 1964, the push for a comprehensive test ban treaty by the Soviet Union met resistance from the United States due to uncertainties about verification and the U.S. nuclear stockpile. Nevertheless, the United States and the Soviet Union agreed to initiate negotiations on a treaty that banned nuclear explosions under a determined explosive yield level. The negotiators of the TTBT needed to determine what the yield threshold should be, how to effectively monitor and detect explosions to ensure that they did not exceed the threshold, and how to regulate peaceful nuclear explosion tests.[51] The threshold limit put a cap on the arms race by precluding the option of testing nuclear weapons that exceeded yields of 150 kilotons, which were frequently conducted by the United States and the Soviet Union and were important for developing first-strike capabilities.[52] Problems soon arose when addressing the issue of verification because yield estimates from seismic measurements had a large margin of uncertainty. The conversions for yield estimates from seismic data required detailed understanding of the geography, types of rock, water levels, and geographic layers between the blast site and the sensors located several kilometers away. But due to political constraints, the measurement instruments, which provided more accurate measurements, were not exchanged between the two countries, and the ratification process for the TTBT was delayed.[53]

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46. "Limited Test Ban Treaty (LTBT)," *Arms Control Association*, www.armscontrol.org/documents/LTBT.
47. "Threshold Test Ban Treaty (TTBT)," *Arms Control Association*, www.armscontrol.org/documents/ttbt.
48. "Peaceful Nuclear Explosions Treaty (TTBT)," *Arms Control Association*, www.armscontrol.org/documents/pnet.
49. "Limited Test Ban Treaty (LTBT)," *Arms Control Association*.
50. William Burr and Hector L. Montford, eds., "The Making of the Limited Test Ban Treaty, 1958–1953," National Security Archive, August 8, 2008, www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB94/.
51. Edward Ifft, "The Threshold Test Ban Treaty," *Arms Control Today*, March 2009, www.armscontrol.org/act/2009_03/LookingBack_Ifft.
52. "Threshold Test Ban Treaty (TTBT)," *Arms Control Association*.
53. Interestingly, the decade before President Ronald Reagan reinitiated the ratification of the TTBT, both the United States and the Soviet Union abided by the agreed-upon 150-kiloton limit with no treaty in place.

Under pressure to negotiate a CTBT in 1986, President Reagan convinced Soviet General Secretary Mikhail Gorbachev to first work on solving the verification questions of the TTBT and PNE Treaty. The negotiations required that the United States and the Soviet Union abide by intrusive requirements. For example, measures of the treaty required both sides to report when they were planning to conduct a test. The treaty also provided a way for both sides to monitor the other's test yields of more than 50 kilotons by drilling a hole near the test site to measure the explosion. Both sides could also conduct on-site inspections for yields greater than 35 kilotons.

For years, neither country had ratified the TTBT or PNE Treaty, until both sides agreed on intrusive but effective verification protocols. Political leaders had established clear goals and accomplished them. The U.S. team, led by Ambassador Paul Robinson, completed the work on the negotiation of the joint set of verification tests that would be used to ratify the TTBT and the PNE Treaty after they had "sat for more than a decade."[54] In a recent lecture given by Ambassador Robinson, he stated, "I'm proud to say the Senate agreed to ratify those [treaties] unanimously, and I believe the reason why was the strong verification that both sides had developed. We both got very familiar with how the proposed verification methods worked and both sides agreed on them, and the treaties and verification protocols remain in force today."[55]

Politically charged events of the time also helped create a sense of urgency for world powers to negotiate treaties to limit nuclear explosions tests. For the LTBT, there was sustained public interest in the course of negotiations and pressure to discontinue nuclear testing. The growing understanding and concerns about the adverse affects of radioactive fallout on human health and the environment garnered political influence from antinuclear activism in the United States and around the world.[56] Many UN General Assembly resolutions were also issued in support of a nuclear test ban, which would be monitored and managed by an international entity.[57] The Cuban Missile Crisis of 1962 brought the United States and Soviet Union close to nuclear war and motivated both countries to make progress on seeking a ban on nuclear testing.[58] Amidst the negotiations for the TTBT and PNE Treaty, India exploded a nuclear weapon in the Rajasthan Desert and claimed that it was a peaceful test, placing pressure on the United States and the Soviet Union to reach an agreement.

The United States and the Soviet Union signed and ratified the TTBT and the PNE Treaty, and the treaties entered into force in 1990.[59] Although the circumstances of the present are very different, it is useful to look back at the concrete steps that have been taken toward a complete ban on nuclear testing. There were many lessons learned and innovative approaches developed to solve technical problems and challenges. These earlier treaties

54. Robinson, Foster, and Scheber, "The Comprehensive Test Ban Treaty: Questions and Challenges."
55. Ibid.
56. Burr and Montford, "The Making of the Limited Test Ban Treaty."
57. "Limited Test Ban Treaty (LTBT)," *Arms Control Association*.
58. Burr and Montford, "The Making of the Limited Test Ban Treaty."
59. Ifft, "The Threshold Test Ban Treaty."

limited the threshold of explosive yield but did not impose a total ban on underground nuclear testing. At the time, there was greater emphasis on solving issues of treaty verification rather than restraint of nuclear testing by the treaties' signatories.

The U.S. Nuclear Test Moratorium: Implications for the Future

Earlier nuclear test-limiting treaties have spent many years pending ratification before their entry into force. Due to the current lack of consensus in the U.S. government on the CTBT, and issues of treaty verification and stockpile reliability, there is no indication that the treaty will be ratified in the near future. Although the CTBT is not in force, the United States and other parties to the treaty are abiding by a nuclear test moratorium under the terms of the Vienna Convention, which does not allow signatories of the treaty to defeat the "object and purpose" of the treaty prior to entry into force.[60] From a technical perspective, the question now is: what are the main scientific and technical challenges that the United States needs to address during this continuing impasse? President Obama promised to pursue the conditions necessary for the global elimination of nuclear weapons but also to maintain an effective U.S. nuclear defense as long as nuclear weapons still exist.[61] There exists an inherent tension between these two goals and the need to assure our allies and deter our adversaries. There is currently no consensus on a national strategy for the roles that nuclear weapons will serve or definitions of the interim steps along the way to the ultimate goal of a world without nuclear weapons. If the CTBT is ratified and entered into force, or if the United States continues to adhere to a testing moratorium as a matter of policy, the United States will need to be ready to adequately respond to threats against itself and its allies.

MANAGEMENT OF THE NUCLEAR WEAPONS STOCKPILE

Over the years, Department of Defense (DOD), DOE, and National Nuclear Security Administration (NNSA) programs have found and fixed many problems in nuclear weapons in the U.S. stockpile. Improved technical understanding and emphasis on warhead safety and reliability have led to a significant revaluation of the SSP in a positive light.[62] It is unlikely that the United States will need to resume nuclear explosion testing, since it is understood that that "so long as modernization proceeds within the framework of existing U.S. policy, it should encounter minimum political difficulty."[63] As a matter of policy, currently the United States does not develop new nuclear weapons designs or conduct nuclear explosive tests, and the United States should maintain the safety, security, and reliability of the

60. Chapter XXIII, Law of Treaties, Vienna Convention on the Law of Treaties, Vienna, 23 May 1969 Entry into force 27 January 1980, http://treaties.un.org/Pages/ViewDetailsIII.aspx?&src=TREATY&mtdsg_no=XXIII~1&chapter=23&Temp=mtdsg3&lang=en.

61. U.S. Department of Defense, *Nuclear Posture Review Report* (Washington, DC: U.S. Department of Defense, April 2010), 1.

62. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 100.

63. Congressional Commission on the Strategic Posture of the United States, *America's Strategic Posture*, 45.

existing stockpile within these boundaries.[64] However, many aspects of the stockpile programs have experienced and are continuing to experience delays in testing due to managerial, technical, and funding issues. For example, it was recently assessed that the NNSA and the DOD did not effectively manage the B61 or the W76 LEPs. Although the B61 LEP is ongoing, the refurbishment of two specific types of B61 bombs, the Mod 7 and Mod 11, was completed in 2008. However, the agencies did not meet all the refurbishment objectives. The manufacture of a key material for the W76, "Fogbank" (the nature of which is classified), was mismanaged and resulted in cost overruns and delays.[65] Management programs for the stockpile LEPs will need to be improved in order to be completed on time and within the budget. This is especially important since the B61 supports U.S. extended deterrence and the North Atlantic Treaty Organization (NATO).[66] Moreover, it is likely that future LEPs will be completed under tighter deadlines and with stringent operational requirements as other warheads approach the end of their service lives.

Regarding the stockpile surveillance program, the assessments that have been made so far are within "acceptable uncertainties."[67] However, it is believed that if the surveillance program does not improve its capabilities and quality of data, the uncertainties will grow.[68] Over time the number of problems will increase, as will the number of questions relating to weapons reliability.[69] Additionally, carrying out the mandate for maintaining the stockpile requires sustained nuclear weapons production capability. One challenge will be to ensure a reliable supply of tritium, an important isotope used in nuclear weapons, for maintaining U.S. stockpiled weapons in the long-term.[70] These problems will certainly need to be addressed in order for the United States to maintain a viable nuclear deterrent for the indefinite future under a nuclear testing moratorium.

NUCLEAR TEST EXPLOSION MONITORING SYSTEM

Even though the United States has yet to ratify the CTBT, it is the largest regular contributor to the CTBTO and the country to host the largest number of IMS stations. The United States should continue to support the IMS, which is currently more than 85 percent complete, whether or not the CTBT is ratified and entered into force.[71] In the future there will be the

64. Ibid.

65. U.S. Government Accountability Office, *NNSA and DOD Need to More Effectively Manage the Stockpile Life Extension Program*, GAO-09-385 (Washington, DC: U.S. Government Accountability Office, 2009).

66. U.S. Government Accountability Office, *DOD and NNSA Need to Better Manage Scope of Future Refurbishments and Risks to Maintaining U.S. Commitments to NATO*, GAO-11-387 (Washington, DC: U.S. Government Accountability Office, 2011), 2–4.

67. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 22.

68. Ibid.

69. U.S. Government Accountability Office, *NNSA Needs to Improve Guidance on Weapons Limitations and Planning for Its Stockpile Surveillance Program*, GAO-12-188 (Washington, DC: U.S. Government Accountability Office, 2012), 22.

70. U.S. Government Accountability Office, *National Nuclear Security Administration Needs to Ensure Continued Availability of Tritium for the Weapons Stockpile*, GAO-11-100 (Washington, DC: U.S. Government Accountability Office, 2010), 1–2.

71. National Research Council of the National Academies, *The Comprehensive Nuclear Test Ban Treaty—Technical Issues for the United States* (2012), 13.

need for maintenance of infrastructure and skills for verification and monitoring of nuclear test explosions.

THE FUTURE OF U.S. TECHNICAL CAPABILITY AND CAPACITY

When considering a program for maintaining a safe, secure, and reliable stockpile, nuclear weapons expertise and knowledgeable personnel are often identified as—by far—the most important and limited resource for the future. Forward-looking assessments for the strategic needs of the United States specify a need for a framework to develop human capital to maintain technical capabilities in the areas of weapons design, development, assessment, and certification.[72] Additionally, there is a perceived inadequacy of the physical infrastructure needed to train personnel in these areas. There is currently no specific statement of policy identifying the capabilities that need to be preserved, or any well-defined management plans to help achieve the technical goals needed for the indefinite future of the United States under the nuclear test moratorium.

Conclusion

Ratification of the CTBT is not on the forefront of the U.S. government's agenda. In the meantime, the United States is investing large amounts of resources to maintain its nuclear stockpile for the indefinite future. Despite the significant improvements in technology relevant to the treaty, there is presently no political or technical consensus on all aspects of the CTBT. Technical issues are part of many factors involved in considering the treaty. It is reasonable to expect that many individuals who were originally skeptical are now persuaded that the case for the CTBT is substantially stronger. But it is impossible to know if the Senate would ratify the treaty if it were voted on in the near future. Contentious questions persist. How would ratification of the treaty (1) impact the defense and national security of the United States, (2) affect nonproliferation, and (3) inhibit or encourage other countries to develop their own nuclear weapons? The questions are complex and involve technical and political judgments. Ultimately, the U.S. government is unlikely to agree to a treaty if Washington perceives that it is being bound to a disadvantaged position while other countries are not.

72. Bruce T. Goodwin and Glen L. Mara, "Stewarding a Reduced Stockpile," AAAS Technical Issues Workshop, LLNL-CONF-403041 (Washington, DC, 2008), 7.

Squaring the Circle? The Nuclear Non-Proliferation Treaty, Iran, and the Challenge of Compliance

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Today, the Nuclear Non-Proliferation Treaty (NPT) is confronted by the challenge of Iran's nuclear program, which in recent decades has placed unprecedented levels of stress on the treaty. It raises the important question of whether or to what degree Iran is actually complying with its international legal obligations under the NPT and, therefore, what the future of the NPT and the nonproliferation regime may be if Iran continues along its current path. However, there are four principal challenges in determining whether a state is in violation of the NPT. First, the treaty is silent on who determines compliance; second, it is not clear how compliance should be verified; third, there is no distinction made between the sensitive and nonsensitive elements of the nuclear fuel cycle; and fourth, there is no discussion of enforcement. With these challenges in mind, and by relying on International Atomic Energy Agency (IAEA) reports and UN Security Council resolutions, this paper finds that while Iran cannot be judged at this time to be in violation of the letter of the NPT, it may already be in violation of the spirit of the treaty. Looking forward, a deal could be proposed wherein the Security Council drops its sanctions in exchange for Iran's ratification of the Additional Protocol. More broadly, there are innovative ways to strengthen the NPT, including by giving the Security Council an extended mandate with respect to states that violate their IAEA safeguards agreements. Ultimately, the NPT ideally would be stronger, less ambiguous, and more exacting on its signatories to not develop a nuclear weapons capability. In that vein, if the Iranian situation continues unabated, it may strain the treaty to its breaking point.

Introduction

As the cornerstone of the international nuclear nonproliferation regime, the Non-Proliferation Treaty (NPT) has been largely successful in limiting the number of nuclear-armed states since its entry into force in 1970. Fortunately for international peace and security, U.S. President John F. Kennedy's famous prediction of a massive nuclear buildup

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by the mid-1970s[2] never came true, and the NPT has played an important role in bringing about that outcome.[3] Yet the treaty was negotiated at a time when the concern over nuclear proliferation was markedly different from the proliferation challenge today,[4] and as a result, many contemporary observers have questioned the future saliency of the treaty in an ever-changing international security environment.[5]

Today, the NPT is confronted by a new and different challenge in the form of Iran's nuclear program, which in recent decades has placed unprecedented levels of stress on the treaty and the international nonproliferation regime. Despite multiple international statutes, declarations, and resolutions designed to condemn and limit Iran's activities, Iran has nonetheless demonstrated its ability to continue making significant progress on its indigenous nuclear fuel cycle, all while claiming to remain in complete compliance with its NPT obligations. Iran's determination has come with hefty real-world consequences, including international economic sanctions, diplomatic isolation, and even assassination and sabotage attempts. It also invites the important question of whether or to what degree Iran is actually complying with its international legal obligations under the NPT and, therefore, what the future of the NPT and the nonproliferation regime may be if Iran continues along its current path.

Hence, this paper will attempt to make an assessment of Iran's compliance status with respect to its international legal obligations under the NPT. In order to do so, this paper first will seek to understand what Iran is actually trying to accomplish through its nuclear ambitions. That is, does it only intend to develop nuclear energy, as it purports, or is the end goal in fact acquisition of nuclear weapons? Second, this paper will explore key legal and operational challenges related to the notion of NPT compliance, including how it is defined, measured, and enforced. Third, this paper will use critical international legal and institutional assessments to attempt to determine the current status of Iran's compliance. Finally, looking ahead, this paper will conclude with a few ways in which the NPT can be strengthened.

Assessing Iran's True Objectives

In order to judge Iran's compliance with the NPT, it is first necessary to determine whether Iran is pursuing a domestic nuclear power program or a nuclear weapons capability. If Iran's ultimate objective is the latter, it arguably would have strong reasons for doing so.

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2. In a 1963 press conference, President Kennedy foresaw "the possibility in the 1970's of the President of the United States having to face a world in which 15 or 20 or 25 nations may have these weapons." See "News Conference 52 (March 21, 1963)," John F. Kennedy Presidential Library and Museum, www.jfklibrary.org/Research/Research-Aids/Ready-Reference/Press-Conferences/News-Conference-52.aspx.

3. Daryl G. Kimball, Welcome (presented at the conference on Addressing the Challenges Facing the NPT at the Arms Control Association, Washington, DC, June 16, 2008), www.armscontrol.org/events/20080617_Morning_Panel.

4. Some examples of contemporary NPT challenges include the secret development of nuclear weapons in South Africa; the contested withdrawal of North Korea from the NPT in 2003; and the attempted nuclear weapons programs of Libya, Syria, and Iraq.

5. Joshua Williams and Jon Wolfsthal, "The NPT at 35: A Crisis of Compliance or a Crisis of Confidence?," *UNA-USA Policy Brief* 7, April 29, 2005, www.carnegieendowment.org/files/UNA_Policy_Brief.pdf.

Scott Sagan[6] and Joseph Cirincione[7] write that there are five primary factors that lead to a decision to pursue nuclear weapons: power, international prestige, domestic politics, technology, and economics. First, the Cold War–era theory that states develop nuclear weapons in response to perceptions of regional and international security threats still holds true today.[8] Second, nuclear weapons can symbolize a country's greatness, and therefore its prestige, in the international community.[9] Third, internal factions competing for power within a country can help influence the outcome of a national decisionmaking process on whether or not to pursue the bomb. Fourth, if a nation has the latent technological capability to produce nuclear weapons, political leaders will largely be unable to resist doing so. Finally, although a nuclear weapons program certainly is resource-intensive and very costly, proponents of developing nuclear weapons argue that they are still more cost-effective than building up conventional capabilities.

If, in the case of Iran, a nuclear weapons capability is the ultimate objective, then all five driving forces can help explain Iran's actions so far. First, Iran must contend with perceived serious regional and international security concerns. Second, it is clear that Iran is actively seeking to become a regional hegemon, and acquisition of nuclear weapons could help secure and reinforce that objective,[10] although Iranian officials have publicly denounced the linkage between nuclear weapons and international renown.[11] Third, Iran certainly has the capacity to develop a full indigenous nuclear fuel cycle, as evidenced by the size and depth of its program thus far. Fourth, Iran has invested significant resources, measured in time, manpower, and money, to acquire this capability,[12] though arguably at a significant national cost. Finally, from what is known about internal Iranian dynamics, although the evidence that Iran actually has made the unified political decision to pursue the bomb is thus far inconclusive, there certainly is pressure within the bureaucracy to do so.[13]

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6. Scott D. Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb," *International Security* 21, no. 3 (Winter, 1996–1997): 54–86.

7. Joseph Cirincione, *Bomb Scare: The History and Future of Nuclear Weapons* (New York: Columbia University Press, 2007), 47–83.

8. The nuclear rise of the Soviet Union was primarily a response to the threat posed by the United States, and later the nuclear activities of France, the United Kingdom, and China were reactions to geopolitical security challenges born of the competition between the Soviet Union and the United States to increase their respective spheres of influence. More recent nuclear states, including India, Pakistan, Israel, and North Korea, demonstrate the extent to which security continues to drive national leaders' calculations.

9. After all, it is no coincidence that the five permanent members of the United Nations Security Council are all nuclear weapons states.

10. Marina Ottaway, *Iran, the United States, and the Gulf: The Elusive Regional Policy* (Washington, DC: Carnegie Endowment for International Peace, 2009).

11. Ali Akbar Salehi, Iran's former ambassador to the International Atomic Energy Agency, once remarked, "I am not among those who believe that nuclear weapons bring prestige. . . . A country like Iran cannot have prestige by acquiring nuclear weapons." Quoted in Michael Friend, "Counterproliferation versus Nonproliferation in the Middle East after Saddam: Lessons from Iraq and Libya," in *Proliferation of Weapons of Mass Destruction in the Middle East: Directions and Policy Options in the New Century*, ed. James A. Russell (New York: Palgrave Macmillan, 2006), 191.

12. Ibid.

13. Patrick Disney, "Is Iran Really After a Nuclear Bomb?" *The Atlantic*, August 2, 2011, www.theatlantic.com/international/archive/2011/08/is-iran-really-after-a-nuclear-bomb/242900/.

Nevertheless, despite this multitude of nuclear weapons justifications, it may be just as likely that Iran is continuing its domestic nuclear activities with the intent to develop a peaceful program exclusively for energy production. The United States and other Western powers have largely dismissed this possibility, having noted that Iran has the fourth-largest oil reserves in the world[14] and concluding that if Iran can rely on these reserves for domestic consumption, it has little to no justification for developing a domestic nuclear program of any kind.[15] However, a 2007 study by the U.S. National Academy of Sciences found that Iran sends the majority of its oil abroad, relying primarily on the revenue from those exports for domestic economic growth; therefore, as the size of its oil reserves declines, Iran will be increasingly unable to use its oil for domestic use and eventually will face a genuine energy crisis that could only be mitigated through nuclear power.[16] Corroborating these conclusions, a 2011 Bloomberg article found that as international sanctions against Iran continued to tighten, Iran was depending more on oil revenues, then valued at $80 billion annually, to prevent complete economic collapse at home.[17] Therefore, Iran may have reasonable justifications for developing nuclear power to diversify its energy mix and reduce its reliance on domestic oil consumption.

QUESTIONABLE MOVES

However, Iran's efforts to enrich uranium, which are at the heart of the international controversy over the Iranian nuclear program, raise the question of whether Iran actually needs to develop this indigenous enrichment capability for what is a very nascent nuclear power–generating capacity. Economically, it is more cost-effective for Iran to purchase low-enriched uranium on the international market than to produce its own nuclear fuel domestically. An independent study conducted by scientists at Pacific Northwest and Los Alamos National Laboratories found that until a state builds between 5 and 20 nuclear reactors for energy-generating purposes, it would not need to invest in a domestic uranium enrichment program to fuel those reactors and would be better off buying its fuel on the global market.[18]

Iran's enrichment efforts, therefore, have become an issue of concern for two reasons. First, to date, Iran has constructed only one reactor capable of generating

14. A January 1, 2012, estimate places Iran's petroleum reserves at 151 billion barrels. See "Crude Oil—Proved Reserves," *CIA World FactBook*, https://www.cia.gov/library/publications/the-world-factbook/rankorder/2244rank.html.

15. Roger Stern, "Oil market power and United States National Security," *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 103, no. 5 (January 2006): 1650–55.

16. Roger Stern, "The Iranian petroleum crisis and United States national security," *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 104, no. 1 (January 2007): 377–82.

17. Indira Lakshmanan, "Iran Clings to Oil Lifeline as U.S. Pushes for Tighter Financial Sanctions," Bloomberg, December 1, 2011, http://mobile.bloomberg.com/news/2011-12-01/iran-clings-to-oil-lifeline-as-u-s-pushes-sanctions.html.

18. See Sharon Squassoni, "The Iranian Nuclear Program," in *Combating Weapons of Mass Destruction: The Future of International Nonproliferation Policy*, eds. Nathan E. Busch and Daniel H. Joyner (Athens: University of Georgia Press, 2009), 285; Thomas W. Wood, Matthew D. Milazzo, Barbara A. Reichmuth, and Jeffrey Bedell, "The Economics of Energy Independence for Iran," *Nonproliferation Review* 14, no. 1 (March 2007): 89–112.

electricity, despite decades of claims by Iranian leaders that the nation seeks to develop an entire network of reactors across the country. The Bushehr light-water reactor, which was finally connected to the Iranian power grid in September 2011 and became fully operational in August 2012,[19] took more than 35 years to build and was successfully completed only because of significant international assistance. Iran's publicly stated objective to produce 7,000 operational megawatts of nuclear power by 2025[20] seems overly ambitious.

Second, Iran has now rejected three multilateral nuclear fuel supply proposals in the past five years alone, including the 2006 incentive package with the P5+1,[21] the 2009 Russian reprocessing agreement, and the 2010 Turkey–Brazil deal.[22] Given the meager size of the Iranian nuclear power program, a rational cost-benefit analysis would confirm to Iran's decisionmakers that any pursuit of indigenous uranium enrichment capabilities would be far too costly at the present time, and that the country would benefit from acquiring its uranium on the open market. Iran, however, has demonstrated its intent to have a robust indigenous enrichment capability "at any price."[23] Observers are hence forced to question whether the size and scope of Iran's uranium enrichment efforts match both its intentions and its capabilities.

In addition to these questionable moves, suspicions have been heightened by Iran's activities in recent years, including an effort to increase uranium enrichment levels to near-weapons usable quality,[24] along with an overall tripling of domestic uranium production.[25] The first move indicates Iran is closer than ever to being able to produce the kind of uranium needed not for nuclear energy, which requires uranium enriched at relatively low levels, but for a possible nuclear weapon.[26] The second development suggests Iran is taking initial steps to stockpile its uranium, either against anticipated attacks on its nuclear infrastructure or in preparation for using that uranium in a larger-scale operation. In the meantime, Iran has recently conducted extensive research on advanced

19. "Iran launches Bushehr nuclear power plant," *RIA Novosti*, September 12, 2011, http://en.rian.ru/world/20110912/166785925.html; "Atomic republic: Iran's Bushehr power plant fully operational," *RT*, August 31, 2012, http://rt.com/news/iran-bushehr-nuclear-operational-038/.

20. Statement by Kamal Kharrazi, former Iranian foreign minister, "Tensions Grow Over Iran's Nuclear Goals," *NewsHour with Jim Lehrer*, September 27, 2004, www.pbs.org/newshour/bb/middle_east/july-dec04/iran_9-27.html.

21. The P5+1 includes the five permanent members of the UN Security Council—the United States, Russia, China, the United Kingdom, and France—and Germany.

22. Kenneth Katzman, U.S. Library of Congress, Congressional Research Service, *Iran: U.S Concerns and Policy Responses*, Congressional Rep. RL32048 (Washington, DC: The Service, November 15, 2011), 31–35.

23. Quoted in Squassoni, 284.

24. David Albright and Christina Walrond, "Determining the purpose of Iran's growing stock of 19.75 percent enriched uranium: Production should be capped," *Institute for Science and International Security*, September 21, 2011, www.isisnucleariran.org/assets/pdf/Determining_the_purpose_of_Irans_growing_stock_of_1975_21Sept2011.pdf.

25. David E. Sanger and William J. Broad, "Iran Says It Will Speed Up Uranium Enrichment," *New York Times*, June 8, 2011, www.nytimes.com/2011/06/09/world/middleeast/09iran.html.

26. Weapons-usable uranium is at a minimum 20 percent enriched, while weapons-grade uranium is typically upward of 80 percent. Power-generating light-water reactors, on the other hand, typically require uranium enriched to between 3 percent and 5 percent.

weaponization-specific activities, including neutron initiators and triggering mechanisms, as well as nuclear-capable ballistic missile delivery systems.[27, 28]

Therefore, it seems that Iran may be moving in the direction of a nuclear weapons capability, not nuclear energy.[29] The combination of heightened enrichment levels, lack of nuclear reactors, past weaponization-specific efforts, and delivery system developments indicate that, perhaps contrary to its rhetoric, Iran is moving inexorably away from a strictly peaceful nuclear program and toward a program primed to deliver an Iranian nuclear weapon in very little time.

CAPABILITIES VERSUS INTENTIONS: NUCLEAR HEDGING

Yet this move toward a nuclear weapons capability may not be a deliberate decision on the part of Iranian decisionmakers with a view to eventually building the bomb. This brings up an important distinction between capability and intention, which underlies the differences in international opinion over Iran's nuclear program. That is, a country may decide to invest in developing the individual technical components of a domestic nuclear fuel cycle but still could remain politically undecided on how it ultimately intends to leverage that capability. It is largely because of this apparent disconnect between technical capabilities and political intentions that the international community is still unclear on Iran's true nuclear objectives.

Despite the above assessment of Iran's possible intentions, therefore, it is difficult to determine whether Iran's political leadership has actually made the decision to pursue nuclear weapons, although it is apparent that it is quickly developing the capability to do so. This was evidenced in February 2010, when Ali Akbar Salehi, head of the Atomic Energy Organization of Iran, stated that Iran has "no limit on enrichment. We can enrich up to 100 percent. . . . We have this capacity and capability. But we never had the intention and we do not have the intention to do so, *unless we need (to)* [emphasis added]."[30] This latent capability is what Eli Levite calls "nuclear hedging," defined as:

> a national strategy of maintaining, or at least appearing to maintain, a viable option for the relatively rapid acquisition of nuclear weapons, based on an indigenous technical capacity to produce them within a relatively short time frame ranging from several weeks to a few years.[31]

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27. Mitra Amiri, "Iran's military gets new missile system," Reuters, May 22, 2011, http://in.reuters.com/article/2011/05/22/idINIndia-57189320110522.

28. For a detailed analysis, see International Atomic Energy Agency, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, GOV/2011/65, November 8, 2011, Annex, www.iaea.org/Publications/Documents/Board/2011/gov2011-65.pdf.

29. John Carlson, "Iran nuclear issue—considerations for a negotiated outcome," *Institute for Science and International Security*, November 4, 2011, www.isisnucleariran.org/assets/pdf/Carlson_Iran_deal_4November2011.pdf.

30. Quoted in Parisa Hafezi, "Iran says nuclear fuel production goes 'very well,'" Reuters, February 11, 2010, www.reuters.com/article/2010/02/11/us-iran-nuclear-salehi-idUSTRE61A4AS20100211.

31. Ariel Levite, "Never Say Never Again: Nuclear Reversal Revisited," *International Security* 27, no. 3 (Winter 2002–2003): 69.

Iran's actions suggest that decisionmakers in Tehran might be pursuing a nuclear hedging strategy by procuring and developing the requisite components and capabilities of a nuclear weapons program for fast breakout, while still remaining just a few steps short of the bomb. If, then, it can be concluded that Iran is moving toward a nuclear weapons capability, even without having made the deliberate decision to have a nuclear weapon, it is necessary and fair to examine Iran's actions, since intentions cannot be as clearly judged or measured. Therefore, the fundamental question becomes: Is Iran, based on its actions rather than on its intentions, in compliance with its NPT obligations?

Assessing Iran's Compliance Status

In order to answer this key question, it is first necessary to examine the relevant NPT Articles that apply to the Iranian case. First, Article II requires all non-nuclear weapons states "not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices," while Article IV guarantees that all parties to the treaty have the "inalienable right" to "develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II." Second, Article III requires non-nuclear weapons states to accept safeguards agreements concluded with the International Atomic Energy Agency (IAEA) "for the exclusive purpose of verification of the fulfillment of its obligations under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices." Iran signed a Comprehensive Safeguards Agreement (INFCIRC/214) in 1974 and an Additional Protocol (AP) in December 2003, although to date the latter has not been ratified by the Iranian legislature. Article III also charges the IAEA with the responsibility to confirm nondiversion; Iran's history of compliance with its safeguards agreement will be examined below.

The articles of the NPT form a crucial foundation for understanding whether Iran's actions constitute noncompliance with the treaty. However, for a near-universal treaty on one of the world's most sensitive national security topics, the NPT is a very short document with exceptionally little detail. Hence, it presents four significant shortcomings that must be understood properly, since they make any compliance assessment inherently difficult.

NPT SHORTCOMINGS

First, the NPT does not articulate who is to be the arbiter of compliance. That is, the treaty demands that states fulfill their treaty obligations, but it is silent on exactly who decides whether these commitments are being met. Certainly, one important actor in this sphere is the United Nations Security Council, which derives its powers from the UN Charter[32] to investigate situations that may pose a threat to international peace and security, determine the existence of any such threat, and take action accordingly. However, while this may mean the Security Council has the authority to determine potential violations of the NPT,

32. Specifically, see Article 34 and Articles 39 through 42, *Charter of the United Nations*, www.un.org/en/documents/charter/index.shtml.

its power to declare a state in noncompliance would have been strengthened if the NPT itself reaffirmed this ability in the treaty text. Similarly, the IAEA can confirm nondiversion of nuclear material from a peaceful nuclear program to military uses as mandated by the NPT, and the IAEA Board of Governors is charged[33] with reporting to the UN Security Council a state's noncompliance with its safeguards agreement. Yet, while such an agreement concluded between the IAEA and an NPT signatory is indeed crucial for verifying that a state's nuclear capability is not geared toward weaponization, there is no clear legal basis in the NPT for the IAEA to be the arbiter of overall NPT compliance.[34] Moreover, a safeguards violation can take many forms and have varying degrees of severity; there is no automatic translation from a safeguards violation to an NPT violation.[35]

Second, the NPT itself does not provide a clear-cut mechanism for how treaty compliance should be verified, and it has "no formal, internationally recognized verification regime attached to it."[36] In the case of Articles I and II, there is no method to confirm that state signatories are not engaging in the receipt, transfer, or assistance of nuclear weapons development.[37] In fact, the sole reference to verifying treaty compliance can be found in Article III, which requires that all states conclude with the IAEA comprehensive safeguards agreements. These are intended to ensure "nuclear energy" is not diverted "from peaceful uses to nuclear weapons or other nuclear explosive devices," and are designed to cover "source or special fissionable material" used in "all peaceful nuclear activities" conducted by the state.[38] This language can be interpreted in different ways, and it can equally mean the diversion of nuclear material from safeguarded facilities, or the clandestine development of nuclear activities or other resources at those facilities.[39] In short, then, the IAEA is vital to NPT implementation, but "cannot effectively measure compliance with the treaty."[40]

Third, the NPT makes no distinction between the benign and the proliferation-sensitive components of the nuclear fuel cycle. That is, it places no specific rights, obligations, or restrictions on the two methods by which a state can develop either nuclear power or a nuclear weapons program, which are uranium enrichment and spent fuel reprocessing. Nations, therefore, have the ability to "acquire nuclear weapons by exploiting the NPT's

33. Specifically, see Article XII, *Statute of the IAEA*, www.iaea.org/About/statute.html.

34. Daniel Joyner writes in a recent article, "The IAEA simply has no legal mandate to produce such a report on activities being carried on within an IAEA member state concerning items and technologies that may be related to the development of a nuclear explosive device, but that are not directly related to fissionable materials or associated facilities. . . . Since the IAEA is acting outside of its legal authority in this section of the report, it does not have a legal standard to apply to its conclusions regarding possible nuclear weapons related activities not involving fissile material." See Daniel Joyner, "Iran's Nuclear Program and the Legal Mandate of the IAEA," *JURIST Forum*, November 9, 2011, http://jurist.org/forum/2011/11/dan-joyner-iaea-report.php.

35. Darryl Howlett, John Simpson, Harald Mueller, and Bruno Tertrais, *Effective Non-Proliferation: The European Union and the 2005 NPT Review Conference*, Chaillot Paper 77 (Paris: Institute for Security Studies, European Union, 2005), 17.

36. Wendy Frieman, *China, Arms Control, and Nonproliferation* (London: Routledge Curzon, 2004), 35.

37. Mason Willrich, *Non-Proliferation Treaty: Framework for Nuclear Arms Control* (Charlottesville, Virginia: Michie Company, 1969), 100.

38. NPT, Article III.

39. One significant loophole in a safeguards agreement is that the IAEA can only access those facilities and locations that the country voluntarily declares and to which the country permits access.

40. Frieman, 35.

failure to define specifically what constitutes the 'peaceful' application of nuclear capabilities."[41] The NPT remains silent on the circumstances or conditions under which countries can indigenously develop these highly sensitive dual-use technologies, which have aptly been referred to as the "choke points"[42] in the nuclear fuel cycle, and instead gives all signatories the "inalienable right" to develop nuclear energy for peaceful purposes. To be certain, the NPT does impose conditions on the general "research, production and use of nuclear energy for peaceful purposes," as articulated in Article IV, which stipulates that such activity must be done in accordance with Articles I and II. Under Article III, moreover, safeguards must be applied to all fissionable material "produced, processed or used" in all peaceful nuclear activities that are conducted "within the territory of [the] State, under its jurisdiction, or carried out under its control anywhere." Nonetheless, these requirements under Articles II, III, and IV apply uniformly to the entire nuclear fuel cycle of a signatory state, and the NPT is considerably weaker as a result. Since states can choose to develop enrichment and reprocessing facilities in accordance with their Article IV rights and even place those facilities under safeguards, they are given the opportunity to develop even to a low degree a nuclear weapons capability while remaining in compliance with the NPT. Indeed, this has happened once already, in the case of North Korea in the 1990s and 2000s. Instead, processes to determine NPT compliance would have been strengthened considerably through an explicit articulation of the conditions or circumstances under which a signatory state could develop enrichment and reprocessing capabilities.

Finally, the NPT does not provide any mechanism for enforcement action if an organizational body of authority declares a signatory state to be in noncompliance with the NPT. As an example, even if the IAEA found a signatory state guilty of diverting weapons-usable nuclear material or activities from enrichment or reprocessing facilities under safeguards, and therefore in violation of its NPT Article III obligations, it is not clear from the text of the treaty what the consequences for that violator would be. The IAEA statute does remedy this shortcoming by delineating in Article XII, Paragraph C, what consequences the IAEA Board of Governors may impose on a state in violation of its safeguards agreement, but the authority for those actions does not flow from the NPT itself. Indeed, former IAEA director-general Mohamed ElBaradei has noted the reliance of the IAEA on the UN Security Council for enforcement of the NPT.[43] Yet, in a similar manner, if the UN Security Council decided to pass a resolution declaring a signatory state in violation of its NPT commitments, its authority to take any enforcement action would stem from Chapter VII of the UN Charter, not from the NPT.

In short, the NPT has some considerable shortcomings that make compliance assessments significantly more challenging. The treaty certainly would have been stronger if

41. Joseph Cirincione, "Enforcing Compliance with the Non-Proliferation Treaty," *Carnegie Endowment for International Peace*, March 24, 2005, http://carnegieendowment.org/2005/03/24/enforcing-compliance-with-non-proliferation-treaty/4hfa.

42. Mark Goodman, "Scope of IAEA Verification of a Fissile Material Cutoff Treaty: The Focused Approach," *IAEA-SM-367/9/05 (2001)*, www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF%20files/Session%209/Paper%209-05.pdf.

43. Quoted in Squassoni, "The Iranian Nuclear Program," 296.

it had included an explicit discussion of the enrichment and reprocessing components of the nuclear fuel cycle, along with an articulation of how compliance should be determined, verified, and enforced. This failure suggests that the NPT might have been intended from its inception to be a fairly "shallow" treaty,[44] which ultimately makes any present-day assessment of a signatory state's compliance status more difficult and less clear-cut.

Ultimately, the NPT does not provide a set of established procedures to assess a state's NPT compliance status and take action accordingly. Nonetheless, the de facto universally accepted arbiters and enforcers of violations of the NPT have become, in fact, the IAEA and the United Nations Security Council. The following assessment of Iran's history of compliance, therefore, will be based on: (1) IAEA reports and resolutions adopted by the IAEA Board of Governors and (2) resolutions adopted by the United Nations Security Council.[45]

IAEA REPORTS AND RESOLUTIONS

The IAEA Board of Governors has produced multiple reports in connection with Iran's safeguards agreement, along with a host of additional resolutions calling on Iran to comply with its obligations.[46] In that vein, the IAEA has in the past explicitly declared Iran in noncompliance with its safeguards obligations: A November 2003 report from then-director general ElBaradei to the Board of Governors (GOV/2003/75) noted, "Iran has failed in a number of instances over an extended period of time to meet its obligations under its Safeguards Agreement."[47] The September 2005 resolution (GOV/2005/77) went one step further, declaring that "Iran's many failures and breaches of its obligations to comply with its NPT Safeguards Agreement . . . constitute non compliance in the context of Article XII.C of the Agency's Statute."[48] To date, however, the IAEA has not explicitly declared Iran to be in violation of its NPT commitments.

At the same time, the Agency has reiterated its concerns over possible military dimensions to Iran's nuclear program, which, if confirmed, could constitute noncompliance with the NPT. The most thorough report to the Board of Governors on possible military dimensions to Iran's nuclear program (GOV/2011/65), dated November 8, 2011, includes a 10-page annex detailing Iran's activities and capabilities that have either dual-use applications or

44. George Downs, David Rocke, and Peter Barsoom, "Is the Good News About Compliance Good News about Cooperation?," *International Organization* 50, no. 3 (1996): 379–406.

45. Any independent assessments concluded by national governments will not be included.

46. The key reports and resolutions pertaining to Iran's implementation of safeguards include: GOV/2003/69 (September 12, 2003); GOV/2003/75 (November 10, 2003); GOV/2003/81 (November 26, 2003); GOV/2004/21 (March 13, 2004); GOV/2004/49 (June 18, 2004); GOV/2004/79 (September 18, 2004); GOV/2004/90 (November 29, 2004); GOV/2005/64 (August 11, 2005); GOV/2005/77 (September 24, 2005); GOV/2006/14 (February 4, 2006); GOV/2009/82 (November 27, 2009); GOV/2011/65 (November 8, 2011); GOV/2012/23 (May 25, 2012); and GOV/2013/6 (February 21, 2013).

47. International Atomic Energy Agency, *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, GOV/2003/75, November 10, 2003, 9, www.iaea.org/Publications/Documents/Board/2003/gov2003-75.pdf.

48. International Atomic Energy Agency, *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, GOV/2005/77, September 24, 2005, 2, www.iaea.org/Publications/Documents/Board/2005/gov2005-77.pdf.

strictly military uses. Nonetheless, the IAEA has not formally declared that Iran is without doubt pursuing nuclear weapons, though it has not ruled out the possibility either:

> While the Agency continues to verify the non-diversion of declared nuclear material . . . by Iran under its Safeguards Agreement . . . the Agency is unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran is in peaceful activities.[49]

Therefore, the IAEA has not determined that Iran is in violation of the NPT, although it has declared Iran to be in violation of its safeguards agreement. As discussed earlier, it is not clear that any safeguards violation translates automatically to an NPT violation; however, if Iran continues to ignore its commitments, it may be declared in further violation of its safeguards agreement. This may prompt the IAEA to decide that when taken together, Iran's failure to comply with various individual stipulations of its safeguards agreement constitutes a wholesale violation of its NPT obligations.

UN SECURITY COUNCIL RESOLUTIONS

Like the IAEA, the UN Security Council has never explicitly declared Iran to be in violation of the NPT. Nonetheless, it has adopted six resolutions in the past five years,[50] all designed to single out Iran for its various IAEA violations and somehow stop it from continuing its nuclear activities.

In 2006, the Security Council passed S/RES/1696,[51] which invoked Article 40 of the UN Charter to "make mandatory [on Iran]" the suspension of uranium enrichment as required by the IAEA in GOV/2006/14.[52] By relying on Article 40, S/RES/1696 indicated the Security Council's willingness to work with Iran and afford it the opportunity to voluntarily comply with GOV/2006/14, and it stated that "full, verified Iranian compliance with the requirements set out by the IAEA Board of Governors would contribute to a diplomatic, negotiated solution that guarantees Iran's nuclear programme is for exclusively peaceful purposes." Nonetheless, S/RES/1696 concluded by stating clearly that Iran's failure to comply with these requirements would prompt further Security Council action under Article 41 of the UN Charter.[53]

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49. International Atomic Energy Agency, GOV/2011/65, 10. Similar verbiage can be found in more recent Board of Governors Reports, including GOV/2012/37 (August 30, 2012), 11, and GOV/2013/6 (February 21, 2013), 12.

50. The six UN Security Council Resolutions are: S/RES/1696 (2006); S/RES/1737 (2006); S/RES/1747 (2007); S/RES/1803 (2008); S/RES/1835 (2008); and S/RES/1929 (2010).

51. United Nations Security Council, Resolution 1696 (2006), S/RES/1696, July 31, 2006.

52. Under Article 40, the Security Council is authorized to "call upon the parties concerned to comply with such provisional measures as it deems necessary or desirable" and to "duly take account of failure to comply with such provisional measures."

53. Article 41 authorizes the Security Council to use non-armed policy tools to enforce its decisions, including "complete or partial interruption of economic relations and of rail, sea, air, postal, telegraphic, radio, and other means of communication, and the severance of diplomatic relations." Particularly in the Iranian case, this would primarily mean economic sanctions.

Iran's decision to ignore the suspension requirements in S/RES/1696 prompted the Security Council to pass a set of international sanctions against Iran under S/RES/1737[54] later that same year. Here, the Security Council invoked Article 41 to make fulfillment of the sanctions binding on all UN members. A few months later, the Security Council determined in S/RES/1747[55] that Iran had failed to comply with both Resolutions 1696 and 1737, and it thus passed a second round of sanctions under Article 41. One year later, the Security Council adopted S/RES/1803,[56] which not only invoked Article 41 again and passed yet another round of sanctions, but also affirmed the IAEA's decision that Modified Code 3.1 of Iran's Comprehensive Safeguards Agreement was still in effect. In September 2008, the Security Council adopted S/RES/1835,[57] which called again on Iran to comply with previous resolutions but imposed no new sanctions. Finally, in June 2010, the Security Council passed S/RES/1929,[58] imposing yet another round of sanctions on Iran and formally declaring Iran's secret development of a nuclear facility at Qom "inconsistent with its obligations under the Subsidiary Arrangements to its Safeguards Agreement."

As a member of the United Nations against whom four binding resolutions have been passed under Article 41, Iran is obligated to "accept and carry out the decisions of the Security Council" in accordance with Article 25 of the UN Charter; its failure to do so, then, constitutes a violation of those Security Council resolutions. Notably, every one of these resolutions, with the exception of S/RES/1835, referenced Articles I and II of the NPT and reaffirmed "the need for all States Party to that Treaty to comply fully with all their obligations" under the NPT; however, the UN Security Council fell short of explicitly declaring Iran in noncompliance.

LETTER VERSUS SPIRIT

The above analysis indicates that, putting aside any assessments of Iran's intentions, its actions have convinced key organizational bodies that Iran is in noncompliance with its safeguards agreements and with various United Nations Security Council resolutions. Yet it is difficult to extrapolate from this analysis and assert with confidence that Iran is actively violating the letter of the NPT itself; certainly, neither the UN Security Council nor the IAEA has ever made this explicit determination.

However, it could be argued that Iran is in violation of the spirit of the treaty for multiple reasons. First, Iran's technological advancements and slow but steady move toward a weapons capability, as detailed above, demonstrate Iran's "nuclear hedging" strategy and suggest it may not be acting in good faith with respect to Article II, which requires that states not manufacture or otherwise acquire a nuclear weapon. Iran's move toward a nuclear weapons capability certainly does not constitute the "manufacture" of nuclear weapons, but if Article II were interpreted literally, then no nonnuclear weapons state would ever be

54. United Nations Security Council, Resolution 1737 (2006), S/RES/1737, December 27, 2006.
55. United Nations Security Council, Resolution 1747 (2007), S/RES/1747, March 24, 2007.
56. United Nations Security Council, Resolution 1803 (2008), S/RES/1803, March 3, 2008.
57. United Nations Security Council, Resolution 1835 (2008), S/RES/1835, September 27, 2008.
58. United Nations Security Council, Resolution 1929 (2010), S/RES/1929, June 9, 2010.

in violation of Article II until an actual nuclear weapon has been assembled. This paradox would completely undermine the objectives of Article II and the NPT, and so Iran's actions cannot be considered a violation of the letter of Article II. Yet the statements and reports of both the IAEA and the UN Security Council indicate Iran's program could be geared toward an eventual nuclear weapons capability. Therefore, it is possible that Iran is already be in violation of the spirit of Article II.

The same type of argument can be made with respect to Articles III and IV. The inability of the IAEA to declare conclusively that Iran is not diverting its nuclear program to military purposes is reflected time and again in Board of Governors resolutions and in UN Security Council resolutions. While this inability is not necessarily a violation of the letter of Article III, it could be considered a violation of the spirit, since Iran has not been completely transparent in its activities and has yet to demonstrate to the international community that its nuclear program is entirely peaceful. Likewise, an assessment of Iran's compliance status with Article IV is predicated on an understanding of Iran's violation of the spirit of Article II. The "inalienable right" to peaceful nuclear energy, therefore, is brought into question, as Iran may be acting against the spirit—and for that matter could also be in violation of the letter—of Article IV if it is pursuing anything other than a strictly peaceful nuclear program.

Conclusion: Impact on the NPT

Despite IAEA condemnation, multiple rounds of Security Council-mandated sanctions, unilateral and bilateral sanctions, diplomatic isolation, computer sabotage, and even targeted assassinations, Iran has continued to make progress on its nuclear program and, whether deliberately or not, seems to be moving closer to a nuclear weapons capability. The IAEA and the UN Security Council have judged Iran, based on its past actions, to be in clear violation of its safeguards agreements and of past resolutions, which are legally binding on Iran, and yet neither body has ever explicitly declared Iran in violation of the Non-Proliferation Treaty itself. One crucial reason for this nondeclaration is that the ambiguity of the NPT leaves open to interpretation exactly what actions constitute noncompliance and how compliance can be verified. As argued above, Iran may already be in violation of the spirit of the NPT, if not the letter, but even if the relevant organizational bodies were to deem Iran noncompliant, it is unclear what enforcement actions Iran would face.

The future of the NPT, then, seems to be at stake. The North Korean case of the 1990s and 2000s brought into question the strength and utility of the NPT when that country developed a nuclear weapons program while remaining within the NPT framework. Today, it seems Iran is moving down the same path, and while the international community may be determined not to let a second country blatantly disregard its international legal obligations, the NPT unfortunately presents very few options for moving all engaged parties away from the status quo. Unless the issues of determining, verifying, and enforcing compliance are not strengthened, Iran will likely face at worst additional sanctions and

diplomatic isolation, while nonetheless moving ever closer to a nuclear weapon. History seems doomed to repeat itself.

Yet creative suggestions to strengthen the fundamental principles of the NPT are worth considering. While the IAEA, as Pierre Goldschmidt writes,[59] does not have the right under its statute to require a state to suspend its nuclear activities, the UN Security Council does have that power. Goldschmidt has therefore suggested that if a state is found to be in violation of its safeguards agreement, the UN Security Council should, among other things,[60] automatically impose a 10-year suspension of that state's right to engage in "sensitive nuclear fuel cycle-related activities,"[61] which would address one of the shortcomings of the NPT, namely, its lack of discussion of the enrichment and reprocessing components of the nuclear fuel cycle.

Along those lines, perhaps the only way forward with respect to Iran is to step back from the status quo of ever tightening sanctions, which after four rounds have demonstrated Iran's increasing unwillingness to cooperate with the IAEA and the UN Security Council, and to reevaluate Iran's incentives for pursuing a domestic nuclear program. The IAEA's hand in verification and inspections would be tightened significantly if Iran were to ratify the Additional Protocol, which it signed in 2003; thus, an agreement to drop Security Council–mandated sanctions in return for AP ratification would go a long way in proving to the international community that Iran is not pursuing nuclear weapons, as it claims.

Ultimately, as nonproliferation expert Yousaf Butt argues,[62] it would be ideal if the NPT were stronger, less ambiguous, and more exacting on its signatories to not develop a nuclear weapons capability. Yet the treaty as it stands today enjoys near-universal support and has recorded many notable successes, perhaps because of its lack of clarity and openness to interpretation. Nonetheless, the Iranian situation is quickly shaping up to be the ultimate test of the Nuclear Non-Proliferation Treaty, and if it continues unabated, may strain the NPT to its breaking point.

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59. Goldschmidt is former deputy director general for safeguards at the IAEA. He writes the IAEA "doesn't have the legal authority it needs to fulfill its mandate and to provide the assurances the international community is expecting from its verification activities." See Pierre Goldschmidt, "Looking Beyond Iran and North Korea for Safeguarding the Foundations of Nuclear Nonproliferation" (presented at the conference on Reassessing Nuclear Nonproliferation's Key Premises at the NPEC Conference, London, November 3, 2011), http://carnegieendowment.org/2011/11/03/looking-beyond-iran-and-north-korea-for-safeguarding-foundations-of-nuclear-nonproliferation/6nz6.

60. Pierre Goldschmidt, *The Urgent Need to Strengthen the Nuclear Non-Proliferation Regime*, Policy Outlook 25, January 2006, http://carnegieendowment.org/files/PO25.Goldschmidt.FINAL2.pdf.

61. Quoted in Squassoni, "The Iranian Nuclear Program," 294.

62. Yousaf Butt, "Don't blame Iran, blame the NPT," *Politico*, November 21, 2011, www.politico.com/news/stories/1111/68794.html.

Arguing in Perfect Harmony: A Search for Order among U.S. Nuclear Force Structure Evaluation Criteria

Jarret M. Lafleur[1]

Recent years have produced an inundation of articles and papers supporting a variety of plans for the future of the U.S. nuclear triad. Most support one of four basic strategies: (1) eliminate the land leg of the triad, (2) eliminate the air leg of the triad, (3) eliminate the sea leg of the triad, or (4) retain all three legs. Typically, each contribution to the debate is distinct in setting forth not only a unique set of preferences among different nuclear force evaluation criteria, but also a unique set of criteria. This limited coordination of evaluation criteria sets complicates both formal decision analysis and the ability to reach mutual understandings within the community. Through a systematic analysis and synthesis of recent nuclear force structure arguments, this work identifies existing communication obstacles and presents nuclear force evaluation criteria in the form of one possible unifying hierarchical structure. With relevance to a variety of policy and engineering analysts and decisionmakers, this hierarchy is intended to allow more complete treatment of the nuclear force structure issue in future discourse, enhanced communication among parties of differing positions, and organization of criteria into a logical structure suitable for formal decision analysis.

Introduction

On December 31, 1957, the U.S. Navy ordered that the U.S.S. *Scorpion* attack submarine, then under construction, be split in two. Inserted between the two halves was to be a

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130-foot-long compartment housing 16 nuclear-armed Polaris ballistic missiles.[2,3,4] The result was the nation's first ballistic missile submarine, the USS *George Washington*. In November 1960, the *George Washington* became operational, joining existing bomber aircraft and land-launched intercontinental ballistic missiles (ICBMs) in deterring nuclear aggression. This force, which has come to be known as the U.S. nuclear triad, has endured to the present day.

TODAY'S TRIAD

Today's nuclear triad consists of some 450 Minuteman III ICBMs, 14 Trident-armed *Ohio*-class ballistic missile submarines, and a combination of 76 B-52H and 18 B-2 nuclear-capable bombers.[5,6] Each leg contributes to the triad a set of strengths that largely balance out shortcomings of the others. The ICBM land leg contributes a rapid response capability, and the sheer number of underground silos presents a formidable barrier to any nation seeking to disable U.S. nuclear retaliatory capability. The stealth of the sea leg provides unparalleled survivability, and the air leg provides overt but flexible forward posturing that is not available through any other leg.

According to an extensive study of nuclear weapons complex costs by the Brookings Institution in 1998, the delivery platforms of the triad have cost the nation over half of the $8.1 trillion (fiscal year [FY] 2012 equivalent) spent on nuclear weapons from 1940 to 1996.[7] The nearly $50 billion (FY12) annual cost of the weapons complex, as estimated in 1998,[8] is about to face new challenges: development programs for a Minuteman III replacement, a new ballistic missile submarine, and a new strategic bomber are all looming on the horizon.[9] In an age of fiscal austerity, the costs of these modernization programs have caused many to reconsider the relevance of the triad in a post–Cold War security environment.

TOMORROW'S TRIAD (OR DIAD)[10]

Recent years have produced an inundation of articles and papers supporting various plans for the future of the nuclear triad. Typically, these plans support one of four basic strategies: (1) eliminate the land leg of the triad, (2) eliminate the air leg of the triad, (3) eliminate the sea leg of the triad, or (4) retain all three legs. For example, a report by the Global Zero U.S.

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2. Robert A. Fuhrman, "The Fleet Ballistic Missile System: Polaris to Trident," *Journal of Spacecraft and Rockets* 15 (1978): 265, 273.
3. Tom Clancy, *Submarine: A Guided Tour Inside a Nuclear Warship* (New York: Berkley Books, 1993), 15–17.
4. Jessica Taylor, "USS George Washington (SSBN-598): The Nation's First Boomer," *Undersea Warfare* 39 (2009): 1–2, www.navy.mil/navydata/cno/n87/usw/usw_winter_09/george.html.
5. Robert M. Gates, *Nuclear Posture Review Report* (Washington, DC: Department of Defense, 2010), 22–24.
6. Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs, *The Nuclear Matters Handbook* (Washington, DC: Department of Defense, 2011), 44–47.
7. Stephen I. Schwartz, *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940* (Washington, DC: Brookings Institution Press, 1998), xxii.
8. Schwartz, *Atomic Audit*, 31.
9. Amy F. Woolf, *U.S. Strategic Nuclear Forces: Background, Developments, and Issues* (Washington, DC: Congressional Research Service, 2012), ii, 14–15, 20–22, 27–30.
10. While the present paper adopts the "diad" spelling variant of the word "dyad" used in other references, both refer to the same concept of a two-legged nuclear force structure.

Nuclear Policy Commission, chaired by retired Strategic Command Commander General (ret.) James Cartwright, favors eliminating the land leg, largely because of concerns about ICBM overflight of Russia in any threatened use against nations other than Russia and the decision time constraints imposed by a force that is, in the words of the authors, on "hair-trigger alert."[11] Others favor the elimination of the sea leg, given the high costs of a follow-on ballistic missile submarine, such a submarine's utility solely for the nuclear mission, and the limited relevance of survivability in likely nuclear-use scenarios.[12] Still others lean toward an ICBM/SLBM diad, concluding that the United States is already on a path toward eliminating the air leg, and that the combination of survivability, promptness, signaling capability, crisis stability, connectivity, number of warheads on alert, number of aimpoints, and ability to penetrate defenses for such a diad most closely resembles the triad ideal.[13] Still others[14,15,16] argue that retaining the triad provides qualities such as strategic stability, hedging capability, survivability, promptness, and flexibility that are important to retain into the future.

As this brief summary begins to illustrate, each contribution to the debate is unique in emphasizing some nuclear force evaluation criteria over others. Given the diversity of preferences and values among stakeholders in the nuclear security community, this is expected. However, this summary also begins to reveal that each contribution brings with it not only a unique set of preferences among different criteria, but also a unique set of criteria.

Structure for the Force Structure Debate

In any decision problem, prevalence of a wide variety of uncoordinated criterion sets poses an analytical dilemma, complicating not only formal analysis but also the ability to engage in constructive discussion and debate. Analysis and debate can become particularly difficult when sets of criteria are introduced in the process of arguing for or against a particular solution. In such cases, the selection and definition of objectives and criteria are coupled with selection of the advocated solution. Certain criteria may be explored in great depth, while others may be omitted.

Regardless of a study's degree of advocacy, arguments are also frequently presented using different terminology and at different levels of criterion abstraction. For example, it is difficult to know whether one study's consideration of presidential decision time is equivalent to another's consideration of crisis stability or promptness. Furthermore, some criteria

11. James Cartwright et al., *Global Zero U.S. Nuclear Policy Commission Report* (Global Zero, 2012).

12. Eli Jacobs, "Should We Eliminate Nuclear Subs?," *PONI Debates the Issues* (blog), Center for Strategic and International Studies, July 18, 2012, http://csis.org/print/38416.

13. Dana J. Johnson, Christopher J. Bowie, and Robert P. Haffa, "Triad, Dyad, Monad?" (Arlington, VA: Air Force Association Mitchell Institute for Airpower Studies Paper 5, December 2009).

14. Gates, *Nuclear Posture Review Report*.

15. C. Robert Kehler and Franklin C. Miller, "A Conversation with General C. Robert Kehler," Council on Foreign Relations, May 30, 2012, www.cfr.org/united-states/conversation-general-c-robert-kehler/p28404.

16. Baker Spring and Michaela Bendikova, "Time to Modernize and Revitalize the Nuclear Triad," Heritage Foundation, Backgrounder No. 2646, January 27, 2012, www.heritage.org/research/reports/2012/01/time-to-modernize-and-revitalize-the-nuclear-triad.

may depend directly on others. For instance, the destructive capacity of U.S. retaliation following a surprise attack is a function of other force characteristics and criteria such as number of warheads on alert, number of aimpoints, survivability, and presidential decision time.

TOWARD STRUCTURED CRITERIA

An analytically appealing alternative to a set of studies with custom-defined criteria is a thorough and solution-agnostic structuring of objectives and criteria from across the literature. Such a structure could allow future analyses to assess alternatives against a consistent set of criteria at a consistent level of abstraction. Importantly, structuring criteria is not synonymous with setting weights or priorities on criteria. As a result, structure not only would help to pinpoint areas of disagreement, but it also may help partition debate into the separate issues of (1) priorities among criteria and (2) expectations of a solution's performance with respect to criteria. Such a structure could also pave the way for more detailed, comprehensive, and quantitative trade studies that can take advantage of powerful decision analysis techniques from the field of operations research.

THE VALUE HIERARCHY: A TOOL FOR STRUCTURING CRITERIA

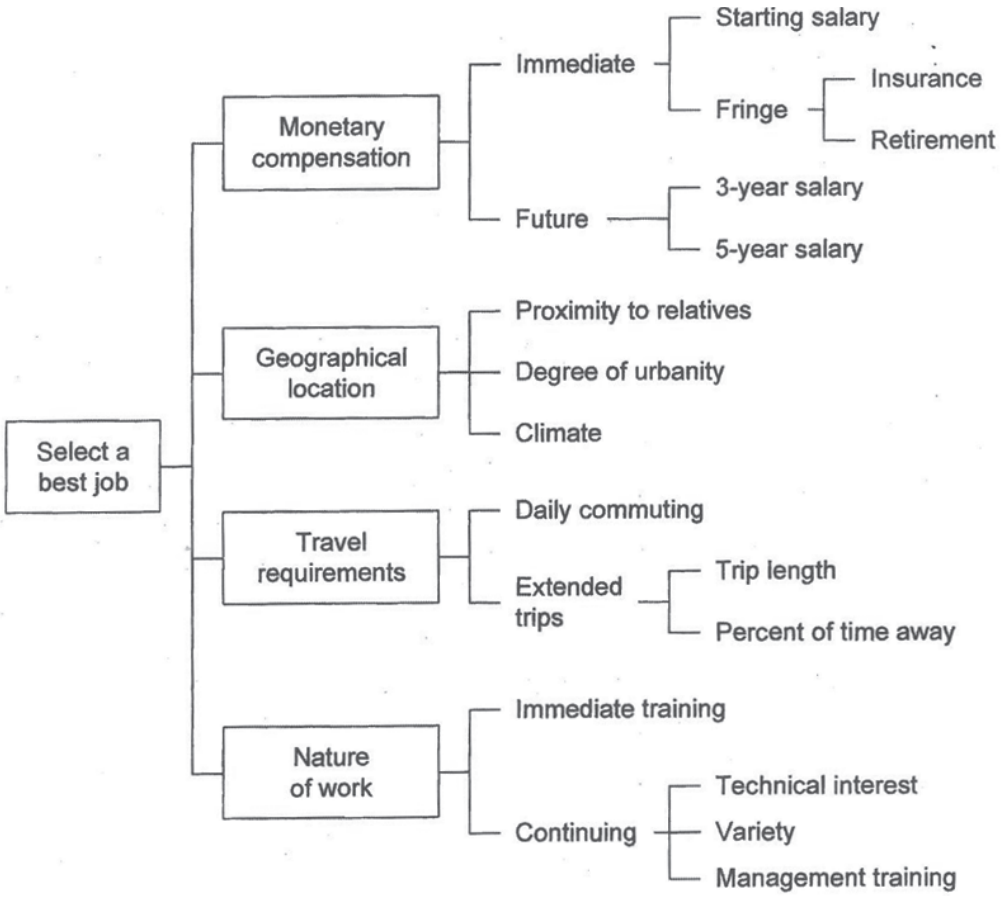
Operations research itself originated from research conducted by scientists and engineers to solve critical operational military decision problems during World War II[17,18] and has grown substantially in the decades since. Within this field, virtually any formal decision analysis begins with a definition and structuring of problem objectives and criteria. Perhaps the most intuitive and popular such structure is the value hierarchy, a tree-like value structure that encompasses the entire set of a decision problem's evaluation considerations and measures. Branches, or lower tiers, of the tree identify criteria that are logical components of the higher-tier root. Figure 1, for example, shows a value hierarchy that might be associated with an individual's job-selection decision, considering top-tier criteria such as compensation, location, travel, and type of work, with further decomposition in each area.

The quality of a given value hierarchy can be characterized according to five properties[19]:

- **Completeness** refers to the degree to which lower-tier criteria adequately cover all concerns related to upper-tier criteria.
- **Nonredundancy** refers to the degree to which the double counting of lower-tier criteria among multiple higher tiers is avoided.
- **Operability** is the degree to which the hierarchy is understandable to its users.

17. Wayne L. Winston, *Operations Research: Applications and Algorithms* (Belmont, CA: Brooks/Cole, 2004), 1.
18. Saul I. Gass and Arjang A. Assad, "History of Operations Research," in *Tutorials in Operations Research*, eds. Joseph Geunes and Paul Gray (Hanover, NH: INFORMS, 2011), 1.
19. Craig I. Kirkwood, *Strategic Decision Making: Multiobjective Decision Analysis with Spreadsheets* (Belmont, CA: Duxbury Press, 1997), 16–19.

Figure 1. Example Value Hierarchy for a Job Decision Problem



From Kirkwood, Strategic Decision Making, *1E. © 1997 Wadsworth, a part of Cengage Learning Inc. Reproduced by permission.*

- **Small size** refers to a desire for simplicity in that, all else being equal, a smaller hierarchy is more desirable than a larger one.
- **Decomposability** is a complex notion referring to the degree to which the weights that a decisionmaker might place on criteria within a tier are independent of any alternative's performance with respect to the criteria.

These properties will be emphasized to varying degrees in the discussions that follow. Particular attention will be paid to the first two properties of completeness and redundancy, which are common shortcomings of nuclear triad and diad discussion structures. Operability generally does not present a problem in the current literature beyond the fact that terminology is not always well defined; however, important goals of the hierarchy that this paper develops will be not only completeness and nonredundancy, but also operability across users of multiple roles. If properly structured, the tiered decomposition of a value hierarchy can allow it to be helpful for users ranging from analysts to organization heads, with each adopting a view at an appropriate depth within the tree.

Literature Analysis

This paper explores the following core question: *What is an underlying, unifying value hierarchy for U.S. nuclear force structure decisions?*

To address this question, eight recent contributions to the nuclear force structure debate are first analyzed in detail. These documents are selected to represent a variety of perspectives and include a mix of government and nongovernment authors, military and civilian authors, triad and diad proponents (including proponents of all three leg elimination options), and formal and informal decision analysis approaches. For each document, a value hierarchy has been derived, based not only on the overall structure of the paper's discussion, but also on a detailed line-by-line reading and the recording of terms that resemble criteria or objectives. In deriving each document's value hierarchy, maximum use was made of any explicit value hierarchy or set of criteria that the work presented.

Ground rules observed in the tracing of these papers' value hierarchies include:

- In cases where a document states a goal that specifies a force structure decision (e.g., the 2010 *Nuclear Posture Review* states that "the United States should retain a nuclear Triad"), this goal or criterion is excluded from the value hierarchy. This rule is associated with the fact that the hierarchy developed in this study is intended to be solution-agnostic.
- No assumptions or observations are made regarding the importance or weights of criteria. If a criterion is mentioned in a paper, it is recorded in the paper's value hierarchy. This ground rule is associated with the fact that this study deals only with the identification of criteria and allows users and decisionmakers to specify the relative weights of criteria within the final value hierarchy.
- No observations or judgments are made regarding the validity of individual papers' arguments. The present work makes observations only on the structure of the arguments' perceivable value hierarchies.

VALUE HIERARCHIES FROM THE NUCLEAR FORCE STRUCTURE DEBATE

In the following several paragraphs, important structural features of each of the eight works considered are summarized, with context provided for their basic arguments. Samples of the derived value hierarchies are also provided. Importantly, the decomposition and structures developed through the analysis of these works allow for the understanding necessary for the development of the underlying, unifying hierarchy detailed in the fourth section of this paper.

***Nuclear Posture Review Report* (2010).** The 2010 Nuclear Posture Review (NPR)[20] offers Defense Department guidance for the implementation of the Obama administration's vision for reducing nuclear risks to the United States and the international community. The NPR outlines five top-tier objectives, namely: (1) preventing nuclear proliferation and nuclear terrorism, (2) reducing the role of U.S. nuclear weapons in U.S. national security strategy, (3) maintaining strategic deterrence and stability at reduced nuclear force levels, (4) strengthening regional deterrence and reassuring U.S. allies and partners, and (5) sustaining a safe, secure, and effective nuclear arsenal. The review recommends that the United States maintain all three legs of the nuclear triad.

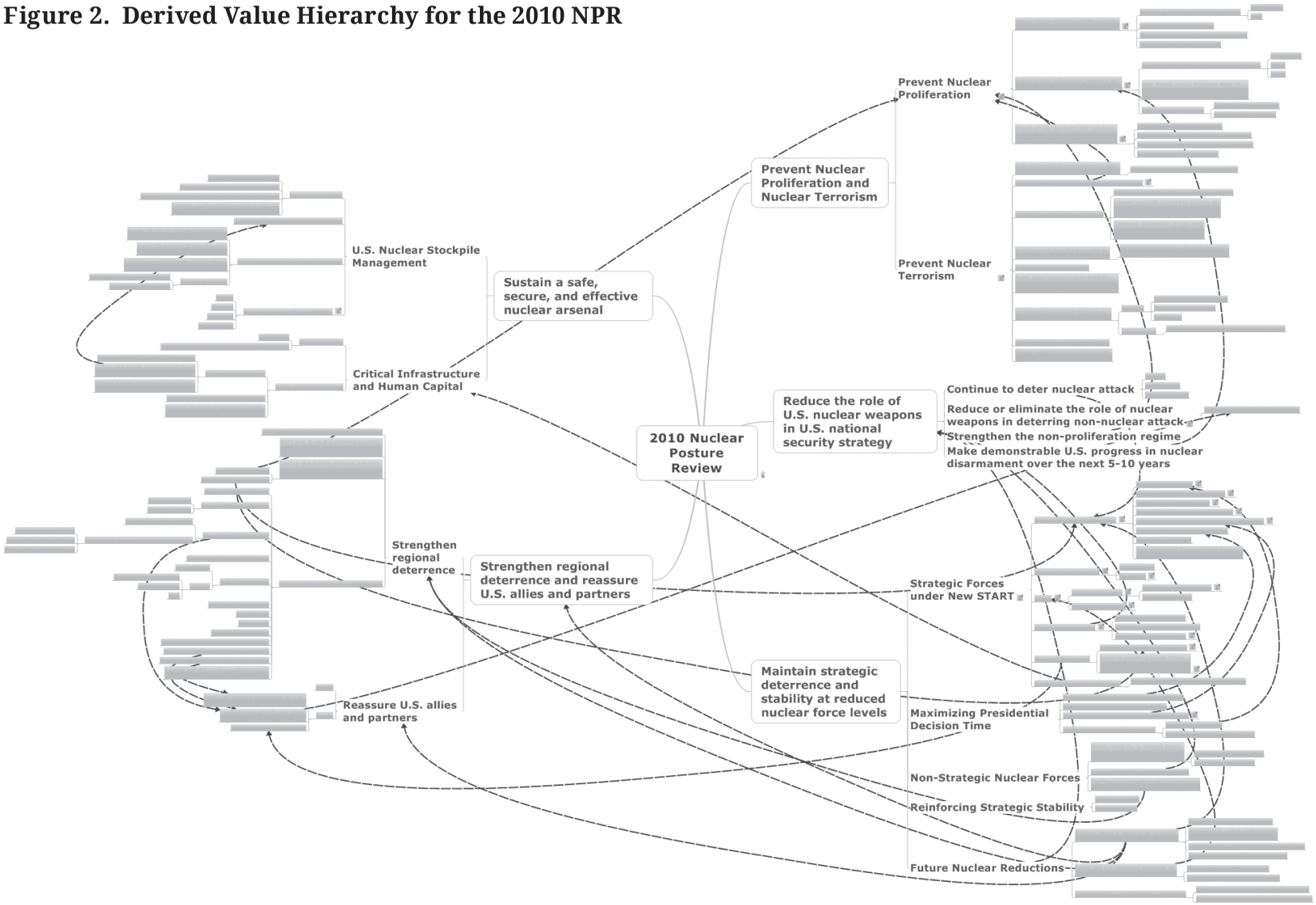
The derived value hierarchy for the NPR is shown in Figure 2. Along with the decomposition of the five objectives that surround the central hub of the figure, this diagram uses dashed black lines to connect criteria that are either redundant or highly correlated. For example, while the fourth top-tier objective is the strengthening of regional deterrence and reassurance, the highly correlated objective of providing extended deterrence is covered two tiers underneath the third objective of maintaining deterrence and stability. Other examples of redundancy within the tree involve criteria of survivability, command and control security, and alert levels. Thus, as Figure 2 helps to illustrate, while the NPR is comprehensive in scope (with 179 elements, the second largest derived in this study) and a definitive statement of national policy, it also contains a high degree of redundancy. That is, if used in formal decision analysis as-is, it would double (or more) count many criteria among multiple higher-tier categories.

A Conversation with General C. Robert Kehler (2012). This hour-long May 2012 Council on Foreign Relations forum[21] highlighted the nuclear force structure perspectives of General C. Robert Kehler, commander of U.S. Strategic Command. During the forum, General Kehler alluded to a variety of objectives for the force, and he provided substantial depth on criteria related to deterrence. While General Kehler did not outline a single explicit top-tier list of objectives, he did emphasize three separate "trios" of objectives: (1) survivability, responsiveness, and flexibility; (2) safety, security, and effectiveness; and (3) the ability to maintain strategic stability, deter adversaries, and reassure allies. The relationships between these three objective sets were not entirely clear, though it is unlikely that all nine were intended as top-tier objectives. In separate parts of his talk, General Kehler also highlighted general deterrent force criteria (such as survivability, promptness, flexibility, hedge capability, and ability to maintain a solid industrial base and highly trained workforce) as well as the fact that deterrence may no longer be a one-size-fits-all proposition, but rather may need to be tailored to individual actors.[22]

"Triad, Dyad, or Monad?" (2009). This paper, authored by analysts and directors of the Northrup Grumman Analysis Center and published by the Mitchell Institute for Airpower

20. Gates, *Nuclear Posture Review Report*.
21. Kehler and Miller, "A Conversation with General C. Robert Kehler."
22. This latter point helps motivate a later discussion regarding the use of deterrence scenarios in a nuclear force structure value hierarchy.

Figure 2. Derived Value Hierarchy for the 2010 NPR



Note the five top-tier objectives surrounding the central hub. Dashed black lines connecting elements across the hierarchy indicate areas of redundancy or high correlation. Lower-tier elements are represented by gray boxes to illustrate structure, and full text of these elements is available upon request.

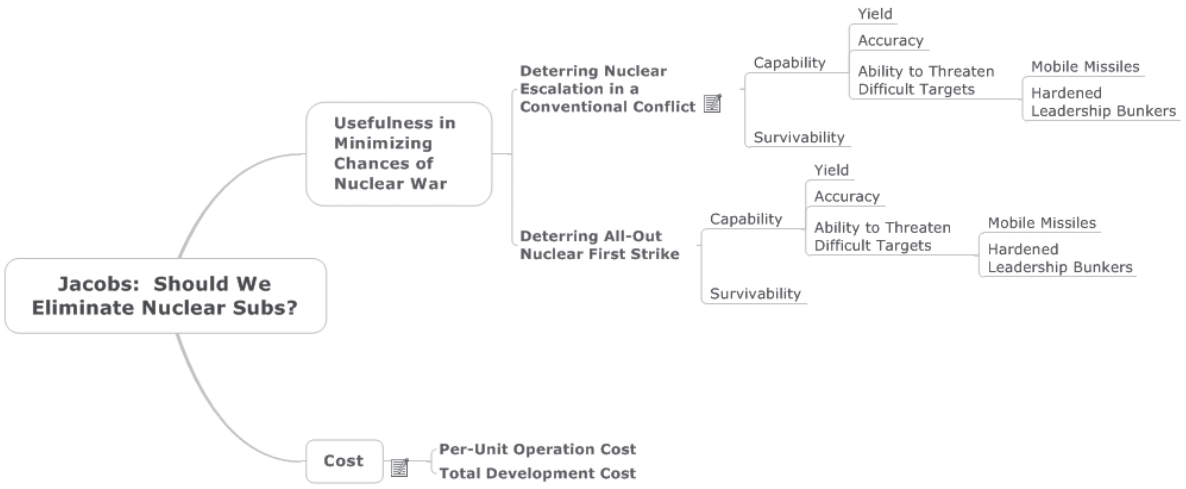
Studies,[23] recommends elimination of the air leg of the triad based on an assessment that explicitly divides criteria into top-tier categories of deterrence and stability. Within each category are four or five criteria, including number of weapons on alert, number of aimpoints, ability to penetrate, promptness, survivability, crisis stability, connectivity, alert signaling, and costs. Positive structural aspects of this paper include its focus on quantitative metrics and, due to its explicit structure, limited redundancy or correlation between criteria. However, in some ways the paper is structurally incomplete. For example, broader considerations of global nuclear stockpile reduction, hedge capability, extended deterrence and assurance, safety, and security are not explicitly considered. Additionally, the rationale for the division of criteria between the two top-tier categories of deterrence and stability is not always clear; for example, while the paper recognizes that survivability contributes to deterrence, survivability is formally allocated to the category of stability. Nonetheless, the paper's decision analysis stands as the most formal and systematic among the eight considered in the present study.

Global Zero Commission Report (2012). Authored by several distinguished former government officials, the Global Zero report[24] advocates for elimination of the land leg of the triad for reasons that include reduction in launch risks due to accidents or rushed decisionmaking and practical use considerations related to Russia overflight. Coverage of additional objectives and criteria in defense of the proposed architecture is extensive. Interestingly, however, while second-tier criteria structure is often clear, top-tier structure is not. For example, the first page of the report begins with a list of five criteria based on which the commission's proposed force structure is desirable. Prior to introducing the detailed force structure proposal, a second set of five desirable attributes is introduced. A number of additional criteria are mentioned later during the description of the proposed force structure. Logical relationships among criteria of these three different lists are not always obvious, and many appear to have overlapping meanings, producing a value hierarchy that appears to contain a high degree of redundancy or correlation.

Senate ICBM Coalition White Paper (2009). Authored by the 10 senators from North Dakota, Wyoming, Montana, Utah, and Louisiana, this paper advocates the maintenance of the land leg of the triad.[25] Its argument is concise and structured, with most discussion focused on criteria that the authors tie to stability, specifically the ability of the force to present an insurmountable challenge to adversaries, protect the survivability of other triad legs, assure allies, and pose a low cost to the nation. The derived value hierarchy for this paper is relatively small (49 elements) and contains minimal redundancy; however, it contains only cursory coverage of many of the same broader considerations that were neglected by the "Triad, Dyad, or Monad?" paper.

23. Johnson, Bowie, and Haffa, "Triad, Dyad, Monad?"
24. Cartwright et al., *Global Zero*, 2012.
25. Kent Conrad et al., *The Long Pole of the Nuclear Umbrella: A White Paper on the Criticality of the Intercontinental Ballistic Missile to United States Security* (Washington, DC: Senate ICBM Coalition, 2009).

Figure 3. Derived Value Hierarchy for "Should We Eliminate Nuclear Subs?"



Heritage Foundation Triad Backgrounder (2012). Reflecting the views of the conservative Heritage Foundation, this paper argues for the maintenance of the nuclear triad.[26] A variety of nuclear force objectives and criteria are covered. Extensive coverage is given to desirable leg-specific qualities, and considerations are included beyond basic deterrence, including cost, treaty obligations, assurance, hedging, and weapons enterprise capabilities. The primary structural shortcoming of the paper, for the purposes of deriving a value hierarchy, is the lack of an explicit list of top-tier force objectives.

"Should We Eliminate Nuclear Subs?" (2012). Perhaps the most controversial viewpoint in the nuclear force structure debate is posed in this paper,[27] which suggests the elimination of the sea leg of the triad, considering cost and the value of a capable offense as opposed to a survivable nuclear defense in likely future nuclear use scenarios. Shown in Figure 3 and containing just 20 elements, the derived value hierarchy for this exhibits no obvious redundancy. The hierarchy makes distinctions between deterrence in scenarios of an all-out nuclear first strike upon the United States versus nuclear escalation in a conventional conflict, and it also distinguishes between capability and survivability. Shortcomings include the fact that limited hierarchical depth exists in these categories of capability and survivability, and no obvious coverage of broader considerations (e.g., of assurance, hedging, treaty negotiation, or infrastructure and workforce objectives) is provided.

General Accounting Office Triad Project Letter (1992). The final work examined for this study is the letter summarizing a two-year General Accounting Office evaluation of the strategic triad sent to Congressman Dante Fascell in September 1992, less than a year after the fall of the Soviet Union. This letter sets forth seven primary measures of effectiveness:

26. Spring and Bendekova, "Time to Modernize," 2012.
27. Jacobs, 2012.

survivability, accuracy, warhead yield and reliability, weapon system reliability, flexibility with respect to arms control, communications, and responsiveness. Additional considerations that do not clearly fit into the seven categories, such as cost, flight test program feasibility, and weapon range, are also discussed. While of small size and with no obvious redundancy, the derived value hierarchy for this work does not clarify the relationship of the additional considerations to the seven listed measures of effectiveness, and it does not cover broader considerations such as assurance, hedging, and infrastructure and workforce objectives.

SOURCES OF DISHARMONY

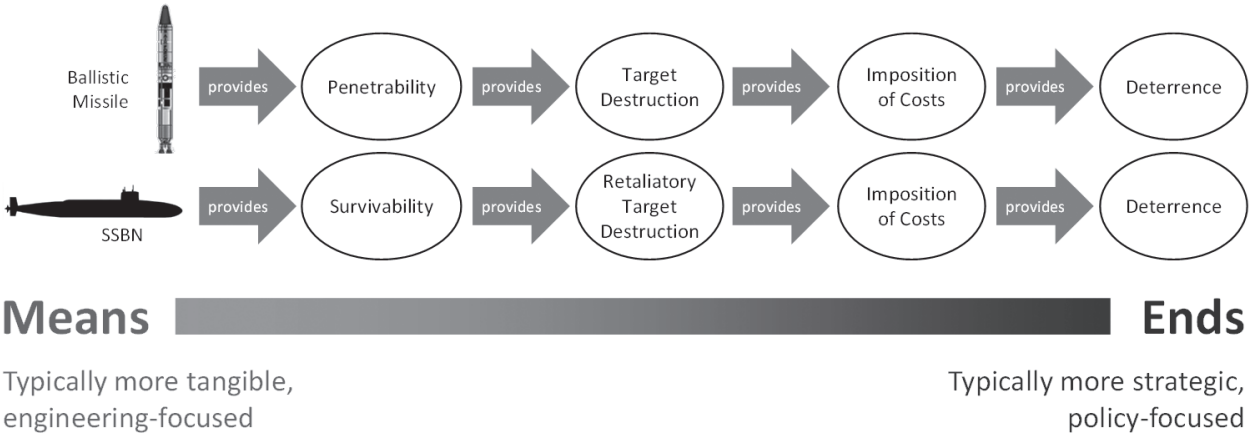
As the previous discussion helps to make evident, an issue common among many of the eight works surveyed is incompleteness in the sets of addressed criteria. While all works consider the objective of deterrence, for example, objectives such as assurance, hedging, and infrastructure and workforce maintenance are commonly neglected. Beyond this insight, analysis of the literature brings to light two helpful criterion-structuring concepts that exist in the literature but are often implicit and underemphasized.

Means vs. Ends Criteria. Particularly in the context of deterrence, discussion in the literature exists in the domains of both means criteria and ends criteria. For example, mixed discussion takes place regarding *how* a force is survivable (e.g., measured in terms of criteria like long warning time or short generation time[28]) as well as *to what extent* the force is survivable (e.g., measured in terms of the size of the surviving force[29]). Similarly, many sources consider criteria such as force structure attributes of penetrability and survivability, while analysts Dana Johnson, Christopher Bowie, and Robert Haffa[30] allude to Defense Secretary Robert McNamara's metrics of retaliatory industrial and population destruction capability. Both are metrics or criteria aimed at measuring an aspect of deterrence, specifically the ability of a deterrent force to impose costs on (rather than, for example, to deny benefits to) an adversary. However, as illustrated in the means-ends spectrum of Figure 4, criteria such as penetrability and survivability are means to achieving target destruction, which is itself a means by which costs may be imposed on an adversary, which is itself a means to achieving deterrence. While means and ends criteria may each have potential benefits and drawbacks in the context of nuclear force structure arguments, and neither is an inherently correct or incorrect choice for making an argument, future advocacy and analysis should take care not to consider *both* means and ends criteria as independent criteria. Doing so effectively double-counts objectives and, in the context of value hierarchies, violates nonredundancy. This issue is addressed explicitly in the unifying hierarchy that this paper proposes.

Scenario vs. General Capability Perspectives. The works surveyed in this study typically recognize that, unlike the forces of the Cold War, a twenty-first century U.S.

28. Cartwright et. al., *Global Zero Report*, 5–6.
29. Johnson, Bowie, and Haffa, "Triad, Dyad, Monad?," 20–21, 23.
30. Johnson, Bowie, and Haffa, "Triad, Dyad, Monad?," 11.

Figure 4. Example of a Means-Ends Criterion Spectrum



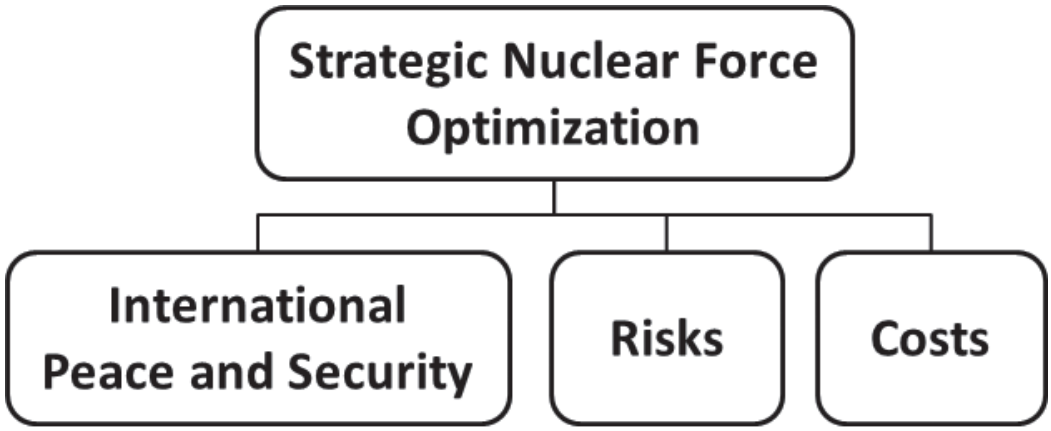
nuclear force must address threats from multiple actors, ranging from peer nuclear weapon states to rogue nations and terrorists. Many works mention the "nuclear umbrella" that the United States extends to ally and partner nations and that U.S. nuclear forces may be called upon as part of a response to attacks on its allies and partners. Some, such as the 2010 NPR, mention the "narrow range of contingencies in which U.S. nuclear weapons may still play a role in deterring a conventional or CBW [chemical and biological weapons] attack," [31] acknowledging that nuclear use may be contemplated as a response to certain non-nuclear attacks or attack threats. Others weigh the likelihood of a bolt-from-the-blue surprise attack against scenarios such as the escalation of a conventional conflict.

The recognition and definition of scenarios or threats against which a nuclear force must deter is arguably an essential element of analyzing the effectiveness of a force structure. Collectively, and in some cases individually, the works studied are quite comprehensive in defining the characteristics of these scenarios and providing examples. However, while they identify scenarios, many of the works go on to select a force structure and express its merits in terms of general characteristics or capabilities (e.g., penetrability, survivability, promptness, responsiveness), rather than making direct links to performance in specific scenarios. Scenario-by-scenario analysis of advocated force structures is rare, and in examples where it may exist, discussion is typically framed around the most likely such scenario. However, given the uncertainty under which future scenarios will materialize, it may be prudent to select a force that deters over a wide variety of possible scenarios. In this case, a systematic scenario-by-scenario analysis may be justified to ensure that a force structure that deters well in one scenario does not perform unacceptably in others.

In sum, while the concept of scenarios and their characteristics is well established in the nuclear force structure analysis literature studied here, authors typically resort to

31. Gates, *Nuclear Posture Review Report*, viii.

Figure 5. Top Tier of the Unifying Value Hierarchy



general capability concepts to express the value of individual force structures. The unifying hierarchy detailed next in this paper proposes a synthesis of these two perspectives in evaluating the overarching objective of deterrence.

A Unifying Hierarchy

The following section presents an overview of a value hierarchy that seeks to unify and logically organize the diverse criteria expressed among this paper's eight surveyed works. This hierarchy aims to particularly respect the properties of completeness, nonredundancy, and operability. As a result, the process used to develop the hierarchy has included not only the recognition and definition of higher-tier categories that cleanly partition lower-tier criteria, but also the rigorous mapping of each of the 449 lowest-tier elements from the eight derived value hierarchies to one or more of the 309 elements of the resulting unifying hierarchy.[32] While this hierarchy is by no means the only such structure that can serve to unify the diversity of force structure criteria used across the literature, it is intended to serve as a useful example of one such tool.

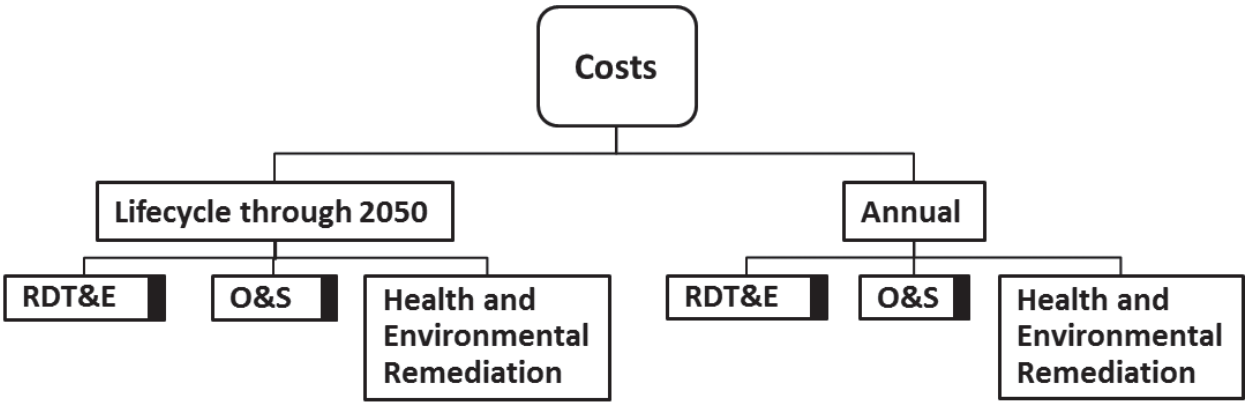
The top tier of this paper's proposed hierarchy consists of three elements, illustrated in Figure 5. As in many decision problems, criteria can be grouped under the three categories of costs, risks, and performance. Performance, in this case, may be considered an overarching goal of international peace and security.

COSTS

The top-tier category of Costs accounts for the different dollar-valued costs associated with the total design, development, production, operation, maintenance, and retirement of the elements of a nuclear force structure. This category is subdivided into the two categories of

32. While this mapping and the full details of the unifying hierarchy are too large to print in the present paper, these details are available upon request.

Figure 6. Cost Decomposition



A black rectangle on the right side of an element indicates that additional detail decomposition exists but is omitted for brevity.

lifecycle costs through a reference year (e.g., 2050[33]) and annual costs, representing two different time scales of concern for policymaking. Each of these subcategories is further divided into the three types of costs referred to in the literature, namely (1) research, development, test, and evaluation (RDT&E), (2) operations and support (O&S), and (3) health and environmental remediation (see Figure 6). While many sources cover these dollar-valued costs in relatively limited depth, it should not be overlooked that these dollar-valued costs are quantified opportunity costs reflecting the amount of U.S. resources expended toward nuclear forces and arsenals that might otherwise be made available for various other military or civil programs.

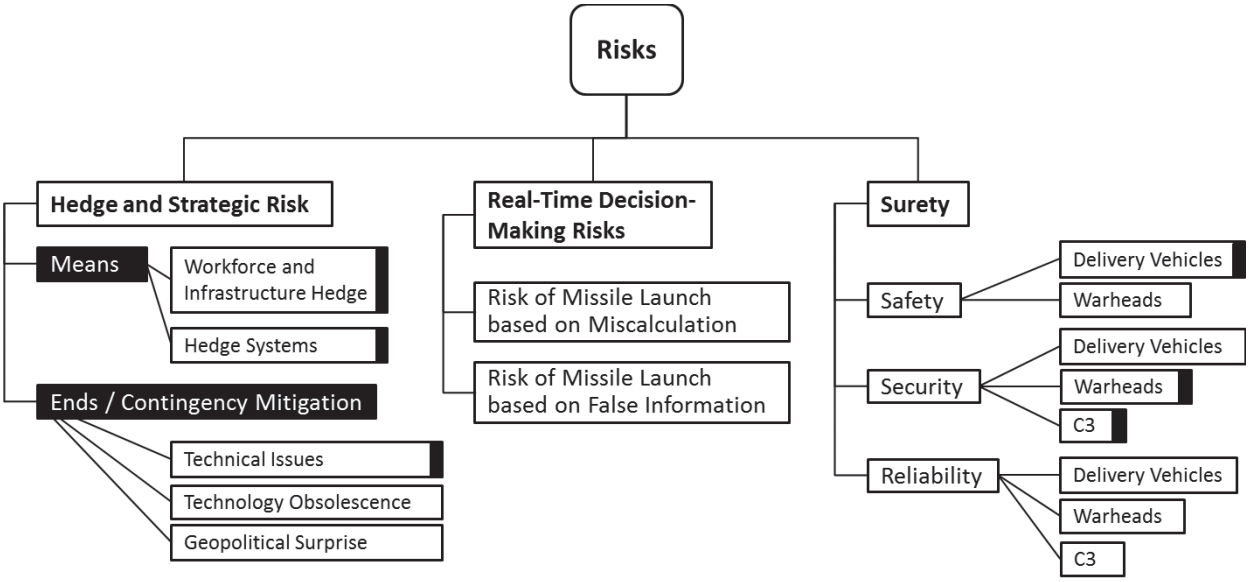
RISKS

The top-tier category of Risks accounts for evaluation criteria related to events whose future occurrence is uncertain but plausible and could prove problematic. Most commonly, the literature expresses these criteria in the two areas of (1) surety and (2) strategic risks against which the United States should hedge. A third category, mentioned in one source,[34] includes real-time decisionmaking risks. Figure 7 illustrates the decomposition of the risks category.

The first subcategory, Hedge and Strategic Risk, expresses objectives related to the mitigation of problems that may arise due to unforeseen technical issues, technology obsolescence, or geopolitical surprise. Discussion in the literature in this area is divided among the *ends* of mitigating these contingencies and the *means* by which this mitigation may be achieved, specifically in areas of workforce and infrastructure hedging (e.g., recruiting, retaining, and developing human capital and critical industrial capabilities in areas such as delivery system and warhead design, test, and manufacturing) and, to a lesser extent, retention of dedicated hedge delivery systems and warheads. To avoid

33. Johnson, Bowie, and Haffa, "Triad, Dyad, Monad?," 15.
34. Cartwright et al., *Global Zero Report*, 5.

Figure 7. Risk Decomposition



A black rectangle on the right side of an element indicates that additional detail decomposition exists but is omitted for brevity. Note that "C3" refers to command, control, and communications.

redundancy, it is recommended that users of this portion of the hierarchy choose whether to focus discussion and evaluation on the ends or means categories, but not both.

The Surety subcategory adopts the Department of Defense *Nuclear Matters Handbook*'s subdivision among safety (risk of unintended weapon operation), security (risk of weapon operation under malicious intent), and reliability (risk of failure given legitimate intent).[35] The safety, security, and reliability categories are further divided into their relevance to delivery vehicles, warheads, and C3 (command, control, and communications) components of the nuclear force structure.

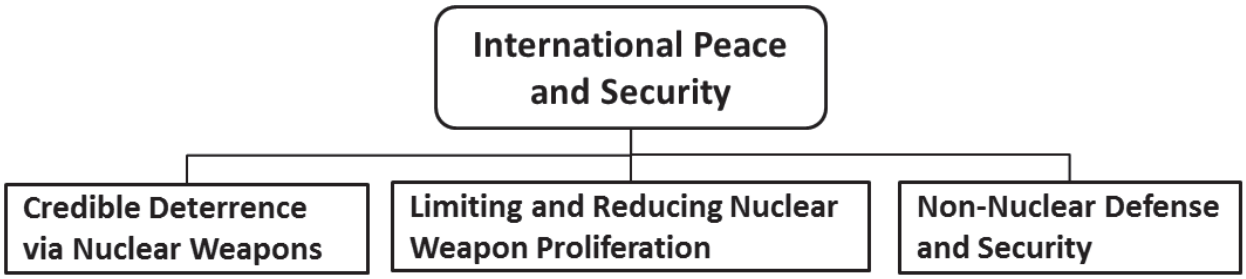
The category of Real-Time Decision-Making Risks includes concerns somewhat beyond the coverage of surety, namely that legitimate intent and successful operation of a weapons system may still be considered problematic if the decisionmaker authorizing use bases his or her decision on false information or miscalculation.[36]

INTERNATIONAL PEACE AND SECURITY

The top-tier category of International Peace and Security contains considerable depth and is the focus of a great deal of the discussion in the nuclear force structure debate. Criteria in this category tend to fall into three major areas, each of which is aimed at the overarching goal of providing national and international security, avoidance of major armed

35. OASD(NCB/NM), *Nuclear Matters Handbook*, 315.
36. Johnson, Bowie, and Haffa, "Triad, Dyad, Monad?," 15.

Figure 8. International Peace and Security Decomposition



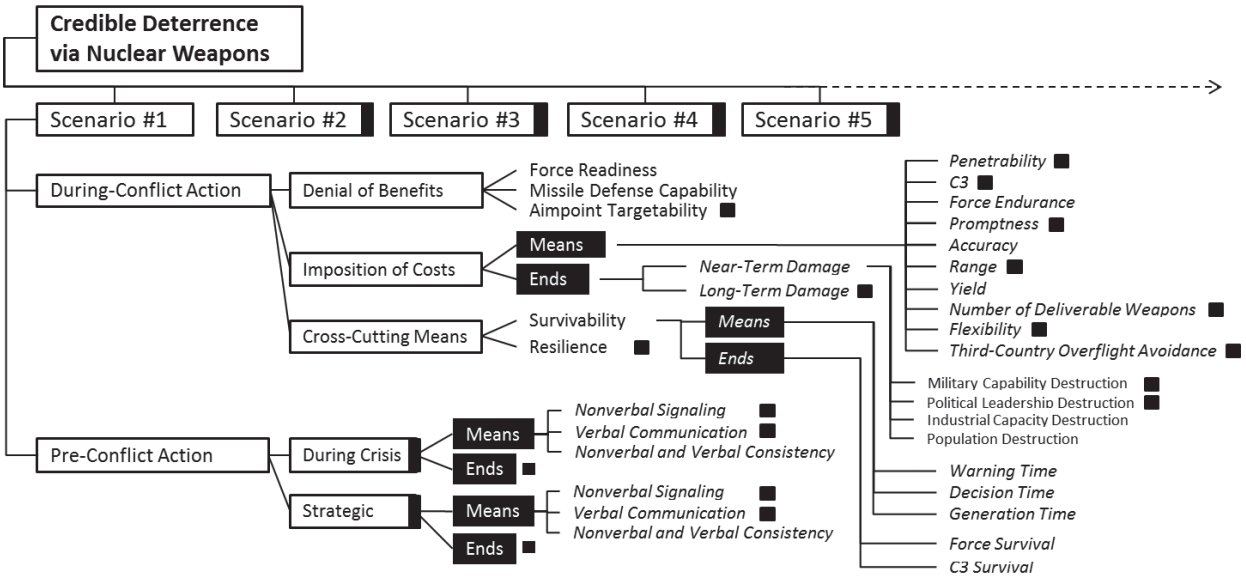
conflicts, and peace. These three areas are Credible Deterrence via Nuclear Weapons, Limiting and Reducing Nuclear Weapon Proliferation, and Non-Nuclear Defense and Security (see Figure 8).

Credible Deterrence via Nuclear Weapons. The objective of Credible Deterrence via Nuclear Weapons encompasses criteria related to the threatened employment of U.S. nuclear weapons for the purpose of deterring the actions of potential adversaries. This category of the hierarchy, decomposed in Figure 9, is perhaps the most complex, and its first-level division recognizes explicitly that deterrence is a highly scenario-specific concept (e.g., a nuclear force that deters an attack on an ally by a nascent nuclear power may have minimal relevance toward the goal of deterring an attack on the U.S. homeland by a major nuclear power). This first-level division thus consists of a number of user-defined scenarios. Each scenario could be defined, for example, by the answers to five questions: (1) Who is being attacked? (United States or an ally/partner); (2) Who is attacking? (major nuclear power, minor nuclear power, nascent nuclear power, non-nuclear power, or non-state actor); (3) How is the attack executed? (nuclear or non-nuclear); (4) What is the attacker's targeting strategy? (counterforce or countervalue); and (5) What is the state of U.S. forces (nongenerated, partially generated, or fully generated). In these terms, for example, an archetypical Cold War "bolt from the blue" scenario would be defined as a major nuclear power executing a nuclear counterforce attack on non-generated U.S. forces. The commonly articulated goal of ally assurance, for instance, is covered by performance of a force structure in scenarios in which allies, rather than the United States, are under attack. Many other scenarios may be defined based on these five variables, and this hierarchy treats the overall objective of deterrence effectively as a portfolio of scenario-specific deterrence capabilities.

Each scenario is subdivided by timescale into two subcategories, namely During-Conflict Action (criteria related to actions that the United States threatens to take if deterrence fails) and Pre-Conflict Action (criteria related to escalation or deescalation actions the United States can take prior to the failure of deterrence). The During-Conflict Action category is divided into three parts, based in large part on the Department of Defense's Deterrence Operations Joint Operating Concept (DO JOC).[37] The first division

37. U.S. Strategic Command, *Deterrence Operations Joint Operating Concept* (Omaha, NE: U.S. Department of Defense, 2006), 5, 24–28.

Figure 9. Deterrence Decomposition

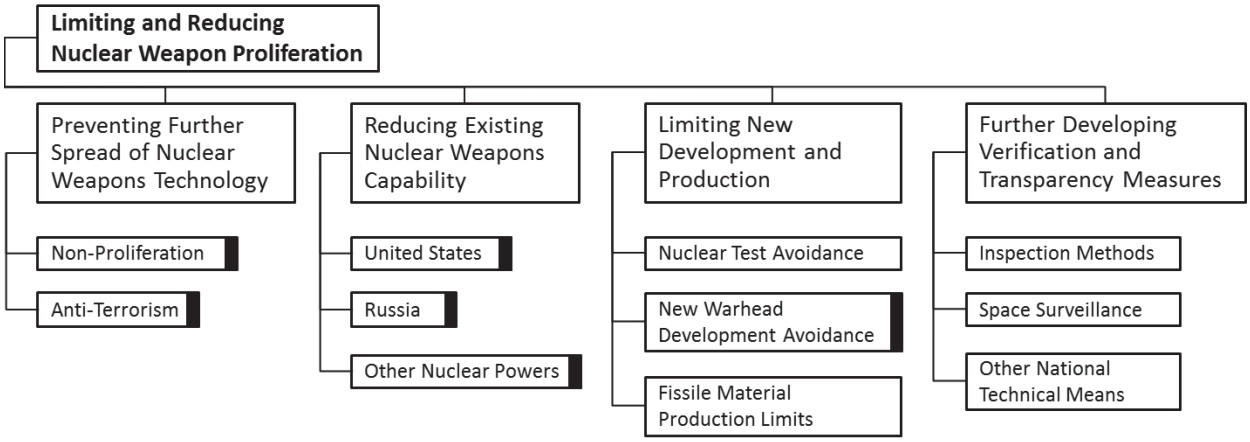


A black rectangle to the right of an element indicates that additional detail decomposition exists but is omitted for brevity.

is Denial of Benefits, incorporating criteria related to measures intended to render an adversary attack ineffective. The second division is Imposition of Costs, incorporating criteria related to methods of imposing costs in retaliation for an adversary's attack. The third division, Cross-Cutting Means, contains criteria of survivability and resilience that have bearing on both benefits denial and cost imposition; for example, a survivable force may both deny the destruction intended by an adversary's counterforce attack and enable a greater retaliatory imposition of costs in the aftermath. The Pre-Conflict Action category is divided into Strategic and During-Crisis subcategories, where the During-Crisis category refers to escalation or deescalation capabilities the United States may wish to have just prior to a possible nuclear outbreak (for example, forward deploying or recalling delivery vehicles, uploading or offloading warheads, or increasing or decreasing alert readiness), and the Strategic category refers to strategic signaling capabilities during periods of peace (for example, reducing or adding warhead capacity per delivery vehicle, or relocating forces to or from foreign soil). The DO JOC's third deterrence pillar of encouraging adversary restraint would fall within this Pre-Conflict Action category.

Many of the lower tiers within this deterrence category contain means vs. ends divisions, indicative of the fact that some sources discuss a given issue on the basis of end effects while others focus on the means to achieving those effects. One example is the Imposition of Costs subcategory. It is very common for nuclear force structure arguments to cite the advantages of their chosen force structure in terms of properties like penetrability, promptness, accuracy, range, and flexibility (e.g., of response magnitude or weapons

Figure 10. Decomposition of Limiting and Reducing Nuclear Weapon Proliferation



A black rectangle to the right of an element indicates that additional detail decomposition exists but is omitted for brevity.

usage). However, Johnson, Bowie, and Haffa[38] allude to Defense Secretary Robert McNamara's metrics of retaliatory industrial and population destruction capability, which are ends produced by those properties. While neither selection is strictly correct or incorrect, in order to avoid redundancy, users of these portions of the hierarchy should choose whether to focus discussion and evaluation on the ends or means categories, but not both.

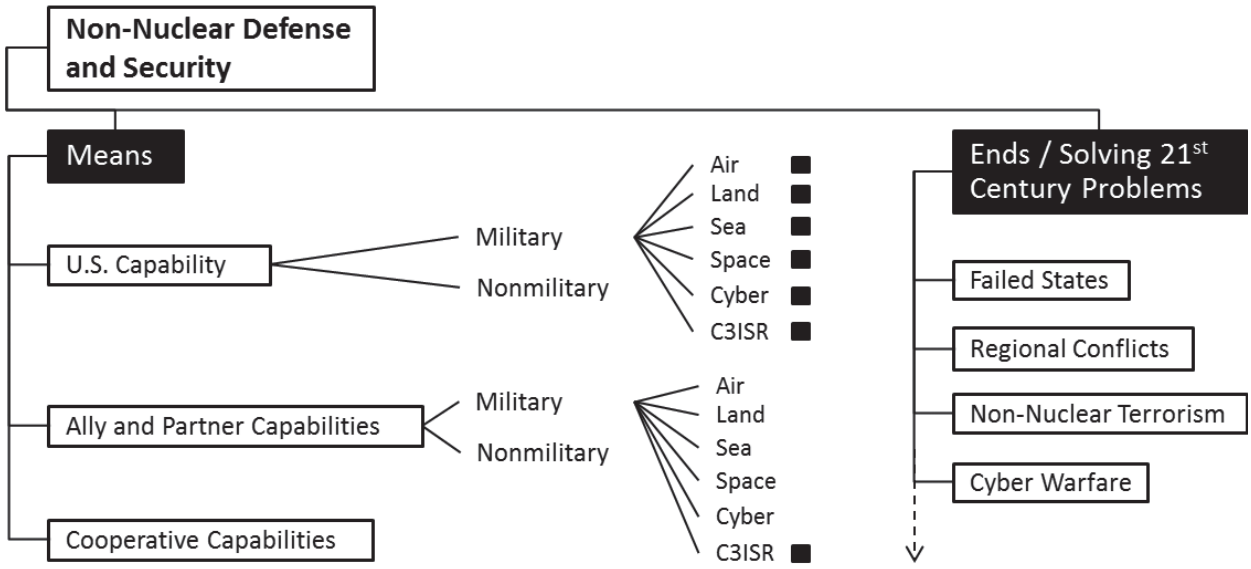
Limiting and Reducing Nuclear Weapon Proliferation. In contrast with deterrence, which seeks global security largely through persuasion against the employment of nuclear weapons, the strategy of limiting and reducing nuclear weapon proliferation seeks security through the elimination of weapons themselves.

This category is subdivided into four distinct subobjectives, as shown in Figure 10. The objective of Preventing Further Spread of Nuclear Weapons Technology encompasses both traditional state-focused nonproliferation efforts as well as anti-terrorism efforts to protect against and intercept smuggled nuclear materials. Reducing Existing Nuclear Weapons Capability encompasses reductions among existing nuclear-armed states, especially the United States and Russia, of numbers of warheads and delivery vehicles. The objective of Limiting New Development and Production encompasses the desire to avoid or limit nuclear tests, development of new military capabilities, and production of fissile materials. The fourth objective of Further Developing Verification and Transparency Measures encompasses goals relating to the improvement of inspection methods, space surveillance methods, and other national technical means.

In a decision context, the weights a decisionmaker may choose to place on this category and its components may vary substantially. For some stakeholders, such as those associated

38. Johnson, Bowie, and Haffa, "Triad, Dyad, Monad?," 11.

Figure 11. Non-Nuclear Defense and Security Decomposition



A black rectangle to the right of an element indicates that additional detail decomposition exists but is omitted for brevity.

with the Global Zero nuclear weapons elimination movement,[39] this limitation and reduction category may resonate strongly. For others, such as U.S. Strategic Command, elements of this category may appear important in the very long term but of more limited relevance in making a near-term force structure decision.[40] Furthermore, certain aspects of a force structure decision, such as a decision to employ a low number of weapons or delivery platforms, may reflect positively in terms of this objective but negatively in terms of the maintenance of credible deterrence. As a result, future evaluations may need to pay particular attention to relative decisionmaker preferences between this category and the category of deterrence.

Non-Nuclear Defense and Security. This final category is discussed somewhat less frequently in the literature but acknowledges that nuclear force structure decisions may have positive or negative implications for non-nuclear defense and security. For example, nuclear force reduction decisions may enable certain prompt global strike capabilities (e.g., conventionally armed ICBMs or the conversion of submarines to accommodate a conventionally armed guided missile capability) and decisions to design future delivery vehicles for dual conventional and nuclear use may impose additional requirements and costs on conventional system development efforts. Reducing the role of nuclear weapons in the national security posture may also impose additional requirements on conventional capabilities. Considerations such as these compose the bulk of the Non-Nuclear Defense and Security decomposition and are considered means criteria, in contrast with the ends criteria of solving twenty-first century problems emphasized by Cartwright et al.[41] (see Figure 11).

39. Cartwright et al., *Global Zero Report*, ii.
40. Kehler and Miller, "A Conversation with General C. Robert Kehler."
41. Cartwright et al., *Global Zero Report*, 2.

Summary and Conclusion

To assist in structuring communication, analysis, and decisionmaking on the current issue of the future of the U.S. nuclear triad, this paper has sought to derive an underlying, unifying value hierarchy for U.S. nuclear force structure decisions.

Following an introduction to the nuclear triad debate and the concept of a value hierarchy from the field of operations research, this paper described the analysis of eight recent and diverse contributions to the nuclear force structure debate, each of which expresses not only unique preferences among evaluation criteria, but also different sets of evaluation criteria. Thorough analysis and derivation of each work's implicit or explicit value hierarchy provided substantial insight into the ways in which force structure evaluation criteria are currently framed. The analysis allowed the rigorous development of a single value hierarchy, consisting of a simple upper-tier structure, which incorporates all criteria expressed by the eight surveyed works—and likely the vast majority of criteria expressed throughout the larger debate.

ADVANTAGES FOR ANALYSTS AND ADVOCATES

Particular attention was paid in the development of this hierarchy to ensuring it is complete, nonredundant, and useful to a wide audience. For example, analysts may find the lower-level decomposition to be highly amenable to developing an aggregate objective function, assigning quantitative scores, and optimizing a detailed nuclear force structure. Likewise, policymakers who need to synthesize analyses from multiple sources may find the highest-tier categories helpful for structuring discussion and thought among disparate opinions.

More precisely, such a hierarchy provides benefits to both policy advocates, who may need to recommend a particular nuclear force structure solution, and policy analysts, who may need to synthesize nuclear force structure arguments from multiple sources:

- **Policy advocates** may benefit from fact that the value hierarchy (1) provides a list of criteria to address in a balanced, complete argument, (2) offers guidance on which criteria are logical components of others, (3) provides a simple mental model of objectives, enhancing communication, and (4) provides a pathway for quantitative, multi-objective decision analysis.
- **Policy analysts** may benefit from the fact that the value hierarchy (1) provides a list of criteria that sources should have addressed in a balanced, complete argument, (2) offers guidance on whether sources are arguing about competing criteria at the same logical tier, (3) helps isolate sources of disagreement between arguments, and (4) provides visibility into which objectives different sources valued more highly than others.

FUTURE DEVELOPMENT

While this paper has proposed one unifying and potentially useful value hierarchy, it is certainly not the only possible hierarchy. Further development in this area, both in terms of incorporating additional perspectives and evaluation criteria and in terms of analyzing the hierarchy itself, would be of substantial value. In the process of developing this paper's hierarchy, the derived value hierarchies of individual advocacy and analysis works were correlated, criterion by criterion, with elements of the unifying hierarchy. This provided, in effect, a large traceability matrix showing how different sources map into the developed hierarchy. This matrix provides, for example, a mechanism by which sources other than the eight examined here can be incorporated into the analysis (by adding more rows to the traceability matrix), and it also provides a mechanism by which analysis can be performed on the relative popularity of various criteria (i.e., more commonly used evaluation criteria will be associated with more populated columns within the matrix). Both of these areas, as well as the development of a method for usefully visualizing the traceability matrix itself, are clear areas for future development.

In closing, this study has provided several insights into the underlying structure of the criteria by which today's analysts evaluate future U.S. nuclear force structures. It is hoped that these insights prove useful to advocates, analysts, and decisionmakers and that the unifying hierarchy that developed from these insights contributes one, and hopefully not the last, step toward a more common language and more transparent and structured discourse on the future of the U.S. nuclear triad.

Potential LEU Encumbrances and Alternatives for the U.S. Production of Tritium for National Security Purposes

David K. Lartonoix[1]

The availability of tritium is essential to the U.S. nuclear weapons stockpile and any potential legal or policy issues impeding its production could have potentially drastic and far-reaching effects on national security. Specifically, potential encumbrances on low-enriched uranium used in the tritium production process have been identified. The legality of these potential encumbrances has been explored and alternatives are suggested should the current production methods ultimately prove to lack long-term viability.

Introduction

Tritium is an essential component of nuclear weapons (NWs) and, therefore, instrumental to national security. Tritium is radioactive and decays with a half-life of approximately 12 years. It is not found in significant quantities in nature and must be replaced periodically as weapons in the stockpile age. Historically, heavy water reactors (HWRs) at the Savannah River Site (SRS) have produced tritium for the nation's NW complex but were shut down for safety concerns in 1988. Since then, U.S. tritium production has been minimal, consisting of specific short-term measures and tritium recycling from decommissioned warheads. Because these methods of replenishment are unsustainable and potentially insecure in the long term, a viable tritium supply must be devised. The most critical component of this analysis involves surveying potential large-scale tritium production alternatives and their associated likelihood of future utilization.

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Overview: Current U.S. Production of Tritium

The Department of Energy (DOE) has contracted with the Tennessee Valley Authority (TVA), a federally owned utility corporation created by Congress during the Great Depression, to irradiate Tritium Producing Burnable Absorber Rods (TPBARs) in TVA's Watts Bar I Nuclear Generating Station for tritium production. Future or backup plans may also include tritium production at two other TVA reactors—Sequoyah-1 and -2—but these reactors are not currently being used for such purposes. Upon sufficient irradiation time and during the reactor refueling outage, the TPBARs are removed from the reactor and transported to DOE's Tritium Extraction Facility (TEF) at SRS, where the tritium is removed and processed (see "Tritium Production Details, Alternative Methods, and Likelihood of Future Use" in this article).

As with all commercial nuclear power plants in the United States, Watts Bar I (and Sequoyah-1 and -2) is fueled with low-enriched uranium (LEU) (typically three to four percent uranium-235). Because natural uranium consists of less than 0.7 percent U-235 (the fissile isotope of uranium necessary for fission in most nuclear reactors), mined uranium must be enriched to the required percent. Currently, there are few companies in the United States that are licensed and have the capability to perform such uranium enrichment for commercial nuclear power fuel. According to the DOE, the only such company legally allowed to provide fuel to TVA to power Watts Bar I and produce tritium is the United States Enrichment Corporation (USEC).[2]

USEC

Privatized as part of the Energy Policy Act of 1992, USEC was contracted to operate the Paducah Gaseous Diffusion (PGDP) uranium enrichment plant in Paducah, Kentucky, and the Portsmouth Gaseous Diffusion Plant in Piketon, Ohio, for the federal government.[3] The Piketon plant would eventually be shuttered and all enrichment operations consolidated at the Paducah plant. Although PGDP produced special nuclear material (SNM) for defense NW purposes many decades before, it was now tasked with enriching uranium to a much lower level to be used in commercial nuclear power plants for civilian electricity production.

Built in the 1950s, PGDP grew to be outdated and inefficient by the late 1990s. Although still functionally viable, operational costs (notably, electricity consumption) at PGDP proved high in comparison to newer plants like URENCO's Eunice, New Mexico, centrifuge enrichment facility. USEC found it difficult to compete on the LEU market; URENCO's centrifuge enrichment plant required approximately one-sixtieth as much electricity to run and,

2. DOE (U.S. Department of Energy), *Interagency Review of the Nonproliferation Implications of Alternative Tritium Production Technologies Under Consideration by the Department of Energy—A Report to the Congress* (Washington, DC: DOE, July 1998), 7.

3. USEC, Inc., "USEC—The Company—History," http://www.usec.com/company/history.

as a result, benefited from significantly lower operational costs.[4] PGDP subsequently lost significant market share in the early 2000s.

Recognizing gaseous diffusion as requiring too much electricity to be economically viable and competitive on the open market, USEC began exploring plans for a centrifuge-based enrichment facility located on the grounds of the retired Portsmouth Gaseous Diffusion Plant in Ohio. USEC's Lead Cascade Demonstration Program (LCDP), licensed by the Nuclear Regulatory Commission (NRC) in 2004, featured AC100 centrifuges, purportedly the most advanced and energy efficient centrifuges in the world. The LCDP, meant to demonstrate the feasibility of using AC100 centrifuges on a commercial scale, began as a small-scale operation. As the demonstration proved more and more successful, additional cascades of centrifuges were added to the line, expanding the size and capability of the facility. In 2007, the NRC licensed the LCDP facility for commercial operations, at which point USEC re-designated the plant the American Centrifuge Project (ACP).[5]

Although proving to be technologically successful, the ACP began to suffer from political opposition. USEC, upon being spun-off from government ownership, continued to be the only U.S.-owned commercial enrichment company. As gaseous diffusion proved to be uneconomical and the company began investing in centrifuge enrichment, USEC required research and development (R&D) funds provided by the U.S. Congress to keep the ACP afloat. During the demonstration phase of LCDP/ACP, no saleable product was being produced. Because it was seen as critical to national defense to retain an indigenous enrichment capability, Congress obliged and continued to provide yearly installments. However, as the program shifted from demonstration phase to commercial production phase, a larger commitment was needed. In 2008, USEC applied for a $2 billion loan under the DOE Loan Guarantee Program, established under the Energy Policy Act of 2005, but was rebuffed.[6] Instead, three years later, DOE answered with a counterproposal. Under the new agreement, USEC would continue to operate ACP as an R&D venture. USEC would receive two years of operational support funding, but not the loan guarantee, which remained "pending" during this time. No assurances were given to USEC that a successful completion of the additional R&D period would result in approval of the loan guarantee.

DOE preferred to delay the decision on a loan guarantee, in part, over concern for USEC's financial status. The company's stock had dropped significantly since its initial public offering approximately a decade prior, Moody's Investor Services had downgraded its ratings for USEC in late 2009, and increasing competition from other enrichment ventures in the United States were cited as reasons to doubt the viability of USEC as a

4. URENCO, "URENCO—Centrifuge cascades," www.urenco.com/page/20/Centrifuge-cascades.aspx.

5. U.S. Nuclear Regulatory Commission, "USEC Inc. Gas Centrifuge," August 12, 2013, http://www.nrc.gov/materials/fuel-cycle-fac/usecfacility.html.

6. USEC Inc., "USEC—The American Centrifuge—The Plant—Funding," www.usec.com/american-centrifuge/what-american-centrifuge/plant/funding.

whole.[7,8] USEC had been heavily investing its own financial resources on a project that looked as if it may never get off the ground. The concern over financial stability perhaps stemmed from USEC's initial privatization. Under the 1992 Act, USEC became a private entity and was contracted solely to operate Paducah and Portsmouth; the government retained ownership of the plants themselves. As a contractor and operator, USEC was spun off with no assets in hand and little financial liquidity. Subsequently, USEC lacked enough collateral to sufficiently back a $2 billion loan guarantee, raising significant doubts in DOE and Congress about whether granting the loan request was advisable, especially in light of the recent backlash pertaining to the Solyndra failure after having received a similar loan guarantee.[9]

Perhaps the only leverage that USEC had in the fight for the loan guarantee was that it remained the only U.S.-owned enrichment company in the United States. The other two domestic commercial uranium enrichment facilities conceived at the time were being developed by Areva, a French company, and URENCO, a Dutch/German/British company. According to the DOE, LEU enriched by either company for use in U.S. commercial nuclear reactors would be ineligible for tritium production.[10]

An interagency review conducted by DOE and reported to Congress in 1998 established the critical link between tritium production for U.S. defense purposes and the debate surrounding the Congressional funding and pending loan guarantee of USEC's ACP. DOE outlined its official position on several key facets of the (at this point, future) decision to use a civilian commercial nuclear power plant to produce tritium for use in NWs. First, DOE asserted that the proposed practice was indeed allowable. "The review concluded . . . that the use of CLWRs [commercial light-water reactors] for tritium production was not prohibited by law or international treaty."[11] This particular statement was in response to critics that claimed the practice violated the long-held tenant of U.S. nonproliferation policy of military-civilian separation of nuclear facilities. DOE went on to point out that historically, "there had been numerous exceptions to the practice of differentiating between U.S. civil and military facilities" and briefly outlined several, from medical isotopes produced in defense reactors to prior examples of the use of the U.S. defense enrichment program for civilian purposes; simply put, "the civil/military separation has never been absolute."[12] Later, the National Defense Authorization Act for Fiscal Year 2000 would expressly give the DOE legal authority to use TVA's Watts Bar and Sequoyah for the production of tritium.[13]

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7. Yahoo! Finance, "USEC Inc. Historical Prices," http://finance.yahoo.com/q/hp?s=USU&a=06&b=23&c=1995&d=09&e=14&f=2013&g=m.

8. "Moody's downgrades USEC ratings," *The Seattle Times*, December 18, 2009, http://seattletimes.com/html/businesstechnology/2010544090_apususecratings.html.

9. Rachel Weiner, "Solyndra, explained," *The Washington Post*, June 1, 2012, http://www.washingtonpost.com/blogs/the-fix/post/solyndra—explained/2012/06/01/gJQAig2g6U_blog.html.

10. DOE (U.S. Department of Energy), *Interagency Review of the Nonproliferation Implications*, 7.

11. Ibid., 3.

12. Ibid., 4–5.

13. Public Law, 106–65, 1999, *National Defense Authorization Act for Fiscal Year 2000,* 113 Stat. 512, October 5, 1999.

Second, DOE concluded that "[tritium] is not classified as a special nuclear material and is therefore not subject to the prohibition in the Atomic Energy Act of 1954, as amended, on the use of such materials for nuclear explosive purposes if produced in a commercial light water reactor."[14] Based on these two assertions, the legal basis for the decision to proceed with tritium production in a civilian reactor, as interpreted by DOE, was declared. However, a third major conclusion of the report, although not largely relevant or concerning in 1998, has become significant in recent years:

> Certain U.S. bilateral agreements for nuclear cooperation prohibit the use of fuel and equipment imported under those agreements from being used for nuclear explosives. In pursuing the CLWR option, DOE would assure its trading partners that no foreign nuclear fuel or equipment supplied that was subject to such restrictions was being used for tritium production in a CLWR.[15]

Clarification of DOE's position on this particular subject was not presented nor did DOE elaborate on "certain U.S. bilateral agreements." DOE administratively limited itself to using domestically-enriched fuel for producing tritium. This was not concerning at the time because DOE also claimed that "ample supplies" existed for such a purpose.[16]

With DOE's report outlining the necessity for the use of only domestically-enriched fuel for the production of tritium, USEC by default was designated as the sole supplier of enrichment services to Watts Bar I. Congress and DOE used this line of reasoning as justification of the continuing financial support of R&D funding for USEC's ACP. When USEC's R&D agreement expired in 2010, Congress lacked a clear plan forward for ACP. Forced to again reconsider the $2 billion loan guarantee, the substance of DOE's 1998 report requiring a domestic source of uranium enrichment began to be questioned by decisionmakers hoping to avoid funding ACP by simply purchasing reactor fuel from a U.S.-located, foreign-owned supplier. As Areva's enrichment plant plans stalled, only URENCO was left as a viable option.

Congressional Research Service Involvement

In May 2012, Representative Ed Markey (D-MA) requested that the Congressional Research Service (CRS) provide background information regarding potential legal restrictions originating from U.S. and international agreements governing the use of uranium to produce tritium. Specifically, Markey wanted insight and guidance from an impartial source as to whether URENCO-enriched fuel could legally be used in Watts Bar I. The impetus for the request to CRS stemmed from Markey's desire to restrict or cut congressional funding to USEC. If the United States was not legally required to domestically enrich uranium for

14. DOE (U.S. Department of Energy), *Interagency Review of the Nonproliferation Implications*, 1.
15. Ibid., 7.
16. Ibid., 8.

tritium production, Markey would prefer that DOE purchase URENCO fuel instead of funding USEC's enrichment capabilities. Markey has for many years been opposed to congressional financial support for USEC.[17]

Two CRS memorandums resulted from the Markey inquiry, one from the policy perspective and one from the legal perspective. The policy memo, dated May 15, 2012, essentially amounts to an initial exploration of the subject. The brief outlined the general issue at hand, URENCO versus USEC, and listed several likely alternative fuel options without going into much depth.[18] The legal assessment, however, offers considerably more detail in its description of the governing factors pertaining to the source of enriched uranium for tritium production.

The legal assessment conducted by CRS, although detailed and thorough, acknowledges its own deficiencies before outlining its assessment of LEU use for tritium production. It notes "the time constraints on this request, the lack of case law or legal authority related to this question, the sensitive nature of the agreements, the limited amount of reliable and publicly available information relating to negotiations and discussions between the United States and the applicable foreign nations, and the resulting difficulties in reaching any definitive interpretive conclusions."[19] Each of these statements is a critical shortcoming, but the assessment attempts to contribute to the context of the debate in a meaningful way. Furthermore, due to the nature and sensitivity of the subject, potentially useful information may be kept confidential by the U.S. government. CRS noted a difficulty in obtaining DOE's justification for its policy of requiring only domestic-enriched uranium for tritium production and assumed that it had not been released publicly. This led CRS to conclude that "[i]t is unclear whether the DOE position is one based on what it judges to be legal requirements, policy considerations, or additional unspoken or informal understandings."[20] Clearly, CRS recognized significant difficulty and uncertainty pertaining to the subject of the request but nevertheless attempted to provide background for Markey's request.

Perhaps the most useful aspect of the CRS legal report is its identification and general description of the international agreements pertaining to nuclear technology by which the United States may be bound in searching for a fuel source for tritium production. Among those most likely to be applicable are the 1992 Washington Agreement and the 1996 Euratom Agreement.

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17. Deirdre Shesgreen, "House reaffirms USEC funding," *Chillicothe Gazette*, July 11, 2013, www.chillicothegazette.com/article/20130710/NEWS01/307100027/House-reaffirms-USEC-funding.

18. Mark Holt and Mary Beth Nikitin, *Potential sources of nuclear fuel for tritium production* (Washington, DC: Congressional Research Service, May 15, 2012), http://markey.house.gov/sites/markey.house.gov/files/documents/2012_0515_CRS_TritiumFuelOptions.pdf, 1–5.

19. Todd Garvey, *Peaceful Use Restrictions on Uranium Enriched at the Urenco Enrichment Facility* (Washington, DC: Congressional Research Service May 21, 2012), http://markey.house.gov/sites/markey.house.gov/files/documents/2012_0521_CRSTreaty.pdf, 1.

20. Ibid., 1–2.

The 1992 Washington Agreement

The 1992 Washington Agreement,[21] between the United States and the governments representing the ownership of URENCO (United Kingdom, Netherlands, and Germany), formed the international legal basis for developing URENCO's uranium enrichment facility in Eunice, New Mexico. The agreement, necessary because any U.S. nuclear-related collaboration on a commercial basis with foreign entities must be solely peaceful in nature according to the Atomic Energy Act Section 123 and 42 U.S.C. §2153,[22] governs the conditions by which European-based URENCO can "transfer" or import nuclear technology into the United States for use by its U.S.-based subsidiary. Specifically, Article III of the agreement states:

> Any ETC [company] Centrifuge Technology, Operations Technology, equipment and components transferred into the United States subject to this Agreement, each Installation, any Nuclear material in an Installation, any special nuclear material produced through the use of such technology, any special nuclear material produced through the use of such special nuclear material, and any data generated at an Installation that is designated Restricted Data while such data are under the jurisdiction of the United States Government or any of the Four Governments shall only be used for peaceful, non-explosive purposes.[23]

This article forms the basis surrounding the debate of using enriched uranium to produce tritium for U.S. NWs. Several clauses are established that prevent the implementer from contributing to NW-related activities, and the central focus of the CRS legal brief is to judge the applicability to the U.S. tritium production program. Because the centrifuge technology, operations technology, and data generated at the site are noncontributors to the tritium program, these factors were not considered; the interpretive difficulties surround the use of SNM produced at the enrichment facility. The phrase "any special nuclear material," dubbed first-generation material by the CRS, most commonly refers to uranium, which clearly is prohibited from direct use in a nuclear weapon per this statute.[24] DOE has concluded[25] and the CRS legal assessment noted[26] that tritium is not classified SNM, which possibly negates the relevancy of this clause of Article III. The second clause limiting the use of "any special material produced through the use of such special nuclear material" (dubbed second-generation material) most commonly refers to plutonium produced in a uranium-fueled reactor. As such, URENCO-enriched uranium is prohibited from fueling a reactor to make plutonium for use in NWs according to the agreement. However, the same

21. *Agreement between the Government of the United States of America and the Four Governments of the French Republic, the United Kingdom of Great Britain and Northern Ireland, the Kingdom of the Netherlands, and the Federal Republic of Germany regarding the Establishment, Construction and Operation of Uranium Enrichment Installations using Gas Centrifuge Technology in the United States of America ("1992 Washington Agreement")*, 1992, www.official-documents.gov.uk/document/cm80/8047/8047.pdf, 1.
22. Todd Garvey, *Peaceful Use Restrictions on Uranium*, 6.
23. *1992 Washington Agreement*, 8.
24. Garvey, *Peaceful Use Restrictions on Uranium*, 3.
25. DOE (U.S. Department of Energy), *Interagency Review of the Nonproliferation Implications*, 3.
26. Garvey, *Peaceful Use Restrictions on Uranium*, 5.

classification of tritium as non-SNM may render the clause non-applicable; however, CRS outlines two possible countering interpretations.

The CRS analysis involves describing two distinct interpretations of the aforementioned phrases, one legally "broad" interpretation and one "narrow" interpretation.[27] Without any legal precedent and lacking relevant case law, CRS is relegated to describing and outlining each case. The narrow interpretation attempts to stick close to the letter of the statute. Under this interpretation, only uranium, plutonium, and other specific SNM would be subject to the nonexplosive use restriction; tritium, as a nuclear material but specifically non-SNM, would be excluded and no part of the Agreement would apply here. This interpretation concludes that URENCO-enriched fuel may be used to power Watts Bar I during tritium production. Legally permitting URENCO, a foreign-owned company, to produce LEU for tritium production conflicts with the stated but unsubstantiated DOE position requiring domestically-enriched LEU for such purposes. In contrast, a broad interpretation of the Agreement asserts that no material derived from URENCO-enriched LEU may be used in a nuclear weapon "no matter how attenuated the eventual non-peaceful use is from URENCO's original enrichment."[28] In other words, tritium is eventually produced from statute-governed material (URENCO LEU) and may only be used for peaceful purposes. Because first-generation material may not be used to produce second-generation material for non-peaceful purposes, the broad interpretation argues that no n^{th}-generation material, by extension, may either. This conclusion precludes URENCO fuel from being used by TVA to produce tritium. With CRS noting shortcomings with both interpretations, a clear legal resolution is not obvious.

The 1996 Euratom Agreement

The Euratom Agreement is the second pertinent international agreement identified by the CRS brief and, though it governs the same exchange with the same parties as the Washington Agreement, it contains its own distinct language. The relevant language requiring interpretation in Article 7 states:

> Nonnuclear material, nuclear material and equipment transferred pursuant to this Agreement and special fissionable material used in or produced through the use of such items shall not be used for any nuclear explosive device or for any military purpose.[29]

As with the Washington Agreement, the wording of the Euratom Agreement is open to interpretation. Because the development of the URENCO uranium enrichment facility does not involve the actual transfer of nuclear or nonnuclear material, the only contested

27. Ibid., 3.
28. Ibid., 4.
29. U.S.-European Atomic Energy Community, *Agreement for Cooperation in the Peaceful Uses of Nuclear Energy between the European Atomic Energy Community and the United States of America* (*"Euratom Agreement"*), 1996, http://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/Euratom_123.pdf, 7.

portion of the Agreement involves the "equipment." The centrifuges being transferred to construct the URENCO facility may logically constitute "equipment," but Article 21 of the Agreement narrowly defines equipment to strictly mean "any reactor as a complete unit."[30] As a result, the centrifuges to be installed are not deemed "equipment" and the applicability of the entire Euratom Agreement to the URENCO LEU is called into question in relation to the tritium production debate.

However, CRS notes that DOE disagrees with this assessment. DOE and other federal employees have been quoted saying that treaty obligations prevent the use of URENCO uranium to produce tritium.[31] With no available DOE analysis or official position statement, the reasons behind DOE's interpretation are unclear.

Current State of USEC, URENCO, TVA, and Tritium Production in the United States

USEC's lease of PGDP from the federal government was scheduled to conclude at the end of May 2012. To continue operations at PGDP for an additional year, a controversial arrangement was devised by several parties. In mid-May 2012, nearing the deadline, the DOE agreed to provide government-owned depleted uranium tails to USEC through the Bonneville Power Administration (BPA), a DOE-owned company that sells electricity produced through federally owned projects, including hydroelectric dams in the U.S. Northwest. Under the agreement, BPA contracted with USEC to re-enrich the tails and then sell a portion of the resulting LEU to TVA for reactor fuel. The arrangement allowed for the continued operation of PGDP by USEC for an additional year.[32]

The following year, negotiations between USEC and DOE did not result in an additional extension.[33] In May 2013, USEC's lease of PGDP officially expired. Even though "USEC expects to continue operations at the site into 2014 in order to manage inventory, continue to meet customer orders and to meet the turnover requirements of its lease with DOE,"[34] activities have shifted to a closeout phase.

Even before the failure to renegotiate a deal with USEC, DOE started to search for a replacement contractor for the Paducah site. A "Request for Expressions of Interest" call went out in February 2013 for "lease or purchase of DOE Paducah Gaseous Diffusion Plant facilities or land near Paducah, Kentucky, either to continue the use of the facilities to enrich uranium, or separately for other nuclear fuel industry applications."[35] The call also

30. Ibid., 16.
31. Garvey, *Peaceful Use Restrictions on Uranium*, 8.
32. USEC, Inc., *Five-Party Arrangement Extends Paducah Gaseous Diffusion Plant Enrichment Operations*, May 15, 2012, www.usec.com/news/five-party-arrangement-extends-paducah-gaseous-diffusion-plant-enrichment-operation.
33. USEC, Inc., "USEC to Cease Enrichment at Paducah Plant," May 24, 2013, http://www.usec.com/news/usec-cease-enrichment-paducah-plant.
34. Ibid.
35. Federal Business Opportunities, "Request for Expression of Interest in DOE Paducah Gaseous Diffusion

listed the potential for inclusion of the large stocks of depleted uranium currently stored at PGDP in the deal.[36] Approximately nine entities (companies, joint ventures), have expressed interest with DOE pertaining to the Paducah Site.[37] Details of the proposed plans or the identities of the interested parties have not commonly been released, as negotiations with DOE are ongoing. However, GE-Hitachi subsidiary Global Laser Enrichment announced it was one of the interested parties with hopes to use its Silex laser enrichment process on the depleted uranium stores.[38] A joint venture between International Isotopes Inc. and Advanced Process Technology Systems has also declared interest. Neither details of DOE's intentions for PGDP nor a timeline for action has been released.

USEC's ACP is ongoing. Additional short-term research and design funding was procured from Congress in 2012 and will expire at the end of 2013. USEC intends to "update the DOE loan guarantee application for the project during 2013."[39] Entering the closeout of PGDP, USEC appears to be resuming the push to build ACP.

Watts Bar I continues to produce electricity for the surrounding Tennessee counties as well as tritium for national defense needs. With 18-month fueling cycles, operating plans have been made several years into the future that account for the use of TPBARs. As previously mentioned, the DOE agreement in 2012 to provide USEC with an additional year of work yielded domestically-enriched LEU made available for tritium production in TVA reactors. This stock of fuel will presumably be used in the upcoming fuel cycles at Watts Bar I to continue to produce power and tritium, as it is the only unencumbered fuel available. As long as DOE's prohibition of nondomestic enriched uranium remains in place, it is unclear where LEU fuel for Watts Bar I will come from once this finite stock is depleted.

Tritium Production Details, Alternative Methods, and Likelihood of Future Use

Although current methods are progressing and are technically sufficient, LEU fuel sources for use in Watts Bar I may prove to be unsustainable. Because the lack of tritium represents a possible threat to the efficacy of the U.S. nuclear deterrent and therefore national security, alternative tritium production options must be explored. Several methods of tritium production exist, each having specific advantages and disadvantages. Currently, light water reactors (LWRs), HWRs, and particle accelerators represent the most likely path to viable tritium production in the United States. Liquid metal reactors (LMRs) and high temperature gas-cooled reactors also hold technological promise but likely will not be

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Plant," February 6, 2013, www.fbo.gov/index?s=opportunity&mode=form&id =ff41cfd2dd03365797d225a2773629a2&tab=core&_cview=1.

36. Ibid.

37. World Nuclear News, "Joint venture confirms Paducah interest," April 9, 2013, www.world-nuclear-news.org/ENF-Joint_venture_confirms_Paducah_interest-0904138.html.

38. Ibid.

39. USEC, Inc., "USEC Provides American Centrifuge Update," March 18, 2013, www.usec.com/news/usec-provides-american-centrifuge-update-0.

feasible in the near term. Science is attempting to prove the technical merits of using alternative or "exotic" means for tritium production.

The experience level within the United States designing, operating, and maintaining tritium production options varies widely, a factor that likely will influence any future undertakings. Also, while only a few various types of reactors currently exist that could reasonably accommodate tritium production, pursuing other options would require building a new facility entirely. As a result, several aspects and characteristics of each system will certainly have an impact on the respective likelihood of future use.

LIGHT WATER REACTOR (LWR)

Tritium can be formed in a LWR by exposing lithium-6 (Li-6) to a neutron flux of any energy according to the following reaction:

$$ {}^{6}_{2}Li + {}^{1}_{0}n \rightarrow {}^{4}_{2}He + {}^{2}_{1}T \tag{1} $$

However, natural lithium is less than eight percent Li-6 and, therefore, needs to be enriched in Li-6 for efficiency and ease of tritium production.[40] A similar and beneficial reaction from Li-7 can also lead to the production of tritium, but it requires a high-energy neutron to initiate:

$$ {}^{7}_{2}Li + {}^{1}_{0}n \rightarrow {}^{4}_{2}He + {}^{2}_{1}T + {}^{1}_{0}n \tag{2} $$

A TPBAR is used to house the lithium being converted into tritium within the LWR core. Specifically, Type 316 stainless steel cladding tubes contain ceramic lithium aluminate ($LiAlO_2$) pellets and a Zircaloy-4 tritium "getter." The "getter" captures, retains, and prevents diffusion loss of the tritium produced and is nickel-plated to prevent oxidation of tube surface walls.[41] After formation, the tritium is trapped within the getter as a metal hydride for later extraction.

The presence of TPBARs within a pressurized water reactor (PWR) has only a minimal effect on reactor operations. However, some tritium diffusion through the cladding wall and into the coolant water has been observed, so care must be used to remain within tritium effluent regulatory limits.

Upon reactor shutdown and removal from the core, the TPBAR is transported to a specialized facility to separate tritium from the supporting materials. This extraction process removes tritium via chemical reaction. Upon further purification, the tritium can be packaged for transportation.

40. Office of Science Education, "Isotopes of the Element Lithium," *Jefferson Lab*, http://education.jlab.org/itselemental/iso003.html.

41. D. D. Lanning, "Tritium Target Qualification Project," December 9, 1999, http://digitalcorpora.org/corp/nps/files/govdocs1/268/268707.pdf, 2.

Tritium can also be produced in specific, noncommercial nuclear reactors that are typically geared toward research. Because research reactors are unique and might be more easily customized, there is the potential for tritium production modification to an existing reactor not originally built for that use. Such an arrangement would have to be made on a case-by-case basis with any such alterations largely based on original system characteristics.

LIKELIHOOD OF FUTURE USE—LWR

LWR production of tritium is the only method currently being used in the United States and, as a result, the likelihood of future use in the short term is high. The LWR method is how tritium is produced in the Watts Bar I reactor and is extracted at SRS's TEF. For the indefinite period, this is DOE's plan to fill the tritium need for defense purposes.

Because of the aforementioned legal uncertainties, LWR production of tritium may not prove to be a long-term solution. Without a more secure source of enriched uranium, legal challenges may derail the current model. Alternative sources of uranium do exist, although few have been explored in enough depth to be considered very likely in the near term. The United States does maintain a quantity of highly-enriched uranium (HEU) that could potentially be down-blended into LEU for use in LWRs to produce tritium. However, much of this HEU has been declared "surplus to U.S. defense needs" and stamped with a presidential promise never to be used for "weapons purposes."[42] Legal interpretation may be necessary to resolve whether down-blending to LEU for tritium production constitutes "weapons purposes." Also, the mechanism for removing this presidential guarantee is unclear. The HEU may have to be kept as a reserve for naval reactor fuel needs. This down-blending process would likely need to be done at PGDP, thus encountering similar hurdles to the current process.

The re-enrichment of DOE depleted-uranium stores also represents a potential option as DOE currently has a vast supply of depleted uranium that is not labeled with presidential or treaty encumbrances. However, an enrichment facility like PGDP would be necessary.

USEC's ACP facility, once completed and fully operational, will represent the only domestic source of enriched uranium if PGDP ends up being mothballed. Enriching natural uranium, down-blending HEU, or re-enriching depleted uranium would each need to progress through ACP if no replacement operator for PGDP is arranged.

Another potential fuel source for TVA reactors could come from the mixed-oxide (MOX) fuel fabrication facilities currently being explored at SRS. The facility would blend surplus weapons plutonium with uranium into a MOX form that could be fabricated into fuel elements to power reactors producing tritium. However, the material may have "weapons purposes" prohibitions on it that would preclude its use.[43] Implementing MOX fuel has

42. Holt and Nikitin, *Potential sources of nuclear fuel for tritium production*, 3.
43. Ibid.

been demonstrated in France,[44] however, no U.S. reactors currently use this fuel type. Also, the project has come under fire for being excessively expensive and constantly faces the threat of being halted.[45]

As a federally owned company, TVA's situation is relatively unique. The company's official website claims that "TVA has an obligation to and a long history of supporting the nation's security requirements."[46] This arrangement makes it unlikely that tritium production would be expanded to any of the other approximately 100 commercial nuclear reactors in the United States.

Another possibility for tritium production is to use a noncommercial LWR. One candidate is the High Flux Isotope Reactor (HFIR), a research reactor located at Oak Ridge National Laboratory. A one-of-a-kind reactor built to supply isotopes for research and medical purposes, conduct materials experiments, and investigate neutron-scattering phenomena, the HFIR offers several potentially attractive characteristics for tritium production. The HFIR operates with an exceptionally high neutron flux, which could lead to high Li-6 conversion rates. In addition, the geometry of HFIR, consisting of a cylindrical fuel region and a fuel-free center cavity, is convenient for Li-6 insertion and withdrawal. The HFIR configuration could present opportunities to measure or enhance production.[47] Although significantly different from using TPBARs in a commercial LWR, research reactors could offer a viable means of tritium production. No proposal has yet been made to use HFIR for tritium production, but it is included to note capability.

Similarly, the Advanced Test Reactor (ATR), located at Idaho National Laboratory (INL), could also be used for tritium production. A research reactor originally built for materials testing and to produce isotopes for research and medical applications, ATR is customizable and operates at a high neutron flux. Its unique serpentine core shape and large test volume would be ideal for tritium production purposes. Over four decades of operational experience also lends a high degree of confidence in reactor functionality and adaptability.[48]

HEAVY WATER REACTOR (HWR)

Another tritium production method involves using a heavy water reactor, aptly named because it uses heavy water as a moderator. Heavy water, rather than H_2O, contains hydrogen atoms that have absorbed an additional neutron and is signified as D_2O. When deuterated water absorbs an *additional* neutron, tritiated water (T_2O) is formed. The simplistic hydrogen absorption process can be described as:

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44. Matthew L. Wald, "U.S. Moves to Abandon Costly Reactor Fuel Plant," *The New York Times,* June 25, 2013, www.nytimes.com/2013/06/26/us/us-moves-to-abandon-costly-reactor-fuel-plant.html?_r=0.

45. Ibid.

46. Tenessee Valley Authority, "Tritium Production at TVA," November 2003, www.tva.gov/news/tritium.htm#chronology.

47. Oak Ridge National Laboratory, "The High Flux Isotope Reactor at ORNL," accessed June 18, 2013, neutrons.ornl.gov/facilities/HFIR/.

48. Idaho National Laboratory, "Advanced Test Reactor," www.inl.gov/research/advanced-test-reactor-research/.

$$ {}_{1}^{1}H + {}_{0}^{1}n \rightarrow {}_{1}^{2}H \tag{3} $$

$$ {}_{1}^{2}H + {}_{0}^{1}n \rightarrow {}_{1}^{2}H \tag{4} $$

The neutron absorption cross-section for deuterium is exceedingly small, only 0.52 millibarns (b),[49] so the production of appreciable amounts of tritium requires a reactor with a high neutron flux. Typically, this characteristic is also accompanied by reactor materials chosen to minimize parasitic neutron absorptions. Unlike tritium production via Li-6, any usable tritium must be extracted via isotopic separation, which is much more challenging than chemical extraction.

LIKELIHOOD OF FUTURE USE—HWR

Because HWRs were utilized at SRS for several decades to produce tritium as part of the nuclear weapon program, the experience and knowledge to create an efficient manufacturing program are well established. However, capabilities may have languished in recent years as no current reactors in the United States operate with a heavy water moderator. Prior projects could easily serve as models for new construction HWRs, but the financial cost would be significant and highly uncertain.

HWRs are operated in foreign countries and successful tritium separation and removal has been demonstrated. Canada operates the world's largest tritium separation facility (Darlington Nuclear Generating Station).[50] Other countries operating HWRs include South Korea and India.

Cost should be considered, as the financial burden of utilizing a HWR for future tritium production is high. However, the level of experience, knowledge, and proof of viability present in the HWR method are not present with many other technologies. Rather than additional hurdles to be overcome, these HWR facets can stand to bolster confidence in new efforts at tritium production.

ACCELERATOR PRODUCED TRITIUM (APT)

Tritium production using a charged particle accelerator has also been investigated, though efforts in the United States have remained strictly in the research and design category. This method uses a particle accelerator to excite charged particles, typically protons, to very high energies and velocities. When an impact target is placed in the path of this proton beam, the charged particles violently collide with impact target atoms and release a large number of subsequent neutrons. These product neutrons form tritium in one of two ways. Throughout research and design efforts, a lithium-aluminum main target, based upon the

49. Alan Munter, ed., "Neutron scattering lengths and cross sections," *National Institute of Standards and Technology*, November 23, 1999, www.ncnr.nist.gov/resources/n-lengths/elements/h.html.

50. CNSC (Canadian Nuclear Safety Commission), *Evaluation of Facilities Handling Tritium*, February 2010, http://pbadupws.nrc.gov/docs/ML1029/ML102990087.pdf, 9.

same reaction used to produce tritium in a LWR, has been proposed in parallel to research endeavors using a helium-3 (He-3) main target. As tritium decays into He-3, a He-3 main target subjected to neutrons would transform the He-3 back into tritium.

A lithium-aluminum main target subjected to a stream of neutrons in an accelerator would function in a similar manner to a TPBAR in a LWR. Differences in the two processes occur at the initiation, but the end results are identical. The proton beam collides with a lead impact target to provide an "avalanche" of neutrons and additional charged particles. It has been estimated that a 1.6 GeV, 250 mA continuous wave beam incident on a lead target could produce a sizeable $5x10^{16}$ n/cm^2/s thermal neutron flux for the conversion process.[51] While water is used to cool the lead and moderate the resultant neutrons, the neutrons interact with Li-6 to produce tritium in the same manner as described for a TPBAR. The tritium extraction process would be similar, relying on chemical differences in the byproducts to separate out the desired tritium. Like TPBARs, individual tubes containing the newly-formed tritium must undergo extraction on a batch system, tube by tube. Of additional concern, however, is the lead impact target, which, now radioactive, requires special disposal handling.

Using a He-3 main target has also been investigated. For this setup, a tungsten impact target is struck by a proton beam to produce neutrons. The neutrons enter a tank of heavy water and react with He-3 contained within a continuously circulating system of piping in the tank according to the following reaction:

$$ {}^{3}_{2}He + {}^{1}_{0}n \rightarrow {}^{2}_{1}T + {}^{1}_{1}p \tag{5} $$

This kind of target offers the considerable advantage that the thermal (2200 m/s) neutron absorption cross section for He-3 is 5333b versus 940b for Li-6, representing almost a six-fold increase in the reaction likelihood.[52] This difference could allow for tritium production at a lower flux or a higher rate of conversion at a higher flux.

A significant difference from other methods is the continuous feed of He-3 and removal of tritium.[53] After tritium and He-3 were separated in the product stream, the He-3 could be fed back into the system. Based on the use of a tungsten target and geometrical differences, there are fewer radioactive waste handling and disposal concerns when using a He-3 target.[54]

LIKELIHOOD OF FUTURE USE—APT

The prospect of APT offers several significant advantages that make the technology attractive. Foremost, several safety and environmental concerns stemming from using reactors

51. G. P. Lawrence, *High Power Linear Accelerators for Tritium Production and Transmutation of Nuclear Waste* (Denton, Texas: Los Alamos National Laboratory, 1990), www.osti.gov/energycitations/servlets/purl/6541091-0991EJ/6541091.pdf, 1.

52. Munter, ed., "Neutron scattering lengths and cross sections."

53. Note: the side-stream of tritium would still contain He-3.

54. GAO (U.S. Government Accounting Office), *Nuclear Science—Consideration of Accelerator Production of Tritium Requires R&D* (Washington, DC: GAO, June 1992), www.gao.gov/assets/220/216452.pdf, 5.

to produce tritium are alleviated by APT. No fissile/fissionable materials are used in the APT process, negating the necessity and dependency upon civilian mining, milling, and enrichment companies and associated regulations and hindrances derived from treaties, executive orders, and presidential administration precedence. With no fissile material, criticality issues are nonexistent and licensing challenges would be less burdensome than with a reactor. Furthermore, although reactors used to produce tritium could potentially be subject to casualty scenarios (loss of coolant accident, station blackout, and so on), thereby endangering personnel, facilities, and the environment, accelerators suffer no such hazards. Lower amounts of radioactive waste would be produced and personnel would be subject to lower amounts of ionizing radiation (maintaining the "as low as reasonably achievable" principle).

However, APT is indeed a new and experimental technology and, for this reason, "DOE did not pursue development of the accelerator concept because it did not believe sufficient time existed to develop the concept, given the immaturity of the technology."[55] Because of the exigency of tritium, DOE decided that further pursuit of APT was not justified.

Cost estimates vary widely for undertaking this approach. A Los Alamos Executive Report from 1989 claims that "[t]he capital cost of the . . . APT design is estimated to about $2.3 billion (1988$USD) . . . [and] includes the accelerator, target building, and supporting facilities, as well as tritium recovery facilities"[56] ($4.5 billion [2012$USD]). This estimate does not include significant electrical costs to run such an accelerator, which may require purchasing or building a coal or natural gas power plant. Offering a differing assessment, a U.S. General Accounting Office study from 1991 claims that DOE (and its contractor) estimated the cost of building an APT system to be $5.3 billion (1989$USD) or $9.9 billion (2012$USD).[57] A CRS report in 1997 called for $5.4 billion (1997$USD) for "actual construction"[58] or $7.8 billion (2012$USD). Cost estimates from various government entities vary considerably and reach into the billions of dollars. The general estimate is that APT may require more initial capital investment than existing methods.

Although APT offers several significant advantages over reactor-produced tritium, future use of the technology in the short-term time frame seems unlikely. Scientific endeavors involving APT will most likely remain in R&D and "proof of concept" phases for the near future. In addition, congressional hesitancy to fund large new ventures in the NW complex will likely prevent future large-scale investment into APT. In the long term, as R&D matures and if short-term tritium production methods prove to be unsustainable, large-scale use of APT could be reexamined.

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55. Ibid., 2.

56. Los Alamos National Laboratory and Brookhaven National Laboratory, *Accelerator Production of Tritium (APT): Executive Report*, March 1989, www.fas.org/sgp/othergov/doe/lanl/lib-www/la-pubs/00186851.pdf, 2.

57. GAO (U.S. Government Accounting Office), *Accelerator Technology for Tritium Production Needs Further Study* (Washington, DC: GAO, October 1991), http://gao.justia.com/department-of-energy/1991/10/nuclear-science-rced-92-1/RCED-92-1-full-report.pdf, 5.

58. Richard E. Rowberg and Clifford Lau, "The Department of Energy's Tritium Production Program," September 1998, University of North Texas Digital Library, http://digital.library.unt.edu/ark:/67531/metacrs752/.

MODULAR HIGH-TEMPERATURE GAS-COOLED REACTOR (MHTGR)

The MHTGR reactor represents a design choice for a significantly low-power, physically smaller unit. The graphite-moderated, typically helium-cooled (although other choices may be available) reactor is often touted for its inherently or passively safe protection systems.

Lithium aluminate spheres are coated in carbon-related compounds (i.e., silicon carbide and others) and aggregated into a target element assembly. Subjected to a neutron flux, the lithium reaction produces tritium inside the coated spheres. Tritium has been shown to diffuse through the sphere's coatings, but significant amounts remain captive inside. Special facilities would be necessary to handle the irradiated target assemblies and extract the tritium from the spheres.[59]

The then-secretary of energy suggested in 1988 that a new $3.6 billion (1988$USD) or $7.0 billion (2012$USD) MHTGR built at INL could be used for tritium production for national security needs. However, four years later, in 1992, the DOE cancelled the gas-cooled reactor program and has made no plans to restart.[60]

LIKELIHOOD OF FUTURE USE—MHTGR

The United States has had two commercial gas-cooled reactors (though not modular) in the past (Peach Bottom and Fort St. Vrain), but both are currently shut down.[61] As a result, there is very little design and operational experience with gas-cooled reactors in the United States, a fact that contributes to the low likelihood of future utilization.

LIQUID METAL REACTOR (LMR)/ MOLTEN SALT BREEDER REACTOR (MSBR)

Although there is less experience pertaining to LMR operation and fewer LMRs exist, LMRs represent an additional means of tritium production.

Some LMRs are designed to operate at a high flux. This characteristic can be used to efficiently convert Li-6 into tritium in the process described previously. In addition, an LMR can be designed to use lithium (or some metallic alloy containing lithium) as a coolant. Producing 20 to 50 times the amount of tritium than in a LWR coolant is an inadvertent side effect. This excess tritium will need to be removed from the coolant in order to maintain low personnel exposure and to create the potential to capture this byproduct for side uses.[62]

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59. Sandra Lee Harms, *Modeling Tritium Release from Triso-coated NP-MHTGR Target Particles*, (master's thesis, MIT, 1992), http://dspace.mit.edu/bitstream/handle/1721.1/72766/27457562.pdf?sequence=1, 10.

60. J. T. Maki et al., *NP-MHTGR Fuel Development Program Results* (Idaho Falls, Idaho: Idaho National Engineering and Environmental Laboratory, October 2002), www.inl.gov/technicalpublications/Documents/2699518.pdf, 1–4.

61. NRC (U.S. Nuclear Regulatory Commission), *Preapplication Safety Evaluation Report for the Modular High-Temperature Gas-Cooled Reactor (MHTGR)*, March 1989, http://pbadupws.nrc.gov/docs/ML0527/ML052780497.pdf, 1–2.

62. Roy C. Robertson, *Conceptual Design Study of a Single-Fluid Molten-Salt Breeder Reactor* (Springfield, Virginia: Oak Ridge National Laboratory, June 1971), www.osti.gov/bridge/servlets/purl/4030941/4030941.pdf.

The Fast Flux Test Facility (FFTF) is a sodium-cooled fast neutron reactor at the DOE's Hanford Site and may be available for tritium production with some retrofitting. Originally designed as an experimental facility to test revolutionary materials and fuels for the DOE with application to the commercial nuclear industry, the FFTF's main characteristic is that it was designed to operate with a high flux, which can be used to irradiate tritium precursors and produce tritium. It was decided in 1993 to deactivate FFTF, but legal battles over the next 20 years have alternately mandated and inhibited various stages of this process. In 2003, it was placed in cold standby with the remaining sodium drained in 2005 by drilling holes in the core support basket. Although it is a significant hurdle to be overcome because operation could not resume in this current state, it may still be possible to restart the facility in a timely, cost-efficient manner because the core itself is intact. FFTF was placed in a long-term storage condition in 2009, but it is uncertain what exactly that entails or what would be required to restart. It is estimated that building a similar facility would cost 2 to 5 billion dollars (2012$USD).[63]

The DOE concluded in 1998 that the government lacked a sufficient quantity of unencumbered plutonium to fuel FFTF beyond approximately 18 months.[64] Significant quantities of potentially useful plutonium have been prohibited from NW use. FFTF could be fueled with HEU; yet, previous concerns of limited HEU stores arise. Because the HEU option dictates a lower tritium production rate, DOE does not think that a sufficient amount would be produced to meet the needs of the stockpile.[65] Furthermore, "the use of HEU would run counter to U.S. policy to minimize the use of this fuel globally."[66] There exists the technological feasibility of using FFTF for tritium production, but additional limiting factors cannot be overlooked.

LIKELIHOOD OF FUTURE USE—LMR/MSBR

No reactors using a lithium coolant currently exist in the United States. Also, very little experience involving lithium-cooled reactors has been obtained. The chances of a reactor of this type being built for the production of tritium appear unlikely.

Conclusion

Tritium is an indispensable component of the U.S. NW stockpile. As a perishable substance, an assured production method is needed to avoid any shortfalls in future supplies. Several options have been outlined with most subject to political, financial, legal, or technological limitations. The future of tritium production for U.S. national security purposes remains ambiguous; an analysis of potential options has yielded several plausible paths forward.

63. DOE (U.S. Department of Energy), "400 Area/Fast Flux Test Facility," October 28, 2012, www.handford.gov/page.dfm/400AreaFPTF.
64. DOE (U.S. Department of Energy), *Interagency Review of the Nonproliferation Implications*, 9.
65. Ibid., 10.
66. Ibid., 12.

The most likely near-term path for tritium production is the continued use of TVA's Watts Bar I reactor. The finite stores of LEU enriched by USEC prior to closing out PGDP most likely represent the last unencumbered fuel for Watts Bar I. As significant uncertainty surrounds the necessity of using domestically-enriched uranium to fuel reactors to produce tritium, future sources of LEU remain unclear.

Down-blending existing stores of government-owned HEU represents perhaps the least financially taxing method of producing LEU for Watts Bar I. The continued use of PGDP at a cost of hundreds of millions of dollars would be required, but this option would cost significantly less than constructing a new facility at a cost likely totaling in the billions. The mechanism for the removal of presidential guarantees (to never again use the particular stores of HEU for weapons purposes) is unknown. Although possibly the least financially taxing option, removing these promises would surely incur political cost. It is unknown to what degree employing this option would endanger stores of HEU reserved for naval reactor use.

The option incurring the least cost politically may be the re-enrichment of unencumbered, depleted uranium tails. Free from politically sensitive or ambiguous restrictions, the breaking of presidential guarantees or international agreements would not be required under this option, but re-enrichment would most likely have to occur at PGDP at a significant financial cost.

The financial and political backing of USEC's ACP represents a difficult dilemma for decisionmakers. If the need for domestic enrichment of uranium for tritium production is deemed to be unnecessary, then this backing is unwarranted. However, if this requirement is upheld or officially justified, decisionmakers will need to back ACP as the only domestic enrichment option currently available, perhaps at a significant personal political cost. Furthermore, additional R&D funding for USEC or the approval of the long-sought loan guarantee would be necessary.

The best option may be to construct a wholly government-owned reactor. DOE has a significant history of operating reactors for defense purposes. As the TEF is currently located at the SRS, siting a reactor on the same grounds may maximize efficiency. Although a PWR similar to commercial generating stations might be appealing, procuring unencumbered LEU for fuel may still pose a challenge. Historical experience using HWRs at SRS should not be overlooked; perhaps HWRs could be used again taking advantage of modern technology. Ultimately, this option would very likely represent a significant cost, and legislative support may be difficult to garner. Although this is the most secure way to assure uninterrupted tritium production for national defense needs, a purpose-built reactor would likely face political and financial hurdles.

A Better Debate on Nuclear Disarmament

Adam Mount[1]

Since President Obama's 2009 speech in Prague, nuclear disarmament has received wider and broader attention than it has had in decades. However, the ongoing debate is deficient in both historical and contemporary perspective: advocates neither draw upon the sophisticated thinking about disarmament that motivated earlier debates, nor have their arguments been updated to reflect the changing moral and strategic conditions that have followed the Cold War. This article provides examples of each tendency and offers suggestions about how to conduct a more constructive debate.

In April of 2009, President Obama traveled to Prague to make his first major foreign policy address. The speech's major initiative was a section in which the president confronted what he called "the most dangerous legacy of the Cold War"—the continued "existence of thousands of nuclear weapons."[2] The spread of nuclear weapons has continued and has raised the worrisome prospect that terrorists could acquire a nuclear weapon. The issue had consequences "for our global safety, our security, our society, our economy, [and] to our ultimate survival."[3] The United States, he argued, has "a moral responsibility to act" to help create a world "free from fear."[4] But the president's proposed solution to the challenge of proliferation was not simply the familiar bundle of mechanisms that make up the global nonproliferation regime; instead, he stated "clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons."[5]

The Prague speech lent new urgency to the national debate on nuclear disarmament that has been simmering since 2007, when former Secretaries of State George Shultz and Henry Kissinger, former Secretary of Defense William Perry, and former Senator Sam Nunn

1. Adam Mount is a PhD candidate in the Department of Government at Georgetown University.
2. Barack Obama, "Remarks by President Barack Obama" (speech, Prague, Czech Republic, April 5, 2009), The White House Office of the Press Secretary, http://www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered/.
3. Ibid.
4. Ibid.
5. Ibid.

published an op-ed in *The Wall Street Journal* that laid out a case for "a world free of nuclear weapons."[6] The piece received widespread attention. With this impressive masthead, analysts moved to develop their understanding of the technical and political requirements for a global disarmament program. It was at this moment that the president went to Prague and lent his considerable support to the goal. The speech generated both wide acclaim and wide resistance. Many analysts were skeptical of the president's "vision," which he conceded might not be reached in his lifetime. Several of these skeptics, having come through a long period of public quiescence on nuclear issues, decried the vision as strange, idealistic, and even unprecedented. Few put Obama's Prague speech in the context of a long history of bipartisan presidential support for nuclear disarmament. Moreover, many contemporary commentators were taken aback by the moral rhetoric in Obama's speeches on the subject. The nuclear historian Michael Krepon, for instance, mused that Obama's 2013 speech in Berlin was "the first time a U.S. president has discussed nuclear weapons in the context of peace and justice."[7]

In fact, Obama's commitment to nuclear disarmament was only the latest statement of a policy that U.S. presidents have held to a greater or lesser extent since the advent of nuclear weapons. Even as it was accumulating a massive arsenal, the United States promoted the norm of nuclear disarmament in prominent speeches, in bilateral agreements with other countries, and in the legal commitment of the Non-Proliferation Treaty.[8] Furthermore, though the White House's relationship with the antinuclear movement has ranged from wariness to outright hostility, administration officials readily adopted the movement's deeply moral arguments in favor of nuclear disarmament. During the 1940s and 50s, many of these arguments were developed by former nuclear scientists, who gained wide notoriety by pressuring administrations to pursue a global agreement on international control of atomic energy. During the 1960s, this relatively centralized advocacy network expanded into a mass movement that filled the streets of European capitals with outraged citizens. Following an interval in which activist attention was concerned with the Vietnam War, the antinuclear movement rekindled in the 1980s, as academics and public intellectuals engaged in sophisticated debates over complex ethical issues. In June of 1982 a million Americans marched on New York to demand a freeze in the development of nuclear weaponry.

Today's nuclear disarmament debate looks very different. Even though disarmament is more widely accepted in the policy community than ever before, the mass movement has largely evaporated. This has provided new opportunities to policymakers anxious to

6. George Shultz, William Perry, Henry Kissinger, and Sam Nunn, "A World Free of Nuclear Weapons," *The Wall Street Journal*, January 4, 2007.

7. Elaine Grossman, "News Analysis: Obama Offers Few Nuclear Policy Surprises in Berlin," *Global Security Newswire*, June 19, 2013, http://www.nti.org/gsn/article/news-analysis-obama-offers-few-nuclear-policy-surprises-berlin/.

8. Although statements in favor of nuclear disarmament are relatively frequent, there have been fewer cases in which U.S. diplomats have offered nuclear disarmament in the context of formal negotiations. There are at least four such examples: in 1946, with Bernard Baruch's plan for international control of atomic energy to the UN Atomic Energy Committee; in 1961, with the presentation of the McCloy-Zorin Accords on general and complete disarmament to the General Assembly; in 1968, in signing the Non-Proliferation Treaty; and in 1986 at a bilateral summit in Reykjavik. Although only half of these commitments resulted in a signed agreement (1961, 1968), the formality of the offer is stronger than a public rhetorical statement.

manage the process of nuclear drawdown cautiously, while also depleting political will. The contemporary debate has left aside many of the previous sophisticated arguments about harm, deterrence, cost, and a more peaceful world as a whole, instead concentrating narrowly on the risks of nuclear proliferation and of certain types of nuclear accidents. In some ways, the previous arguments in favor of disarmament have been discarded ignominiously; in other ways, their logic has been adopted uncritically, without having been updated for a dramatically different strategic context. The debate has largely been conducted in the halls of government and in the conference rooms of Washington think tanks in predominantly technical terms. Following the Prague speech, a great deal of effort was devoted to examining the technical feasibility and diplomatic sequencing of the policy,[9] but very little consideration has been given to evaluate whether disarmament is a goal worth pursuing. Far from being a semantic or academic question, the purposes for which nuclear disarmament is pursued will have important implications for force structure, triad recapitalization, deterrence dynamics and low numbers, sequencing and verification of drawdown, and nonproliferation diplomacy. To help put the current debate into context, this paper will outline some of the arguments that had previously propelled the debate on nuclear disarmament, comparing past arguments with their contemporary versions and offering suggestions about how the debate can better reflect the new strategic context.

Arguments in Nuclear Ethics

Nuclear ethics is a vast and varied field. Politicians, laypersons, public intellectuals, academic philosophers, and strategists have all advanced the dialogue. Ethical arguments moved easily between politicians' podiums, the seminar rooms of university faculty, and the banners of protesters. As arguments circulated, they would gain or lose components or emphasis would be placed on different parts. Reduced to their basic features, there are three arguments against the possession of nuclear weapons based on intent, identity, and outcomes. The final instrumental argument is the most complex and most prominent in the debate, the argument based on harm (or, alternatively, security). This last argument can cut both in favor of disarmament and against, and it has oscillated between each position over time as the technological and strategic contexts have changed.

HARM

An argument based on harm is in some way present in nearly every appeal for and against nuclear disarmament. Although ubiquitous, the argument itself is complex and multifaceted: arguments based on harm vary widely in terms of the type of harm to be avoided, the role

9. A number of recent volumes have made excellent progress on these issues, including: Catherine Kelleher and Judith Reppy, *Getting to Zero: The Path to Nuclear Disarmament* (Palo Alto, CA: Stanford Security Studies, 2011); George Perkovich and James Acton, *Abolishing Nuclear Weapons: A Debate* (Washington, DC: Carnegie Endowment, 2009); Barry M. Blechman and Alexander K. Bollfrass, eds., *Elements of a Nuclear Disarmament Treaty* (Washington, DC: Stimson Center, 2010); Barry M. Blechman and Alexander K. Bollfrass, eds., *National Perspectives on Nuclear Disarmament*, (Washington, DC: Stimson Center, 2010); Tanya Ogilvie-White and David Santoro, "Introduction: The Dynamics of Nuclear Disarmament," *The Nonproliferation Review* 17, no. 1 (2010): 17–21.

harm plays in the structure of the argument, and the tradition drawn upon. In this way, both advocates and opponents of disarmament endeavor to prevent some form of harm—be it death, war, suffering, tyranny—through defense, deterrence, or disarmament. The argument's ubiquity and complexity makes for a particularly knotty task, but prevention of harm is a basic obligation that is generally thought to adhere to all individuals and institutions.

The most common variant of the argument based on harm proposes an injunction against killing innocent civilians. The principle has been present in most ethical traditions and a number of transnational advocacy efforts, but it has received a particularly nuanced and influential expression in just war theory. According to this tradition, warfare must be subject to the requirements of discrimination (of force to combatants) and proportionality (that the harm inflicted by the use of force is warranted by the good achieved). A number of observers have relied on these concepts and have doubted whether nuclear weapons could be employed in a way that met either criterion. The philosopher Thomas Donaldson has called this feature of nuclear weaponry, "technological recalcitrance," which is to say that they are "recalcitrant to the intentions of their users: they are relatively uncontrollable, subject to accidents, and strikingly indiscriminate in the scope of their damage."[10]

A particularly pervasive and dramatic version of this argument holds that there is value in the preservation of civilization as a whole that generates an additional obligation to refrain from nuclear use. Although it sounds extreme now, the thought that employing nuclear weapons could mean the extinction of the human race was a nearly ubiquitous feature of both activist and official rhetoric for much of the Cold War, and the concepts of a "nuclear holocaust," or a threat to "civilization," or "humanity" became commonplace. Although many have expressed this worry, dating back to the earliest days of antinuclear advocacy, its most eloquent and influential expression was in Jonathan Schell's 1982 book, *The Fate of the Earth.* The impossibility of conceiving of the value of civilization means that "better dead than red" arguments must be mistaken: "there can be no justification for extinguishing mankind, and therefore no justification for any nation ever to push the world into nuclear hostilities."[11] George Kennan gave the argument a religious connotation. "This civilization," he wrote, "is not the property of our generation alone. We are not the proprietors of it; we are only the custodians . . . who are we, then, the actors, to take upon ourselves the responsibility of destroying this framework, or even risking its destruction?"[12]

HARM, SECURITY

A casual look at rhetoric about nuclear ethics would frame the issue as a familiar struggle between activists who levy moral arguments against strategists and politicians who issue self-interested replies in return. But a close look at these apparently rationalistic replies shows that the argument in favor of nuclear deterrence is underwritten by moral considerations as

10. Thomas Donaldson, "Nuclear Deterrence and Self-Defense," in *Nuclear Deterrence: Ethics and Strategy*, ed. Russell Hardin et al. (Chicago: University of Chicago Press, 1985), 165.; Ibid.
11. Jonathan Schell, *The Fate of the Earth* (New York: Knopf, 1982), 130.
12. George F. Kennan, *Nuclear Delusion* (New York: Pantheon, 1982), 206.

well. In this case, moral content is not read into an argument that is couched in nonmoral terms; in fact, many of the proponents of nuclear deterrence understand national defense as a moral imperative. The argument is an inversion of the argument based on harm above, arguing that prevention of harm requires the maintenance of the nuclear arsenal.

As with other arguments, the argument based on security has a number of variants. All variants insist that possession of nuclear weaponry is permissible for the sake of national security. Most expressions of this argument hold that the practice of nuclear deterrence is morally acceptable; many argue that deterrence is morally required of statesmen. Many argue that counterforce use of nuclear warheads would be acceptable in retaliation for an attack.[13] Some condition their support for nuclear deterrence on the proviso that possession of nuclear weapons be temporary. Many recommend limitations on the use, size, or type of the nuclear arsenal instead of full disarmament.[14]

The political philosopher Michael Walzer, in *Just and Unjust Wars*, gave an eloquent expression to this position. In the nuclear age, "Deterrence is a way of coping with that condition, and though it is a bad way, there may well be no other that is practical in a world of sovereign and suspicious states. We threaten evil in order not to do it, and the doing of it would be so terrible that the threat seems in comparison to be morally defensible."[15] Although "mutual disarmament would clearly be a preferable alternative," this may simply be too unlikely in the present day to rely upon.[16] In this view, the moral value of civilization simply outweighed the moral cost of participating in nuclear deterrence. The columnist George Will, for instance, accepted that deterrence is hostage-taking and that due to their inability to distinguish combatants from noncombatants, nuclear weapons "cannot be approved."[17] "But," he asserted, "they can be tolerated if the unilateral renunciation of them would bring on an intolerable evil (such as subjugation to an evil regime), and if the nation strives to reduce and end reliance on them."[18] Deterrence, says Will, is "a great enough good to justify involvement with nuclear weapons."[19]

INTENTION

Without minimizing the ethical significance of nuclear weapons' ability to cause tremendous harm when used, some observers have realized that this fact has an additional implication

13. Christopher Morris, for instance, gives an unusually frank defense of the claim that nuclear retaliation would be morally permissible. Christopher Morris, "A Contractarian Defense of Nuclear Deterrence," in *Nuclear Deterrence: Ethics and Strategy*, ed. Russell Hardin et al. (Chicago: University of Chicago Press, 1985), 94.

14. Substantial cuts that far exceeded U.S. policy at the time fit this category if the argument is made that this smaller stockpile is required for national defense. See, for instance, Harold A. Feiveson, "Finite Deterrence," in *Nuclear Deterrence and Moral Restraint: Critical Choices for American Strategy*, ed. Henry Shue (Cambridge: Cambridge University Press, 1989).

15. Michael Walzer, *Just And Unjust Wars: A Moral Argument With Historical Illustrations* (New York: Basic Books, 2006), 274.

16. Ibid.

17. George Will, "Nuclear Morality," in *The Apocalyptic Premise: Nuclear Arms Debated*, eds. Ernest W. Lefever and E. Stephen Hunt (Washington, DC: Scarecrow Press, 1982), 276–7.

18. Ibid., 275.

19. Ibid.

for the ethical permissibility of possession of nuclear weapons. Even without ordering the use of nuclear weapons, policymakers can face moral appraisal as a result of having formed an intention to use those weapons. In the Catholic and other deontological traditions, the moral appraisal of actions depends to a large extent on the intent behind an action and not simply the action itself. As a result, the practice of deterrence may be wrong in itself. Because the purpose of a nuclear arsenal is deterrence and this is likely unavoidable given the fact of possession, the argument based on intent is indirectly an argument against possession. As the Cold War unfolded and policymakers demonstrated restraint in the use of nuclear weapons, the intent-based argument developed into a criticism of a *conditional* intention to use nuclear weapons—that is, an intent to use them in retaliation for an attack. Although the argument based on intent is philosophically complex, in fact it is behind the common feeling that possession of nuclear arsenals reflects badly on national identity and weighs on the character of each citizen and policymaker. As a result, the argument was crucial in motivating the popular disarmament movement and was uniquely positioned to influence policymakers on moral grounds.

The argument based on intent was present from the early days of the nuclear age and continued to develop steadily, especially in the voluminous Catholic literature on nuclear ethics. Although the logic behind the argument is reasonably intuitive, its connection to Catholic ethics and its reliance on the concept of intention kept it from circulating widely as a complete ethical argument. Still, the argument based on intent was behind many of the more emotive concerns of protestors, including disgust with statesmen who seemed to be "prepared" to do the unthinkable.

The argument based on intent does not appraise past or expected future actions. Instead, the formation of an intention to deploy nuclear weaponry is taken to be an act worthy of criticism in the present. This is so for two reasons. First, forming an intention to conduct nuclear deterrence has implications for the likelihood of nuclear war taking place. In the case of nuclear deterrence, forming a conditional intention to retaliate creates "a plan which makes the imposition and maintenance of such risk necessary (causally) to . . . being successful."[20] For a statesman to form an intention to carry out nuclear deterrence therefore has very real effects on the world external to his own mind: he must give orders to subordinates, recommend legislation, publicize his intention, and ask for votes from civilians. This causes other individuals (both subordinates and adversaries) to form, maintain, and authorize conditional intentions to deploy nuclear weapons, making each of them morally culpable in the event of nuclear war. The statesman also commits himself to resisting developments that contradict the practice of nuclear deterrence.

Secondly, the formation of an intention also allows for an appraisal of the agent's character. Because intentions help to produce action, the act of forming an intention is in part a decision about who an agent wants to be. As a result, forming an intention "reflects the

20. Gerald Dwordkin, "Nuclear Intentions," in *Nuclear Deterrence: Ethics and Strategy*, eds. Russell Hardin et al. (Chicago: University of Chicago Press, 1985), 44.

agent's values by showing what he is prepared to do (under certain circumstances)."[21] By maintaining deterrence, a president shows himself willing to use nuclear weapons, probably against innocent civilians. By extension, that democratic societies are willing to have immoral intentions formed in their name is reflective of degraded collective values. In this sense, Arthur Stein argued that deterrent threats represent "a deracination from humanity, and from the humanity within ourselves."[22] As R. A. Markus put it, "in a double sense, our very humanity is at stake."[23]

IDENTITY

A persistent worry among those concerned with nuclear weapons is that the maintenance of a nuclear arsenal is incompatible with U.S. values. The first variant of the argument holds that a nuclear arsenal is subversive of democratic accountability; the second, of psychological well-being. The argument was presented from the earliest stirrings of anti-nuclear activism, when U.S. nuclear scientists and public intellectuals initially worried whether democracy could withstand the secrecy necessary to manage a nuclear military. But as the years passed and the United States acclimated itself to the vicissitudes of the Cold War, the argument evolved to criticize this very acclimatization, wondering whether a people could retain their sanity, living calmly under the threat of destruction.

Sen. Hubert Humphrey, preparing in 1950 for a second run at the presidency, argued that unilateral disarmament was the only way to reclaim "the basic moral purpose which is the fabric of our democratic way of life."[24] This was true because it would restore the moral authority of the United States to lead the postwar world, but also because of the threat to the country's democratic structure itself. "The chronic threat of war, even without its advent, must inevitably create a state of perpetual crisis and resultant loss of human freedom . . . . Under the stress of continuing war tension, the body politic may well transform itself into a garrison-prison state."[25] In this context, Hans Morgenthau worried that, "The great issues of nuclear strategy . . . cannot even be the object of meaningful debate . . . because there can be no competent judgment without meaningful knowledge."[26]

A number of prominent thinkers also believed that willingness to risk extinction reflects an illness in human society. Albert Schweitzer, in his lecture accepting the 1952 Nobel Peace Prize warned that, "we are becoming inhuman to the extent that we become supermen . . . ," and that, "in resigning ourselves to our fate without a struggle, we are

21. Jeff McMahan, "Deterrence and Deontology," in *Nuclear Deterrence: Ethics and Strategy*, ed. Russell Hardin et al. (Chicago: University of Chicago Press, 1985), 48.

22. Arthur Stein, "Introductory: The Defense of the West," in *Nuclear Weapons, a Catholic Response*, ed. Gertrude Elizabeth Margaret Anscombe (Oxford: Sheed and Ward, 1962), 31.

23. R. A. Markus, "Conscience and Deterrence," in *Nuclear Weapons, a Catholic Response*, ed. Gertrude Elizabeth Margaret Anscombe (Oxford: Sheed and Ward, 1962), 77.

24. Hubert Humphrey, "God, Man, and the Hydrogen Bomb" (Washington, DC, February 22, 1950), 7, http://www.mnhs.org/library/findaids/00442/pdfa/00442-00262.pdf/.

25. Ibid., 3.

26. Hans J. Morgenthau, "What Ails America?," *The New Republic*, October 28, 1967, http://www.newrepublic.com/book/review/what-ails-america.

guilty of inhumanity."[27] As late as 1982, George Kennan thought that, "this entire preoccupation with nuclear war is a form of illness that "can be understood only as some form of subconscious despair on the part of its devotees—some sort of death wish, a readiness to commit suicide for fear of death."[28] Indira Gandhi professed herself to be "deeply distressed and also astonished at the apathy which one sees, almost a resignation or acceptance of such a horrifying event [as nuclear war] . . ."[29]

INSTRUMENTAL GOALS

Some disarmament advocates have also recommended nuclear disarmament as a means of pursuing other objectives to which they attach moral significance. The first wave of disarmament activism was particularly fertile for bold contemplation, as advocates rushed to arrange the complex of norms of nuclear restraint to draw compelling connections between issues. The early association with world federalism encouraged broad thinking about the benefits of disarmament to justify the expansive policies under consideration. In particular, advocates suggested that multilateral disarmament could help to prevent the onset of war; others asserted that the expenditures necessary to maintain a nuclear arsenal could be redirected to poverty alleviation at home or abroad.

By far the most common instrumental argument for disarmament was as a means to securing a more peaceful world. Although this was a common goal at the height of the Cold War in the sense of decreasing tensions with the Soviet Union, the sentiment took on a much more specific and more utopian impulse in the late 1940s. Scores of articles and speeches began from some version of the premise that without international control of atomic energy, the next war would be inevitable and devastating. For these thinkers, as for the Nobel chemist Harold Urey, "the atomic bomb is not the fundamental problem at all . . . the fundamental problem is war. If there is another war, atomic bombs will be used."[30] To those involved in international politics in the early Cold War—thinkers who could not yet rely on nuclear deterrence—the enormous destructive power of atomic weapons was plainly a reason to consider limits on their adoption. This expectation generated much of the renewed interest in banning war entirely. It is why Sen. Hubert Humphrey called a global complete disarmament agreement "a moral alternative to world chaos,"[31] and roughly why British Prime Minister Clement Attlee argued that "unless we can devise human relationships other than those which have obtained through the ages, destruction on an unbelievable scale may fall upon our civilization."[32] As a result, the Nobel chemist and physicist Irving Langmuir hoped that "we may someday come to regard the atomic

27. Albert Schweitzer, "The Problem of Peace" (presented at the Nobel Peace Prize Acceptance Speech, Stockholm, Sweden, 1954), http://www.nobelprize.org/nobel_prizes/peace/laureates/1952/schweitzer-lecture.html.

28. Kennan, *Nuclear Delusion*, 199.

29. Olafur Grimsson and Nicholas Dunlop, "Indira Gandhi and the Five Continent Initiative," *The Bulletin of the Atomic Scientists*, January 1985.

30. Harold C. Urey, "A Scientist Views the World Situation," *Bulletin of the Atomic Scientists*, February 15, 1946, 4.

31. Humphrey, "God, Man, and the Hydrogen Bomb," 12.

32. "THE NATIONS: Two v. the Atom," *Time Magazine*, November 18, 1945.

bomb as the discovery that made it possible for mankind to bring an end to all war."[33] In 1945, when public figures made admonishing reference to the "realities" of the international system, it was in support of the need for transnational solutions to stop war.[34] It was this thinking that led the Truman administration to offer the Baruch Plan to the United Nations Atomic Energy Commission in 1946. The 1960s' calls for a test ban treaty and the 1980s' nuclear freeze movement carried similar, if more modest, arguments with them: if the momentum of the Cold War could be halted, even in a limited way, this might represent a foothold for lessening tensions and a more ambitious agreement.

The Current Debate

It will not be surprising if the above discussion feels uncomfortable or antiquated; these arguments are rarely made today. As the nuclear disarmament debate evolved in past decades from a vehicle for world federalists to the comparatively modest demands of the nuclear freeze movement of the 1980s, the arguments have evolved to take on a new hue.[35] In the years since the four horsemen rekindled widespread interest in nuclear disarmament, the debate has taken place almost exclusively within the argument based on harm. Opponents of nuclear disarmament argue that the world continues to be a dangerous place and the maintenance of a nuclear arsenal is a prudent hedge against geostrategic uncertainty, as well as regional threats that may only be deterred with nuclear weapons.[36] Disarmament proponents, on the other hand, argue that the world continues to be a dangerous place and the elimination of our nuclear stockpile can help to alleviate these threats. For their part, the four horsemen's article is essentially a list of threats to the United States: the North Korean nuclear test, the prospect of nuclear terrorism, and the likelihood of proliferation to states lacking robust nuclear security standards.

At the same time, a summary recognition of the moral import of nuclear disarmament is common but rarely explained or relied upon to make a substantive point. In this respect, the four horsemen's op-ed noted that nuclear disarmament was "consistent with America's moral heritage."[37] George Perkovich and James Acton, of the Carnegie Endowment for International Peace, "believe that nuclear-weapons states have political and moral obligations to seek to eliminate all nuclear arsenals," but also stipulate that "these obligations stem from Article VI of the [Non-Proliferation Treaty]."[38] They worry that failure to live up to these obligations could induce wider noncompliance with the treaty regime. Without

33. Irving Langmuir, "An Atomic Arms Race and Its Alternatives," in *One World or None: A Report to the Public on the Full Meaning of the Atomic Bomb*, eds. Dexter Masters and Katharine Way (New York: The New Press, 2007), 148.

34. In this case, Sen. Joseph Ball: "Toward the Super-State," *TIME*, November 19,1945, 28.

35. Although few Washington conservatives during the 1980s would have agreed that the nuclear freeze movement had modest aims, a fissile materials cutoff and a comprehensive test ban treaty had been the official preference of the White House until the Nixon administration.

36. Matthew Kroenig, "Nuclear Zero? Why Not Nuclear Infinity?," *The Wall Street Journal*, July 30, 2011.

37. Shultz et al., "A World Free of Nuclear Weapons."

38. George Perkovich and James Acton, "Introduction" in *Abolishing Nuclear Weapons: A Debate*, eds. George Perkovich and James Acton (Washington, DC: Carnegie Endowment for International Peace, 2009), 16.

further explanation, the country's obligations seem primarily legal in nature; they are lent weight by an instrumental calculation that perceived failure of Article VI would lead to additional proliferation.[39]

Each case—an assessment of threat and an assertion of moral significance—are emblematic of a widespread tendency to offer incomplete or inconclusive arguments in favor of nuclear disarmament. The result is a disarmament debate that is simplistic and disingenuous, populated mostly by slogans that fail to engage the complex issues on which the question should be decided.

As an example of the issue's complexity, consider the simple fact of the Cold War's end. This fact, the most important feature of the international system today, means that the world is a safer place since the end of the Cold War, especially for great powers.[40] The incidence of war has declined globally, and the transition of the international system from a bipolar to a unipolar world has not led to a resurgence of great power wars.[41] On the contrary, relations between great powers are historically stable. As a result, citizens and policymakers no longer live under the constant threat of a massive nuclear war. This simple and obvious fact has major implications for the disarmament debate. Advocates of disarmament have been quick to point out that this fact removes much of the ethical justification for the maintenance of nuclear arsenals and deterrence: Walzer and Will's impulse to use threat to outweigh the moral troubles of deterrence is now less acute. However, disarmament advocates have not also come to grips with the reciprocal fact: arguing based on threat feels inappropriate to a safer world. Although constant vigilance is required, the plausibility of significant nuclear accidents among the industrial countries is low. Although low-probability/high-impact threats like nuclear terrorism demand attention, the evidence that terrorists are interested in and capable of attaining fissile materials for explosives is also sparse. Because of this, nuclear disarmament proponents' arguments that rely on a dangerous world for their resonance may fail to connect with reality.[42]

These considerations about geostrategic threat have serious implications for how the disarmament debate evolves. First, they incentivize certain strategies for disarmament proponents in the White House, Congress, and activist groups. Arguments based on threat rely on careful assessments of geostrategic risk that are made far from the everyday lives of citizens, many of whom in any case grasp that the world is less threatening than it was a quarter century ago. As a result, arguments based on threat are not normative for everyday people: they discourage rather than encourage participation in the nuclear debate.

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39. Although their volume explicitly disavows a discussion of the purposes or goals of disarmament, describing the import of the moral dimension might also have serious consequences for the process and methods of disarmament.

40. Micah Zenko and Michael A. Cohen, "Clear and Present Safety," *Foreign Affairs* (March/April), March 1, 2012, http://www.foreignaffairs.com/articles/137279/micah-zenko-and-michael-a-cohen/clear-and-present-safety.

41. See generally J. Joseph Hewitt et al., *Peace and Conflict 2012: Executive Summary* (College Park, MD: Center for International Development and Conflict Management, 2012).

42. And certainly, incomplete arguments on this score will be unconvincing because, as we have seen, the simple identification of a threat can contribute to an argument both for and against disarmament.

Disarmament advocates interested in encouraging public participation should consider finding ways to update other arguments. Arguments based on intention may be a better means of adjusting to a decreased-threat environment than dwelling on the relatively low threats of nuclear terrorism and nuclear accidents in the United States. As Jonathan Schell has argued, maintaining a nuclear arsenal after the threat that justified it has expired will strike many voters as ominous.[43] It may also strike voters as unnecessarily costly, if disarmament advocates can present credible and nuanced assessments of the relative cost of maintaining the arsenal.

Arguments based on intention also require updating. If the need for deterrence is less acute, the need to cultivate and maintain a retaliatory intention may be lower, which may be why arguments based on intention sound shrill and uncivil in today's society. However, the many people who believe that deterrence remains necessary to maintain national security cannot hold this view. As a result, advocates may wish to explore ways to frame arguments based on intention that are reflective of the common acceptance today that nuclear weapons are commonplace. This may both alleviate the extremity of arguments based on intention and underscore the strangeness of continuing to hold retaliatory policies in a relatively safe world. Arguments based on intention have the benefit of drawing on and strengthening the nuclear taboo, which is increasingly acknowledged as an invaluable component of global nuclear politics.[44] They also do not require proponents to vilify certain countries or denigrate the nuclear security protocols of others. As the typical targets of these kinds of arguments will be crucial to negotiating any global arms control agreement, justifying disarmament efforts on these grounds may substantially set back the effort.

Secondly, these considerations about the threat environment have important substantive implications. If nuclear disarmament is now less a means of addressing threat, it can be pursued differently as a matter of policy. Acknowledging this transition might allow advocates the latitude to explore agreements and plans that place less emphasis on strict conditionality and verification and more emphasis on cost savings or a preferred force structure. For instance, moving away from arguments predicated on threat should better support the burgeoning movement to pursue unilateral stockpile reductions.[45] If advocates and policymakers judge that this is the best way to encourage movement toward disarmament in today's fractious political climate, they should recognize that arguments predicated on threat may undercut rather than assist this mechanism.

If the goal is a more peaceful world, the administration should pursue ways to link disarmament initiatives with nonproliferation agreements, attempting to expand the scope of the Non-Proliferation Treaty by reasserting the original trade-off between disarmament and nonproliferation obligations. Meanwhile, arguments based on identity and intention

43. Jonathan Schell, *The Unfinished Twentieth Century* (London: Verso, 2001).

44. Nina Tannenwald, *The Nuclear Taboo: The United States and the Non-Use of Nuclear Weapons Since 1945* (Cambridge: Cambridge University Press, 2007), 1–29.

45. Pavel Podvig, "A Case for Unilateral U.S. Nuclear Warhead Reductions," *Bulletin of the Atomic Scientists* (2013), http://thebulletin.org/case-unilateral-us-nuclear-warhead-reductions; Lawrence M. Krauss, "Letting Go of Our Nukes," *The New York Times*, July 6, 2013.

will closely support some of immediate steps that can be taken to decrease the salience of nuclear threats in national security policy, including revisions of nuclear targeting doctrine or no-first use policies.[46]

Third, the changed threat environment has implications for the need for future study. Although analysts have made major progress in understanding the political conditions of a disarmament agreement and the technical steps required to verify it,[47] there continues to be a tremendous need for nuanced studies about the sequencing of drawdown, deterrence stability at low numbers, the connection between nonproliferation and disarmament, different methods of pursuing triad recapitalization, and the influence of ethics and public opinion on the process. Importantly, each of these studies should be explicit about the reasons for disarmament, and these should be scrutinized and evaluated as carefully as any factual or instrumental claim.

In short, we cannot afford to debate a subject as important as nuclear disarmament without a firm grasp of the reasons for and against the policy. The issues are too complex and too consequential for incomplete, inconclusive, or disingenuous arguments. Simply rehearsing the standard arguments for or against disarmament is likely to bring analysts into conflict with their own preferred positions, as many popular arguments conflict with their supposed implications. Lastly, dismissing the Obama administration's policy of nuclear disarmament as historically aberrant or utopian overlooks a long and rich tradition in U.S. foreign policy thinking that included many of the country's best strategic minds.

46. For a nuanced and recent look at these issues, see George Perkovich, *Do Unto Others: Toward a Defensible Nuclear Doctrine* (Washington, DC: Carnegie Endowment for International Peace, 2013).

47. Jeffrey W. Knopf, "Nuclear Disarmament and Nonproliferation: Examining the Linkage Argument," *International Security* 37, no. 3 (December 13, 2012): 92–132; James M. Acton, *Deterrence During Disarmament: Deep Nuclear Reductions and International Security* (Abingdon, Oxon: Routledge, International Institute for Strategic Studies, 2011).

Red Lines or Green Lights? U.S. Extended Deterrence in Pacific Maritime Disputes

Mira Rapp-Hooper[1]

In the last several years, U.S. allies in Northeast Asia have become increasingly involved in low-level conflicts over disputed maritime territories. Although they have not yet escalated, these conflicts could provoke major wars involving the United States and China and/or North Korea, especially because some claimants are holders of U.S. security guarantees. This paper argues that extended deterrence is particularly hard to make credible where territorial disputes are concerned. It evaluates the spectrum of U.S. extended deterrence commitments in the Pacific, demonstrating that not all U.S. commitments to maritime disputes involving allies are created equal. It also assesses the likelihood of an adversary challenge, arguing that the greatest risk of conflict involving a U.S. ally may be in the South China Sea. It offers policy recommendations accordingly.

In his June summit with Barack Obama, Chinese President Xi Jinping stated his country's intention to defend disputed island territory in the East China Sea.[2] China's 2013 Defense White Paper also referred to the Senkaku/Diaoyu dispute as a primary strategic priority.[3] That the Senkaku/Diaoyu dispute has heated up in recent years is of no small importance to Washington: Japan is a holder of a U.S. security guarantee, and any military conflict between China and Japan over the uninhabited islands could therefore involve the United States. There are other maritime disputes that involve a U.S. treaty ally as one of the claimants, including South Korean holdings near the Northern Limit Line (NLL) and Philippine claims in the South China Sea.

During the Cold War and since, the United States' security guarantees, backstopped by

1. Mira Rapp-Hooper is a PhD candidate in political science at Columbia University. She is the 2013–2014 Stanton Nuclear Security Fellow at the Council on Foreign Relations.
2. "In Summit with Obama, Xi Declares Senkakus China's 'Core Interest,'" *Asahi Shimbun*, June 12, 2013, http://ajw.asahi.com/article/asia/AJ201306120057.
3. "The Diversified Employment of China's Armed Forces," Information Office of the State Council, The People's Republic of China, April 16, 2013, Beijing, http://news.xinhuanet.com/english/china/2013-04/16/c_132312681.htm.

the U.S. nuclear umbrella, have rarely been challenged. However, these disputed territories constitute a future hurdle for U.S. extended deterrence for three reasons. First, they have, thus far, involved low-level conventional provocations that the U.S. nuclear umbrella is not designed to deter. Second, in most of these cases, it is not clear whether the claimants' defense treaty with the United States is intended to apply to the disputed territory. Few discernible red lines exist. Third, the disputed territories themselves are of little inherent value to the United States. These three factors combined mean that extended deterrence over disputed territories in the Pacific is especially difficult to make credible.

Despite the fact that these disputes have been outstanding for decades, China's rise and North Korea's nuclearization mean that they are unlikely to return to dormancy. Extended deterrence in maritime conflicts is just one of many important strategic questions that are raised by the shifting global power balance and the United States' increased attention to East Asia. If, as many experts predict, however, these maritime disputes are the most likely potential flashpoints in this "Pacific Century," the United States must review its extended deterrence policy toward these disputes and decide, rather than demur, on its posture in each case.[4] Although any of these conflicts would begin at low levels, the adversary in each case is nuclear-armed, and potential for serious escalation is possible.[5] Rather than wait until a conflict is imminent, the United States should carefully consider whether it is willing and able to defend its allies at each of these potential flashpoints. It must also consider the military strategies that are best suited to the defense of these interests.

The remainder of this paper proceeds as follows. It begins with a theoretical discussion of why deterrence is difficult when red lines are unclear and when the interest involved is of limited value to the security patron (the United States).[6] Although there are some clear benefits to the United States hedging its position in these Pacific maritime conflicts, there are also significant drawbacks. Next, the paper will summarize the three important maritime disputes involving U.S. allies, as well as the position the United States has taken on each. Following this, it will analyze the strength of the United States' extended deterrence commitments in each of these disputes in terms of stated intentions and proximate military capabilities, demonstrating that there is a de facto tiered hierarchy of U.S. commitments in these Pacific disputes. The strength of the potential adversary challenge in each conflict is also addressed. The extent of the U.S. commitment is sufficient for deterrence in the near term, but this may not remain so as Chinese military capabilities expand. Of the three scenarios presented, the Chinese are most likely to be able to assert their interests in South China Sea

4. Former Assistant Secretary for East Asia Kurt Campbell recently predicted as much in remarks at the Asan Washington Forum, June 24, 2013; Avery Goldstein argues that maritime sovereignty disputes may have replaced Taiwan as the most likely trigger of a crisis between the United States and China. See Avery Goldstein, "First Things First: The Pressing Danger of Crisis Instability in US-China Relations," *International Security* 37, no. 4 (Spring 2013), 54. On the term "Pacific Century," see Hillary Clinton, "America's Pacific Century," *Foreign Policy*, November 2011, www.foreignpolicy.com/articles/2011/10/11/americas_pacific_century.

5. On this point, see Avery Goldstein, "First Things First," 49–89.

6. For more on this, and a more general discussion of extended deterrence challenges in East Asia, see Linton Brooks and Mira Rapp-Hooper, "Extended Deterrence, Assurance, and Reassurance in the Pacific During the Second Nuclear Age," *Strategic Asia 2013–2014* (Forthcoming).

disputes with the Philippines a decade from now. As such, the United States should implement more formal extended deterrence consultations with the Philippines and seriously consider whether it is willing to asymmetrically escalate over an ally's maritime claims.

Extended Deterrence in Dispute

There are several important theoretical reasons why extended deterrence is especially difficult when an ally has a territorial dispute. Security guarantee treaties involve a commitment by a patron (in this case, the United States) to defend an ally (South Korea, Japan, or the Philippines) against an attack on its home territory. Specifically, U.S. treaties involve a promise of defense against armed attack on territories under an ally's "administrative control," pledging to treat these as a "common danger."[7] If it is unclear, however, whether a particular island falls under an ally's administrative control, it becomes difficult to express a clear deterrent threat to adversaries to keep those claims from being challenged.

Deterrence is a form of coercion and may be defined as bargaining under the threat of punishment. Generally, a deterrent threat takes the form: "if you do X, I will do Y." In the case of extended deterrence, that threat takes the form: "if you do X to my ally, I will do Y to you."[8] For the United States, X is generally an unprovoked attack, and Y is some form of military retaliation, up to and including the possible use of nuclear weapons, which serve as a backstop to extended deterrence guarantees. If it is unclear whether or not a patron believes a certain territory belongs to its ally, however, this threat cannot be clearly articulated. If the domain of a country is unknown, an adversary cannot distinguish what does or does not constitute an attack on a U.S. ally, and therefore what conditions could bring that adversary into a major war with the United States. This scenario results in an imprecise red line, with a red line defined as territory or objective that a state may credibly threaten to defend.[9]

Recent international relations research suggests that clarity about borders or the international legal status of a territory can help to prevent conflict. Political scientists Paul Huth, Sarah Croco, and Benjamin Appel find that international law and agreements act as focal points that can help resolve territorial disputes.[10] Political scientists David Carter and Hein Goemans demonstrate that clear borders can help to facilitate bargaining.[11]

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7. See, e.g., United States-Republic of Korea Mutual Defense Treaty: http://avalon.law.yale.edu/20th_century/kor001.asp; United States-Japan Treaty of Mutual Cooperation and Security: http://www.mofa.go.jp/region/n-america/us/q&a/ref/1.html; United States-Philippines Mutual Defense Treaty: http://avalon.law.yale.edu/20th_century/phil001.asp.

8. Thomas C. Schelling, *Arms and Influence* (New Haven: Yale University Press, 2008), 74.

9. For more on red lines and imprecise red lines in particular, see Daniel Altman, "Red Lines and Fait Accomplis," International Studies Association Annual Meeting, San Francisco, 2013, 1.

10. Paul K. Huth, Sarah E. Croco, and Benjamin Appel, "Does International Law Promote the Peaceful Settlement of International Disputes? Evidence from the Study of Territorial Conflicts since 1945," *American Political Science Review* 105, no. 2 (May 2011), 415–436; Paul K. Huth, Sarah E. Croco, and Benjamin J. Appel, "Bringing Law to the Table: Legal Claims, Focal Points, and the Settlement of Territorial Disputes since 1945," *American Journal of Political Science,* 57, no. 1 (2012), 90–103.

11. David B. Carter and Hein E. Goemans, "The Making of the Territorial Order: New Borders and the Emergence of Interstate Conflict," *International Organization* 65, no. 2 (2011), 275–309.

Schelling has also remarked on the importance of recognized boundaries as focal points.[12] Pacific maritime disputes lack these international legal focal points. With no further statements by security guarantors to add clarity, red lines in these potential conflicts are blurry at best.

Furthermore, extended deterrence is also difficult to make credible when the object being defended is of limited value to the patron making the deterrent threat.[13] Unlike Western Europe during the Cold War, the United States is hard-pressed to claim that uninhabited, rocky islets constitute a vital U.S. national interest.[14] Indeed, these islands almost certainly do not. This fact means that it is unsurprising that the United States has declined for decades to state a position on many of its allies' territorial claims.[15] It would perhaps be more surprising if the United States committed itself unequivocally to the defense of these littoral holdings. Combined with the lack of clear red lines, however, limited U.S. interest makes disputed territories particularly vulnerable locations for adversary challenges.

There are, however, some obvious benefits to imprecise commitments. Explicitness and clarity contribute to the credibility of commitments, but imprecision, or calculated ambiguity, allows a patron to avoid some of the international reputational cost of backing down.[16] Indeed, states often opt for flexibility over the credibility that comes along with specificity.[17] Vague threats may also incur fewer domestic political costs for the sender.[18]

Additionally, vague U.S. commitments in these territorial disputes may mitigate potential moral hazard.[19] If allies are certain of U.S. backing in a crisis over a maritime claim, they may be more likely to escalate once a skirmish begins. These territorial disputes inspire nationalism in all of the countries involved. Nationalist groundswell coupled with a firm U.S. commitment could make disengagement very difficult if a crisis were to begin to boil. Furthermore, it is possible that even a fuzzy commitment will suffice to dissuade an adversary from serious encroachment.

Ambiguity has its drawbacks, however. The absence of clear red lines invites limited probes by adversaries. If an adversary is interested in testing a patron's commitment to

12. Thomas C. Schelling, *The Strategy of Conflict* (Cambridge: Harvard University Press, 1980), 8.

13. Daryl Press argues that a country must have serious interests at stake in a conflict to make its threats credible, although he does not apply this argument to extended deterrence *per se*. Daryl G. Press, *Calculating Credibility: How Leaders Assess Military Threats* (Ithaca: Cornell University Press, 2005), 6–7.

14. Schelling, *Arms and Influence*, 67.

15. For more on this general argument, see Mira Rapp-Hooper, "An Ominous Pledge," *The Diplomat*, September 26, 2012, http://thediplomat.com/china-power/uncharted-waters-for-extended-deterrence-in-east-china-sea.

16. Richard Ned Lebow, *Between Peace and War: The Nature of International Crises* (Baltimore: Johns Hopkins, 1981), 85.

17. Glenn H. Snyder and Diesing, *Conflict among Nations: Bargaining, Decision Making and System Structure in International Crises* (Princeton: Princeton University Press, 1977), 216–17.

18. Robert F. Trager and Lynn Vavrek, "The Political Costs of Crisis Bargaining: Presidential Rhetoric and the Role of Party," *American Journal of Political Science* 55, no. 3 (July 2011), 527.

19. For a discussion of moral hazard in alliance politics see Brett V. Benson, Patrick R. Bentley, and James Lee Ray, "Ally Provocateur: Why Allies Do Not Always Behave," *Journal of Peace Research* 50, no. 1, 47–58.

its ally, or hopes to incrementally encroach on a disputed territory, blurry red lines may not only fail to deter, but might also invite challenges to the patron's security guarantees.[20] If an adversary knows that the United States and its ally do not agree about the status of the disputed territory, it may capitalize on this uncertainty and try to present the allies with a *fait accompli* or exploit the disagreement in the allies' positions to rend the alliance itself.

Furthermore, if an ally is drawn into a territorial dispute and the United States has not taken a clear position one way or the other, Washington has less leverage over both the ally and the adversary. It runs the risk that the conflict will escalate while the United States ponders whether or not to intervene, undermining crisis readiness. As one well-known scholar observed, "[d]eterrence should be ambiguous only when it is a bluff."[21] The United States may be inviting maximum danger if it fails to formulate a clear deterrent threat in advance, but then chooses to fight when an attack comes.[22] Because it has not stated clearly whether or not its security guarantees apply to key disputed territories, Pacific maritime conflicts may pose a significant risk.

Trouble at Sea?

There are three maritime disputes that all involve a U.S. security guarantee holder as a claimant and are particularly challenging for U.S. extended deterrence. The first is the Senkaku/Diaoyu dispute between Japan and China. The second involves disputes in the South China Sea between the Philippines and China. The third is the standoff between North and South Korea over the Northern Limit Line.[23]

SENKAKU/DIAOYU

The islands referred to as Senkaku in Japanese and Diaoyu in Chinese are part of the Ryukyu island chain.[24] The islands sit between Japan and China, and although they are inhabited primarily by goats, they are located near strategic sea lanes. They are also close to fishing areas and are proximate to potential oil and gas reserves. Japan has administered the islands since 1895. Tokyo claims the rights to do so were acquired through the Treaty of Shimonoseki at the end of the First Sino-Japanese War. Following Japan's surrender to the Allies at the conclusion of World War II, the United States controlled the Ryukyus.

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20. Schelling, *Arms and Influence,* 66–67.

21. Richard K. Betts, "The Lost Logic of Deterrence," *Foreign Affairs*, March/April 2013, www.foreignaffairs.com/articles/138846/richard-k-betts/the-lost-logic-of-deterrence.

22. Ibid.

23. Another important dispute in this region is the Dokdo/Takeshima/Liancourt Rocks dispute between Japan and South Korea. Because this involves two U.S. treaty allies as opposed to one ally and one adversary, this dispute does not engage extended deterrence in any traditional sense, although it does present a host of unique problems.

24. These islands are also claimed by Taiwan and are referred to as "Diaoyutai" there. I do not analyze the Taiwanese position in this dispute, however, as the Taiwanese do not have reason to believe that their informal security guarantee from the United States would apply to a militarized conflict over their island claim.

The United States attempted to transfer authority back to the Japanese with the reversion of Okinawa in 1972, and China has contested this authority since.[25]

In 2010 and 2012, Japan and China clashed publicly over the status of the islands, sparking strong nationalist responses in both countries, as the islands hold symbolic value in each. China has recently increased patrols and exercises near the islands. It has also deployed a collection of buoys, which Japan believes are an intelligence collection effort. Chinese vessels' incursions on Japanese maritime territory have occurred dozens of times since the most recent clash over the Senkakus in September 2012.[26] Additionally, in December 2012, China scrambled jets over the islands for the first time in 55 years.[27] China's 2013 Defense White Paper also lists its claim to the Diaoyu islands as one of China's top three military priorities.[28]

Since reverting control of the Senkakus to Japan, the U.S. government has insisted that it takes no official position on the territorial dispute. It has, however, also been U.S. policy since 1972 that the U.S.-Japan Security Treaty covers the Senkakus, because Article 5 of the treaty stipulates that the United States is bound to protect "the territories under the Administration of Japan."[29] Going further in January 2013, then-Secretary of State Hillary Rodham Clinton stated: "we oppose any unilateral actions that would seek to undermine Japanese administration" of the islets. The United States therefore maintains a distinction between sovereignty and administrative control and opposes challenges to Japanese administration.[30]

SOUTH CHINA SEA

The Philippines also has several outstanding maritime disputes with China. The Philippines and China both claim the Scarborough Shoals and the Spratly Islands.[31] The area is mostly of interest to claimants because of potential oil, gas, and mineral deposits. Claimants are also interested in protecting sea lanes. China is keen to use the South China Sea to provide sanctuary and open sea access for nuclear submarines, destroyers, and aircraft carriers.[32] The Philippines reported seven incidents of Chinese harassment at sea in 2011.[33] The president of the Philippines announced his country's intention to rename the South China Sea the "West Philippine Sea" in 2011, and China and the Philippines clashed

25. Mark E. Manyin, *Senkaku (Diaoyu/Diaoyutai) Islands Dispute: U.S. Treaty Obligations* (Washington, DC: Congressional Research Service, 2013), 1.

26. "China Navy Plans to 'Wear Out' Japanese Ships in Diaoyu Islands," *China Defense Mashup*, March 7, 2013, www.china-defense-mashup.com/china-navy-plans-to-wear-out-japanese-ships-in-diaoyu-islands.html.

27. Hiroko Tabuchi, "China Scrambles Jets in Island Dispute with Japan," *New York Times*, December 13, 2012, www.nytimes.com/2012/12/14/world/asia/japan-scrambles-jets-in-island-dispute-with-china.html.

28. "The Diversified Employment of China's Armed Forces."

29. Manyin, *Senkaku (Diaoyu/Diaoyutai) Islands Dispute*, 1.

30. Ibid.

31. Other claimants to territories in the South China Sea include Malaysia, Brunei, Vietnam, and Indonesia, but none of these are holders of U.S. security guarantees.

32. Leszek Buszynski, "The South China Sea: Oil, Maritime Claims, and US-China Strategic Rivalry," *The Washington Quarterly* 35, no. 2 (2012), 144–45.

33. Ibid., 142.

over the Scarborough Islands in a month-long standoff in 2012.[34] In the latter dispute, China erected a barrier to block Philippine vessels, entered waters it had not previously administered, and attempted economic coercion.[35] In mid-2013, the Philippines accused China of encroaching on its maritime territory and referred to the Chinese occupation of the Scarborough Shoals as "illegal."[36]

The Philippines has taken its Scarborough dispute with China to the International Tribunal on the Law of the Sea for arbitration.[37] The United States has reaffirmed its defense commitment to the Philippines, but has declined the Philippines' request to state publicly that the mutual defense treaty covers the disputed territory.[38] Even if the United States does not acknowledge Philippine administration, it still retains the right to intervene in the dispute because the treaty includes potential for aid in the case of an attack on either party's "armed forces, public vessels, or aircraft in the Pacific."[39] The United States has pressed for mediation by the Association of Southeast Asian Nations (ASEAN) in disputes in the South China Sea.[40] It has also urged the Philippines and all interested parties to abide by the 2002 Declaration on the Conduct of Parties in the South China Sea. As such, U.S. support for the Philippines' claims against China has not been nearly as strong as its support for Japan in the Senkaku/Diaoyu standoff.[41]

NORTHERN LIMIT LINE

A third important maritime border dispute exists between North and South Korea. The North disputes the NLL, the western maritime boundary of military control established by United Nations Command in 1953 following the signing of an armistice in the Korean War.[42] The North did not dispute the border for two decades, but in 1973 Pyongyang moved to redraw it. The North's "West Sea Demarcation Line" lies farther south and would give it

34. Floyd Whaley, "U.S. Reaffirms Defense of Philippines in Standoff with China," *New York Times,* May 1, 2012, www.nytimes.com/2012/05/02/world/asia/us-reaffirms-defense-of-philippines-in-standoff-with-china.html?_r=0.

35. Joshua Keating, "China has the Philippines on the Ropes," *Foreign Policy*, September 4, 2012, http://blog.foreignpolicy.com/posts/2012/09/04/china_has_the_phillipines_on_the_ropes; "China Sends Ships to Disputed Islands," *Wall Street Journal*, September 11, 2012, http://online.wsj.com/article/SB10000872396390444100404577644563527295118.html; Bonnie S. Glaser, "China's Coercive Economic Diplomacy," *The Diplomat*, July 25, 2012, http://thediplomat.com/2012/07/25/chinas-coercive-economic-diplomacy/.

36. Stuart Grudgings and Manuel Mogato, "China Agrees to South China Sea Talks Amid New Row with Manila," Reuters, June 30, 2013, www.reuters.com/article/2013/06/30/us-asean-southchinasea-idUSBRE95T03V20130630.

37. Jethro Mullen, "Philippines Takes Territorial Fight With China to International Tribunal," *CNN.com*, January 22, 2013, www.cnn.com/2013/01/22/world/asia/philippines-china-territorial-dispute.

38. Floyd Whaley, "U.S. Reaffirms Defense of Philippines."

39. Walter Lohman, "Scarborough Shoal and Safeguarding American Interests," *The Heritage Foundation,* May 14, 2012, www.heritage.org/research/reports/2012/05/south-china-sea-dispute-between-china-and-the-philippines-safeguarding-americas-interests.

40. Patrick Ventrell, "South China Sea," U.S. Department of State, Press Release, August 3, 2012, www.state.gov/r/pa/prs/ps/2012/08/196022.htm.

41. "Declaration on the Conduct of Parties in the South China Sea," ASEAN, November 4, 2002, www.asean.org/asean/external-relations/china/item/declaration-on-the-conduct-of-parties-in-the-south-china-sea.

42. Dick K. Nanto, *North Korea: Chronology of Provocations, 1950–2003* (Washington, DC: Congressional Research Service, 2013), 19.

control of five islands that are administered by South Korea.[43] North Korea has challenged South Korean control of waters around the NLL several times since the 1990s.[44] The most recent challenges include the shelling of Yeonpyeong Island and the sinking of the South Korean corvette *Cheonan* in 2010, which resulted in the death of 46 crew members.

The United States has not historically defended the legality of the NLL and has instead prioritized the integrity of the armistice between the North and South.[45] A Central Intelligence Agency document previously assessed that the NLL "has no legal basis in international law," and the United States tends to refer inquiries regarding the NLL's status to the United Nations.[46] After the 2010 shelling of Yeonpyeong, one of the more serious provocations on the Korean Peninsula since 1953, there was some disagreement between South Korea and the United States on the proper response to future, similar provocations.[47]

A Spectrum of Ambiguity

The United States' stated position on each of these three disputes involves some amount of ambiguity. Consideration of both the U.S. public position on the conflict (state intentions) and the military capabilities the alliance deploys in close proximity to the contested area are both important metrics to evaluate the overall strength of the United States' extended deterrent commitment. Public position and proximate military capabilities are each categorized as "low," "medium," or "high." The United States' public commitment would be deemed "high" if it employed mutual security language, stating that an attack on the disputed territory will be treated as an attack on the United States. Commitments may be deemed "medium," or "low," depending on the degree to which the United States has suggested that the alliance applies to the disputed territory. Military capabilities are evaluated as "high" if the alliance partners can intervene in a maritime dispute rapidly, and are likely to be able to deny a challenger its military goal. Capabilities are deemed "low" or "medium," depending on the extent to which they deviate from these criteria. Assessments of public commitment and alliance capability are then combined to produce a rough measure of the threat that Washington is communicating to adversaries with respect to potential challenges regarding these disputed territories.

The degree of uncertainty in the U.S. commitment varies significantly across the conflicts. One expert recently referred to the seemingly inconsistent U.S. position on the administration versus the sovereignty of the Senkakus as a "disturbing contradiction."[48]

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43. Terence Roehrig, "The Origins of the Northern Limit Line Dispute," North Korea International Document Project, The Wilson Center, http://www.wilsoncenter.org/publication/the-origins-the-northern-limit-line-dispute.

44. "Factbox: What is the Korean Northern Limit Line?" Reuters, November 23, 2010, www.reuters.com/article/2010/11/23/us-korea-north-nll-idUSTRE6AM2O820101123.

45. Roehrig, "The Origins of the Northern Limit Line Dispute," Document 3, Document 5.

46. Ibid., Document 6.

47. Chico Harlan, "Yeonpyeong Attack Raised South Korea's Resolve," *The Japan Times*, April 16, 2013, www.japantimes.co.jp/news/2013/04/16/asia-pacific/yeonpyeong-attack-raised-south-koreas-resolve/#.UlsIALxQ3bE.

48. Betts, "The Lost Logic of Deterrence."

Although not inaccurate, the longstanding U.S. claim that the U.S.-Japan treaty covers the Senkakus is arguably the firmest formal statement of interest among the three disputes discussed (I classify it as "moderate" to "high"). Statements that the U.S.-Japan treaty covers the islands and that the United States would oppose any change in administration suggest that the United States probably would enter a military conflict over the Senkakus. The Japanese navy is qualitatively among the best in the world. The United States deploys 47,000 troops in Japan, meaning that once a conflict was under way, U.S. intervention could be substantial. The Senkakus are, however, located 200 miles from the nearest U.S. military installation on Okinawa, so there is some risk that miscalculation could start a low-level conflict before the United States was present. The capabilities that the alliance can devote to a potential conflict here in short order should qualify as "moderate" to "high," with geography being a complicating factor. The overall deterrence commitment in this dispute is characterized as "moderate."

The United States' refusal to rule on the legality of the NLL constitutes a less firm public commitment than the one it has taken on the Senkakus. For nearly as long as the United States has stated that the U.S.-Japan treaty covers that dispute, it has demurred on questions of NLL legality and passed them to the United Nations, making the public stance on the maritime boundary a "moderate" public commitment. NLL disputes have all taken place relatively close to the mainland, however, and the NLL is a maritime extension of the DMZ. The United States has 28,500 troops on the Korean Peninsula, most of which are near the DMZ. In early 2013, the United States and South Korea announced a doctrine of proportional response to any North Korean provocations.[49] These factors combine with a history of the United States standing by its South Korean ally to yield a military commitment classification of "high." U.S. intentions toward and capabilities near the NLL therefore combine to produce a "moderate" to "high" extended deterrence commitment here.

The refusal to state that the U.S.-Philippines treaty covers the Scarborough Shoal or Spratly Islands and the expressed desire to see South China Sea conflicts settled by ASEAN mediation makes the Philippines' disputes the weakest U.S. extended deterrence commitment of the lot (classified as "low"). Although the Scarborough Shoals are located less than 150 miles from the Philippines, the United States has maintained no permanent military bases there since 1992. The government of the Philippines has granted to the United States permission to make use of old bases with prior approval. It is highly unlikely that this will occur on its former scale, however, and generally unclear how much of a permanent U.S. military presence Southeast Asia can expect as part of the United States' rebalancing.[50] Although this region could be reinforced relatively quickly, the proximate U.S. military presence should be classified as "low." The United States' extended deterrence commitment to the Philippines' maritime

49. "Officials Sign Plan to Counter North Korean Threats," American Forces Press Service, March 24, 2013, www.defense.gov/News/NewsArticle.aspx?ID=119615.

50. Travis J. Tritten, "Philippine Government Gives OK for US to Use Old Bases, Newspaper Reports," *Stars and Stripes*, June 7, 2012, www.stripes.com/news/pacific/philippines/philippine-government-gives-ok-for-us-to-use-old-bases-newspaper-reports-1.179790.

claims is therefore classified as "low" overall. The U.S. extended deterrence commitments to each of these three potential conflicts are summarized in Table 1 below.

Table 1. U.S. Extended Deterrence Commitments

U.S. Extended Deterrence Commitment		
NLL	*Senkakus*	*South China Sea*
Moderate-to-high	Moderate	Low

A Spectrum of Challenges

There is also variation in the degree to which the U.S. adversary presents a potential challenge in each one of these maritime disputes, with threat again measured in terms of capabilities and intentions. For each of these cases, the key metric is the likelihood that the adversary will challenge a U.S. ally militarily, possibly leading to a broader war involving the United States.

North Korea has, in recent years, demonstrated both the capability and intent to attack militarily near the NLL. The next time Pyongyang is tempted to provoke South Korea, the NLL may still be an attractive target, although it should be less so than in 2010. The recent U.S.-South Korea "counter-provocation" doctrine is designed to deal with threats like the shelling of Yeonpyeong and promises an immediate response-in-kind to attacks. According to former U.S. Forces Korea Commander Walter Sharp, the new doctrine is intended to communicate to the North that a U.S.-South Korean response to provocation will be "swift, strong, and punishing."[51] This should make the North less likely to believe that it can shell South Korean-held islands with impunity. Provocations with some plausible deniability, like the sinking of the *Cheonan,* probably remain the most attractive option if the North hopes to split the U.S.-South Korean alliance as it considers a response. North Korea may become more interested in testing the U.S. commitment to the NLL if operational command transfers to South Korea in 2015, especially if some U.S. troops are withdrawn. Nonetheless, the alliance should still be able to control escalation and provide a prompt response to aggression. The North Korean threat at the NLL is classified as "moderate," with the possibility of revision in the coming decade.

The Chinese challenge to both the Senkakus and the South China Sea is likely to increase in the coming years. Writings by the People's Liberation Army (PLA) state a general goal to secure Chinese influence within the first island chain by 2020, and the first island chain contains both disputed territories.[52] China's 2013 Defense White Paper states that "some country" (interpreted here as the United States) made maritime standoffs tenser through the strengthening of its alliances, presumably a reference to both the Senkakus and the South China Sea.[53]

51. General Walter Sharp speaking at the Asan Washington Forum, June 24, 2013.
52. Buszynski, "The South China Sea," 145.
53. "The Diversified Employment of China's Armed Forces."

The 2013 White Paper specifically highlights the Senkaku/Diaoyu dispute as a top military priority. It also accuses Japan of "making trouble" over the Senkaku/Diaoyus. In October 2012, a former Chinese Ambassador to Japan stated that the Senkakus were "a time bomb planted by the [United States] between China and Japan."[54] According to this narrative, the United States' position in the dispute is an effort to preserve its own preeminence and contain China's rise.[55] Additionally, following the Sunnyland Summit between Barack Obama and Xi Jinping, there was controversy over whether Xi had called the Diaoyus a "core interest" of China's, which would have put the islands on par with Taiwan and Tibet.[56] Although it has been generally agreed that he did not make this classification, military leaders have strongly implied that this is nonetheless the case.[57] The June controversy, the "time bomb" metaphor, and the listing of the Diaoyu dispute as a top defense priority all suggest that China's interests in the claim are strong, and its potential to challenge in this location in the coming years is "moderate" to "high."

Of late, the China has also been deploying large numbers of ships to the East China Sea for exercises, and one expert has commented that the "operational goal in the East China Sea is to wear out the Japanese Maritime Self-Defense Forces and the Japanese Coast Guard."[58] The PLA navy already outnumbers the Japanese navy, but the latter is qualitatively superior. Growth in China's military capabilities, particularly its naval, air, and missile forces, will steadily increase the costs of dealing with this contingency as time goes on.[59] The capabilities and overall threat level may therefore be considered "moderate" to "high."

China has been most vocal about its position on the Senkaku/Diaoyus in recent years, but its claims in the South China Sea are of greater consequence economically and for regional security over the long term. China's political leaders have not yet called the South China Sea disputes a "core interest," but, as in the Senkakus/Diaoyus, military leaders have said that these claims constitute issues of sovereignty.[60] As far as interests are concerned, the Chinese threat may be deemed "moderate" at present. China's current ability to project substantial power into the South China Sea region is limited, however. The PLA's combat aircraft lack ability to operate efficiently far from home, but this will change if China continues to invest in aircraft carrier and air-refueling capabilities. Currently the United States can have high confidence in its ability to mount a direct defense of the Philippines.[61] China's threat in terms of capabilities is "low," and overall the present

54. Jane Perlez and Keith Bradsher, "Ex Envoy Says U.S. Stirs China-Japan Tensions," *New York Times*, October 30, 2012, http://www.nytimes.com/2012/10/31/world/asia/in-speech-organized-by-beijing-ex-diplomat-calls-islands-dispute-with-japan-a-time-bomb.html?_r=0.

55. Ely Ratner, "China's Victim Complex," *Foreign Policy.com*, April 19, 2013, http://www.foreignpolicy.com/articles/2013/04/19/china_s_victim_complex.

56. Zachary Keck, "Did Xi Call Diaoyu/Senkakus a 'Core Interest?'" *The Diplomat*, June 14, 2013, http://thediplomat.com/china-power/did-xi-call-diaoyusenkakus-a-core-interest/.

57. "China Navy Plans to 'Wear Out' Japanese Ships in Diaoyu Islands."

58. Ibid.

59. James Dobbins, David C. Gompert, David A. Shlapak, Andrew Scobell, *Conflict with China: Prospects, Consequences, and Strategies for Deterrence* (Santa Monica: RAND, 2011), 5–6.

60. David C. Gompert, *The Future of Sea Power in The Western Pacific* (Santa Monica: RAND, 2013), 98.

61. Dobbins et al., *Conflict with China*, 4–6.

threat can be classified as "moderate" to "low." The adversary threat in each contingency is summarized in Table 2 below.

Table 2. Potential Adversary Challenge

Potential Adversary Challenge		
NLL	*Senkakus*	*South China Sea*
TB:Moderate	Moderate-to-high	Moderate-to-low

Comparing Table 1 and Table 2, it is clear that despite the United States' lack of clarity of commitment to the Pacific maritime disputes, its overall extended deterrence efforts and potential for adversary challenges are relatively well matched at present. The United States need not hastily firm up its position in any of these three disputes in an effort to bolster deterrence. The longer-term regional balance, however, is not nearly so equitable.

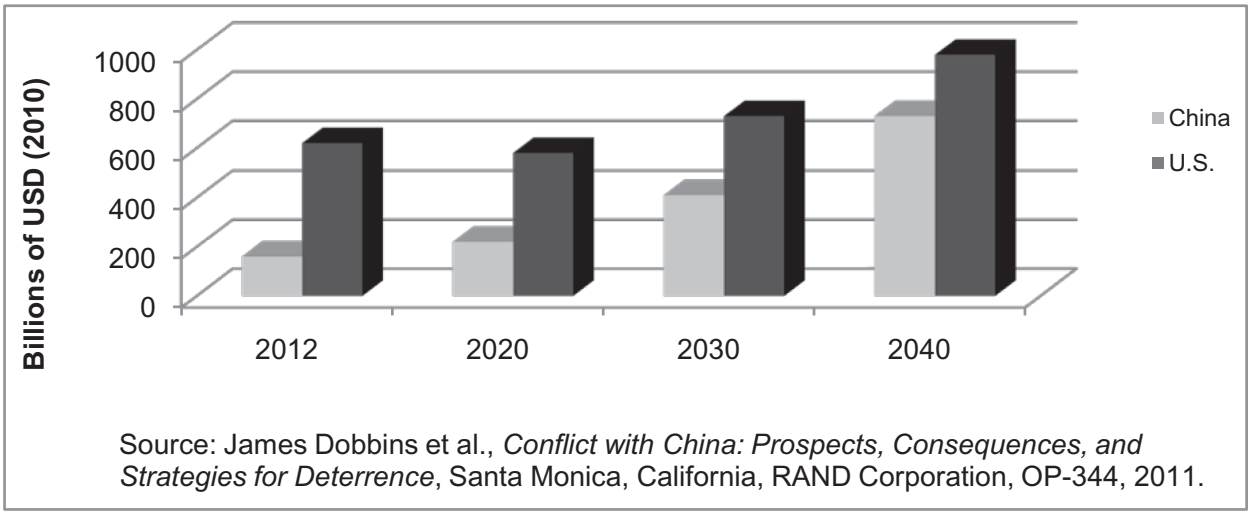
Looking Ahead

Despite the United States' so-called pivot to Asia, the assessments in Tables 1 and 2 are unlikely to hold constant in the decades to come. There is no reason at present to believe that the North Korean conventional military threat will increase substantially, but it will be difficult for the United States to retain concentrated sea superiority against China. China's defense spending is outpacing even its rapid Gross Domestic Product growth, and its military expenditures are largely focused on its Pacific-oriented capabilities. Although projections show that the United States will continue to exceed Chinese defense spending for the next several decades, Washington is not likely to be able to match China's spending in the region. A recent report suggests that even if 33 percent of the U.S. defense budget supports Pacific Command, the Chinese will probably spend 66 percent of their budget in the same area, meaning that Beijing will outspend the United States in the region overall (see Figure 1 for projected defense spending).[62]

According to prominent analysts, China's military investment strategy has focused on "deterring, defeating, or degrading" the United States' ability to intervene in a Pacific conflict.[63] PLA strategists believe that by striking U.S. forces quickly (and perhaps even preemptively), they may be able to seriously limit the duration, scope, and geography of a conflict in the region.[64] This asymmetric Chinese strategy is aimed at making U.S. intervention in a Pacific conflict significantly more costly. As one group of analysts has argued, it is plausible that in a decade the United States could be deterred from intervening on behalf of an ally over a maritime dispute if interests are limited and stakes are high.[65]

62. Gompert, *The Future of Sea Power*, 105.
63. Ibid., 106.
64. Ibid., 108.
65. Roger Cliff, Mark Burles, Michael S. Chase, Derek Eaton, and Kevin L. Pollpeter, *Entering the Dragon's Lair: Chinese Anti-Access Strategies and their Implications for the United States* (Santa Monica: RAND, 2007), 41, quoting Jiang (1997).

Figure 1. Project Defense Spending of China and the United States through 2040



Source: James Dobbins et al., *Conflict with China: Prospects, Consequences, and Strategies for Deterrence*, Santa Monica, California, RAND Corporation, OP-344, 2011.

One could argue that U.S. interests are limited in any dispute over a minor maritime territory belonging to an ally. The previous analysis has demonstrated, however, that there exist de facto tiers of U.S. extended deterrence commitments. The United States has taken a fairly strong position in both the Senkakus and NLL disputes and has the proximate military capabilities to enforce those commitments on short notice. If the North escalated a provocation on the NLL, this would most likely be in spite of strong U.S. deterrent efforts, rather than for lack of them. At present, the PLA probably could not prevent the United States from providing assistance in the Senkakus. The United States has, however, made an effort to keep its entanglements limited in the South China Sea. This is, unsurprisingly, the geographic area in which the United States is least equipped to mount a local defense. If the United States' "low" extended deterrence commitment to the Philippines' claims remains constant but Chinese capabilities to project power over its economic interests improve markedly, the South China Sea is the most obvious place for a serious military challenge. This is of significant consequence for U.S. strategy and policy.

Extended Deterrence in Uncharted Waters

The de facto tiers of U.S. extended deterrence commitments in maritime sovereignty disputes have several implications. First, without expressly committing itself to defend the Philippines around Spratly or Scarborough, the United States can take actions that will make a challenge there less likely. One important step would be the formation of a U.S.-Philippines extended deterrence consultation mechanism. The United States holds strategic dialogues with its Japanese and South Korean allies. These not only allow Washington to communicate to its partners how it provides for deterrence and defense, but they help allies synchronize their positions on regional disputes. If the United States does not intend

to defend an ally's maritime claims, these dialogues are an apt place to share that information, minimizing moral hazard. The United States and the Philippines can also hold new and increasingly comprehensive tabletop and joint military exercises to prepare for maritime contingencies. Additionally, the United States may find it prudent to help the Philippines strengthen its own military capabilities. Short of a firmer public commitment on South China Sea conflicts, then, there are several ways that the alliance can improve its deterrent signals and reduce the risk of escalation.

This de facto commitment hierarchy also raises some questions about the United States' own strategy for military action in the Pacific. The U.S. response to Chinese development of anti-intervention strategies and capabilities has been the development of an operational concept known as Air-Sea Battle, which is intended to "defeat threats to access." Air-Sea Battle envisions attacks on an adversary's command, control, communications, computers, intelligence, surveillance, and reconnaissance, followed by the destruction of weapons launchers and the defeat of any actual weapons that may be used.[66] If Air-Sea Battle were used to preempt a Chinese anti-access campaign in the South China Sea, this would require rapid, asymmetric escalation that would likely include attacking targets on the Chinese mainland. Given that the United States has declined to make firm alliance commitments in the South China Sea, should it really embrace a highly escalatory operational concept that could quickly lead to full-scale war once a maritime skirmish breaks out? If these island disputes do not warrant a firm upfront political commitment, is Air-Sea Battle the appropriate approach to managing conflict once it begins?

Finally, as they assess whether or not the United States is willing to defend allies' maritime claims, policymakers should balance the potential costs of firmer commitments with the costs of concessions. A refusal to commit militarily to the Scarborough Shoal need not have implications for the Senkaku/Diaoyus. More importantly, declining to commit militarily to a maritime dispute need not be an indicator that the United States would be anything less than resolute if it came to the defense of an ally's homeland.[67] As Thomas Schelling remarked, "if one is about to make a concession, he needs to control his adversary's expectations; he needs a recognizable limit to his own retreat. If one is to make a finite concession that is not to be interpreted as capitulation, he needs an obvious place to stop."[68] Refusal to go to war with China over a small, uninhabited island would be, by definition, a limited retreat. But if the United States is to maintain strong alliances and avoid unnecessary wars, it should not demur on the choice between conflict and concession indefinitely.

66. Admiral Jonathan Greenert and General Mark Welsh, "Breaking the Kill Chain," *Foreign Policy.com*, May 16, 2013, www.foreignpolicy.com/articles/2013/05/16/breaking_the_kill_chain_air_sea_battle?page=0,1.

67. See generally, Daryl G. Press, *Calculating Credibility: How Leaders Assess Military Threats* (Ithaca: Cornell University Press, 2005).

68. Schelling, *The Strategy of Conflict*, 71.

Naval Nuclear Propulsion: A Feasible Proliferation Pathway?

Alicia L. Swift[1]

There is no better time than now to close the loophole in Article IV of the Nuclear Non-Proliferation Treaty (NPT) that excludes fissile material for peaceful military use (e.g., naval nuclear propulsion) from nuclear safeguards. In the past, only nuclear weapon states have had naval reactor programs, so this loophole has been of little concern. However, in the last several years, the military fuel cycle loophole has become more worrisome with the advent of four nonnuclear weapon states (NNWSs) openly pursuing naval nuclear propulsion for submarines, civilian icebreakers, and oil tankers. These states include Argentina, Brazil, Iran, and Canada, with the potential for other NNWSs to follow suit. This paper examines the likelihood that NNWSs will succeed in developing naval reactors and also the ramifications of the expansion of naval forces on deterrence and regional stability. Possible solutions to close the loophole are discussed, including amending the NPT, expanding the scope of the Fissile Material Cutoff Treaty (FMCT), employing low-enriched uranium (LEU) fuel instead of highly-enriched uranium (HEU) fuel in naval reactors, creating an export control regime for naval nuclear reactors, and forming individual naval reactor safeguards agreements.

Introduction

The success and viability of the nonproliferation regime established in 1970 by the NPT rests upon the actions of states party to the treaty, as well as those outside of the NPT regime. Its survivability has recently been brought into question as a result of ineffective review conferences such as the one in 2005, the complaint by the Non-Aligned Movement that the nuclear weapon states (NWSs) are not upholding their NPT obligations due to slow reductions in stockpile numbers, and the provocative actions of so-called rogue states such as Iraq, Iran, and North Korea. It is therefore often argued that if the nonproliferation regime is not strengthened, it may collapse altogether, leading to the spread of nuclear weapon technology.

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One method to bolster the NPT is to close existing loopholes that may allow states to obtain fissile material or nuclear technology and break out from the regime. These ambiguities include the ability under Article X to withdraw from the treaty with three months' notice—having already benefitted from the civilian nuclear cooperation guaranteed by the treaty—and, more worrisome, to exclude from safeguards a peaceful military fuel cycle such as naval nuclear propulsion under Article IV. Until recently, the second loophole was not of concern because the only states with a military fuel cycle were NWSs, and the question of stockpiling unsafeguarded material was rather irrelevant. However, in the last several years, NNWSs such as Brazil, Argentina, Iran, and Canada have expressed interest in developing naval reactor technology for use in submarines, surface ships, and icebreakers. Icebreakers are civilian and therefore could be safeguarded under the NPT; however, submarines and surface ships would not be within the realm of safeguards due to the military fuel cycle loophole. Such a program in a NNWS could allow a state to illicitly stockpile special nuclear material for a covert nuclear weapon program.

A second reason for concern over the military fuel cycle loophole is that the development of nuclear navies may lead to regional destabilization. First, in general, increasing military capabilities adds to regional tension. By adding nuclear technology to the mix, instability grows even more. This is because nuclear technology is seen to be prestigious and the pinnacle of scientific achievement, whether it be the enrichment, fabrication, or reprocessing of nuclear fuel, the production of medical isotopes, or the construction of nuclear reactors. Consequently, a nuclear navy can provide nearly the same level of prestige for a NNWS as a nuclear weapon program while remaining within the NPT regime. However, with tension resulting from a state in the region developing new military capabilities and a higher level of prestige, other states may decide to develop the same capabilities in order to provide a comparable level of deterrence and status. Such an unsettling effect could also encourage a NNWS, having developed naval reactor technology, to abandon a peaceful military program in order to covertly pursue nuclear weapons. Therefore, naval nuclear technology (NNT) may serve as both the means for a covert weapon program and the cause.

This premise can be illustrated by the relationship between India and Pakistan. India recently leased from Russia a nuclear submarine and also launched an indigenous nuclear submarine design (developed with assistance from Russia). It has been reported that Pakistan is also pursuing NNT in response to India's new naval capabilities.[2] It is credible that such competitive behavior could also be expected from NNWSs.

To address the challenges presented by the military fuel cycle loophole, the reasons and motivations for a country to develop NNT must be examined. This will enable a better understanding of why a state would pursue naval nuclear propulsion, serve to explain the current actions of some states, and predict the future actions of others. The paper will conclude with solutions available to the international community to close the military fuel

2. Usman Ansari, "Pakistani Navy to Develop Nuclear-Powered Submarines: Reports," *Defense News*, February 11, 2012, www.defensenews.com/article/20120211/DEFREG03/302110003/Pakistani-Navy-Develop-Nuclear-Powered-Submarines-Reports?odyssey=mod|newswell|text|World.

cycle loophole, such as amending the NPT, expanding the scope of the FMCT, employing low-enriched uranium (LEU) fuel instead of highly-enriched uranium (HEU) fuel in naval reactors, creating an export control regime for naval nuclear reactors, and forming individual naval reactor safeguards agreements.

History of the Nuclear Non-Proliferation Treaty

In order to understand the gravity of the military fuel cycle loophole, one must first start with the origins and principles of the NPT. The NPT was introduced by Ireland in 1961 to the United Nations (UN) General Assembly, where it was unanimously approved.[3] On July 1, 1968, after the cessation of negotiations, the NPT was opened for signature and entered into force on March 5, 1970.[4] To date, all countries have signed and ratified the treaty except Israel, India, and Pakistan.[5] North Korea has, however, withdrawn from the treaty and developed nuclear weapons.

Comprised of 11 articles, the NPT includes a significant provision that no NWSs transfer nuclear weapons to or otherwise assist in developing such weapons for any NNWS.[6] NNWS signatories reciprocally agree not to obtain or attempt to develop nuclear weapons, but in giving up their right to such arms, they are guaranteed the "inalienable right . . . to develop research, production and use of nuclear energy for peaceful purposes."[7,8] NWSs also promise "in good faith" to reduce the size of their nuclear arsenals and eventually completely disarm.[9] Finally, the NPT allows any signatory to withdraw at any time if they give the United Nations Security Council three months' notice, a provision that was exploited by North Korea in 2003.[10,11]

To prevent "diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices," all NNWSs are required to conclude individual nuclear safeguards agreements with the International Atomic Energy Agency (IAEA), the branch of the UN responsible for enforcing the NPT, thereby allowing for international verification of states' compliance.[12,13] These comprehensive safeguards agreements were outlined in

3. Richard Rhodes, *Arsenals of Folly: The Making of the Nuclear Arms Race* (New York: Vintage, 2007), 72.
4. Ibid., 73.
5. Thomas Reed and Danny Stillman, *The Nuclear Express: A Political History of the Bomb and Its Proliferation* (Minneapolis: Zenith, 2009), 143.
6. Rhodes, *Arsenals of Folly*, 72.
7. Ibid., 73.
8. International Atomic Energy Agency, *Information Circular 153: The Structure and Content of Agreements Between the Agency And States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons* (Vienna: United Nations, 1972), 3.
9. International Atomic Energy Agency, *Information Circular 140: Treaty on the Non-Proliferation of Nuclear Weapons* (Vienna: United Nations, 1970), 4.
10. Ibid., 5.
11. Frederic L. Kirgis, "North Korea's Withdrawal from the Nuclear Nonproliferation Treaty," *The American Society of International Law*, January 2003, http://www.asil.org/insigh96.cfm.
12. International Atomic Energy Agency, *Information Circular 140*, 2.
13. Ibid., 3.

1972 by the IAEA's *Information Circular 153* (INFCIRC/153), which served for many years as the model safeguards agreement for a NNWS signatory to the NPT.[14] INFCIRC/153 requires states to routinely declare and report the status of their nuclear facilities and fissile materials, which in turn are inspected and verified by the IAEA.[15] IAEA safeguards were substantially strengthened in 1997 with the adoption of INFCIRC/540 (corrected) and the model Additional Protocol (AP), which provides to the IAEA additional verification measures to ensure treaty compliance. The AP is now considered the gold standard among IAEA safeguards agreements, and the United States joins many other states in pressing for universal adoption.

However, as stated earlier, not all nuclear facilities and fissile materials are required by the NPT to be placed under international safeguards. As described in Section 1.19(a) of the *IAEA Safeguards Glossary, International Nuclear Verification Series, Vol. 3*, safeguards do not apply to the "nuclear propulsion of submarines or other warships" because these serve a military function and do not fall into the category of "peaceful use" that is the scope of the NPT. This explicit language has created a legal loophole for a NNWS to develop a naval nuclear propulsion program and declare its fuel cycle outside of the purview of the IAEA while remaining in full compliance with the NPT. For this reason, a state could use NNT as a cover story for a covert nuclear weapon program. Unfortunately, the AP does not apply to naval nuclear propulsion and so even if a state were to adopt the AP, the military fuel cycle loophole would still exist.[16]

History of the Development of Naval Nuclear Propulsion

It is also important to examine the history of the development of naval nuclear propulsion in order to evaluate the recent declarations to pursue such technology by several NNWSs. Analyses such as these are also useful to determine which countries are most likely to pursue this technology in the future.

The era of naval nuclear propulsion first began with the launch of the USS Nautilus submarine in 1955 by the United States, followed soon thereafter by aircraft carriers and cruisers. The United States shared these designs with the United Kingdom, whereas the Russian, Chinese, and French nuclear navies developed separately. Currently, there are approximately 120 nuclear submarines in service between the five NWSs. To keep shipping lanes open and clear of ice, the Russian naval nuclear propulsion program also developed civilian nuclear-powered icebreaker ships. The most recent naval nuclear propulsion

14. NWSs also conclude voluntary safeguards with the IAEA, and while optional, they often do so to encourage NNWSs to follow suit.

15. John Carlson, "IAEA Safeguards Additional Protocol," *International Commission on Nuclear Non-proliferation and Disarmament*, January 20, 2009, www.icnnd.org/documents.

16. International Atomic Energy Agency, *Information Circular 540 (Corrected): Model Protocol Additional to the Agreement(s) Between State(s) and the International Atomic Energy Agency for the Application of Safeguards* (Vienna: United Nations, 1997), 4.

program is that of India, an NPT non-signatory with nuclear weapons, which first launched its nuclear-powered submarine in 2009.[17]

Of these six countries, only France and China use LEU fuel in their submarines. HEU fuel, defined as having an enrichment level greater than 20 percent uranium-235, is often cited as a superior technology for naval reactors because it allows for more compact designs and shorter response times. This allows for quick changes in power levels, which in turn allow for more rapid maneuvering in tactical situations, such as torpedo evasion. Additionally, HEU reactors can go longer periods without refueling and can stay at sea longer, thereby reducing the size of the fleet that must be purchased and maintained. For these reasons, it is often argued that a HEU-fueled naval reactor causes nuclear submarines to be more survivable in a conflict, with the potential to carry out a second strike in the event that the motherland is attacked with nuclear weapons. Icebreakers are also said to be better with HEU fuel because the larger amount of power generated more easily opens shipping lanes.[18] For these reasons, a majority of states employ HEU fuel in their naval reactors.

However, HEU fuel in naval reactors sets a dangerous precedent for the nonproliferation regime. First, HEU in general is a proliferation risk; someone with insider knowledge of a nuclear facility could obtain and sell HEU on the black market to terrorists or a rogue state pursuing a covert nuclear weapon program. Additionally, HEU-fueled naval reactors make the future of a verifiable and effective FMCT more uncertain. As currently proposed, FMCT verification would only apply to the civilian fuel cycle and, therefore, contains the same military fuel cycle loophole as the NPT.[19] Finally, by establishing a technology hierarchy through the oft-made declaration that HEU fuel is better than LEU fuel for naval nuclear propulsion, a NNWS developing NNT would prefer the better technology when developing its naval reactor program. This is especially true for those states seeking the prestige a nuclear program provides.

Reasons for a Nonnuclear Weapon State to Pursue Naval Nuclear Propulsion

There is an inherent desire for all nations to increase their international standing through trade, military prowess, technology, or other similar means. With respect to technology, nuclear science and engineering is generally regarded as elite. Only a handful of countries have nuclear technology, making it akin to an exclusive club. Therefore, to have nuclear technology such as NNT signifies that a country is well-off.

17. World Nuclear Association, "Nuclear-Powered Ships," February 2013, www.world-nuclear.org/info/Non-Power-Nuclear-Applications/Transport/Nuclear-Powered-Ships/#.UYanNbXvtjY.

18. Greg Thielmann and Wyatt Hoffman, "Submarine Nuclear Reactors: A Worsening Proliferation Challenge," *The Arms Control Association*, Threat Assessment Brief, July 26, 2012, 2, www.armscontrol.org/threats/ Submarine-Nuclear-Reactors-A-Worsening-Proliferation-Challenge%20.

19. Christopher A. Ford, "Five Plus Three: How to Have a Meaningful and Helpful Fissile Material Cutoff Treaty," *The Arms Control Association*, March 2009, www.armscontrol.org/act/2009_03/Ford.

In addition to the desire for increased international prestige, states also pursue naval nuclear propulsion for military purposes, the first of which is deterrence. As previously specified, states want similar military technologies to their adversaries in order to reduce the likelihood of an attack on their nation. Nuclear submarines provide more effective deterrence than other military systems because of the submarines' increased survivability.

During the Cold War, the Soviet Union developed nuclear submarines in order to deter a nuclear attack by the United States. By introducing a capability that would most likely survive a land-based nuclear attack, the submarines offered the Soviet Union a more survivable second strike deterrent to U.S. attack. The United States' nuclear submarines similarly deterred the Soviet Union. In a more recent example, India has advanced naval capabilities which need to be deterred; hence, one reason for the alleged development of comparable NNT by Pakistan.

Offensive military capabilities are an additional motivation for a nuclear navy, especially if there is tension or conflict with other countries. Examples of this phenomenon include the building tension between China and India over dominance of the South China Sea and the simmering conflict between Argentina and the United Kingdom over the Falkland Islands. In the case of Pakistan, the volatile conflict with India over control of the Kashmir region, added to India's significant conventional superiority, has no doubt pushed Islamabad to develop offensive military capabilities such as nuclear submarines.

Nonnuclear Weapon States Desiring a Nuclear Navy

With reasons for developing a nuclear navy thus outlined, these motivations can be examined in the context of individual states and regions to determine the likelihood of successful development of NNT and the resultant implications of such developments. First, states that have openly declared the intent to develop a nuclear navy will be examined, including Brazil, Argentina, Iran, and Canada. Second, states that have not stated this intent but have the capability to develop NNT will be similarly studied, including Germany, Japan, South Korea, Taiwan, North Korea, Israel, Saudi Arabia, and Turkey. To fall into the second category, states have sea access, an advanced nuclear fuel cycle, a desire for increased prestige or national defense capabilities, and the ability to afford a nuclear navy (refer to the footnote for the 2012 list of gross domestic products [GDPs] used in this assessment).[20]

DECLARED NNT STATES

Of all of the countries that have openly declared their pursuit of naval nuclear propulsion, Brazil, which has steps in place to develop a nuclear-powered submarine by 2023, is the

20. The World Bank, "GDP (current US$)," 2012, http://data.worldbank.org/indicator/NY.GDP.MKTP.CD?order=wbapi_data_value_2012+wbapi_data_value+wbapi_data_value-last&sort=desc.

most likely candidate to acquire nuclear-powered submarines. To achieve this objective, Brazil entered into an agreement with France in 2008 to purchase both diesel- and nuclear-powered submarines. According to the contract, France will teach Brazil how to construct diesel and nuclear submarines so that it may have an indigenous program, with the understanding that Brazil will develop the naval nuclear reactors itself.[21]

Although developing naval reactor technology is no easy undertaking, Brazil stands a high chance of success for several reasons. First, Brazil understands nuclear technology. Brazil has a highly-developed nuclear fuel cycle and is capable of mining uranium, enriching and fabricating reactor fuel, and reprocessing spent fuel. The country also operates two nuclear power reactors, with a third under construction, clearly demonstrating an understanding of nuclear reactor design.[22] As a result, Brazil's land-based naval reactor prototype is on track for completion in 2014.[23] Second, Brazil can afford NNT, recently replacing Britain as the seventh largest world economy according to a recent article in *The New York Times*.[24] Additionally, Brazil has an already-developed nuclear sector that should require little capital to develop naval reactor technology. Finally, Brazil has a strong national desire to increase its international prestige. Brazil, which held a non-permanent seat on the United Nations Security Council as recently as 2011, is highly vocal about becoming its sixth permanent member.[25,26] This bid has gained the support of countries such as Russia, France, the United Kingdom, and Portugal. However, Brazil still needs more supporters such as the United States, whose current administration has instead supported India for the position.[27,28] For these reasons, it is highly likely Brazil will have a nuclear submarine in the next decade.

Therefore, the only remaining question is what Brazil will design for its naval reactor. Interestingly enough, there is no stipulation in the contract with France that Brazil must use LEU fuel in its submarines, and although Brazil has stated that its designs will most likely employ LEU fuel, there is no requirement for this to be the case.[29] With a self-contained fuel cycle, Brazil could not easily be prevented from invoking the NPT military fuel cycle loophole, developing HEU-powered naval reactors, and removing the requisite material from international safeguards. This would set a dangerous precedent

21. Serena Kelleher-Vergantini, "Brazil Moves Toward Nuclear Submarine," *The Arms Control Association*, April 2013, www.armscontrol.org/act/2013_04/Brazil-Moves-Toward-Nuclear-Submarine.

22. Globalsecurity.org, "Nuclear Weapons Programs," September 21, 2012, www.globalsecurity.org/wmd/world/brazil/nuke.htm.

23. Kelleher-Vergantini, "Brazil Moves Toward Nuclear Submarine."

24. Bernard Aronson, "Can Brazil Stop Iran?," *The New York Times*, April 3, 2012, www.nytimes.com/2012/04/04/opinion/can-brazil-stop-iran.html?_r=0.

25. United Nations Security Council, "Countries Elected Members of the Security Council," http://www.un.org/en/sc/members/elected.shtml.

26. United Press International, "Brazil Campaigning for Permanent U.N. Security Council Seat," October 16, 2009, www.upi.com/Top_News/Special/2009/10/16/Brazil-campaigning-for-permanent-UN-Security-Council-seat/UPI-71131255711794/.

27. Wilder A. Sanchez, "Building Support for Brazil's Bid at the UNSC," *Atlantic-Community.org*, April 4, 2013, www.atlantic-community.org/-/building-support-for-brazil-s-bid-at-the-unsc.

28. Ed Henry and Sara Snider, "Obama Backs Permanent Seat for India on Security Council," *CNN*, November 8, 2010, www.cnn.com/2010/POLITICS/11/08/obama.india.address/index.html.

29. Kelleher-Vergantini, "Brazil Moves Toward Nuclear Submarine."

for the nuclear nonproliferation regime, call into question Brazil's commitment to its NPT obligations, and result in uncertainty as to whether it is pursuing a nuclear weapon program.

Although Brazil, as of late, has a good record of safeguards compliance with the IAEA, it is worrisome that its publicly-stated reason for obtaining NNT is a need to protect nearby off-shore oil interests. This is false; diesel submarines would be more than adequate for patrolling coastal waters and come with a much lower price tag. This justification is especially disquieting when one recalls Brazil's alleged pursuit of nuclear weapons while under military leadership, ceasing with a regime change in the late 1980s. It is additionally worrisome because Brazil's past actions led Argentina to also develop a covert nuclear weapon program, due to the competitive relationship between the two countries.[30,31,32] Given these facts, it is credible that if Brazil were to develop HEU-fueled nuclear submarines, another regional arms race with Argentina could result.[33]

It is not unrelated that shortly after Brazil publicly announced the pursuit of NNT, Argentina responded with a similar plan to develop naval nuclear propulsion but has not yet decided whether it will be employed in submarines or civilian icebreakers. Like Brazil, Argentina is very likely to be successful in developing NNT. One reason is that its nuclear program is as advanced as Brazil's, with the indigenous capability to generate medical isotopes, produce heavy water, enrich uranium, and fabricate reactor fuel. Argentina also has four nuclear power reactors (two in operation, one under construction, and a fourth in planning stages). If Argentina were to use its current nuclear reactor technology in the new TR-1700 submarines provided by Germany and being assembled in-country, it has been predicted that Argentina could have nuclear-powered submarines as early as 2020, three years before Brazil.[34] Finally, Argentina has the impetus of past and present conflicts with the United Kingdom over the Falkland Islands and its competitive relationship with Brazil that will push it toward the development of NNT.

However, Argentina's success in the fabrication of naval nuclear reactors, although probable, is less likely than Brazil's due to Argentina's smaller economy and some reports that the hull of the German-built TR-1700 submarine is not strong enough for a nuclear reactor. Therefore, it is more likely that Argentina will develop naval nuclear propulsion for HEU-powered civilian icebreakers similar to those employed by Russia.[35] In such a

30. United Press International, "Brazil's Submarine Project Well on Way," March 4, 2013, www.upi.com/Business_News/Security-Industry/2013/03/04/Brazils-submarine-project-well-on-way/UPI-76321362436162/.

31. Nuclear Threat Initiative, "Country Profile: Brazil," August 2012, www.nti.org/country-profiles/brazil/.

32. United Press International, "Argentina Aims to Revive Nuclear Exports," January 18, 2013, www.upi.com/Science_News/Technology/2013/01/18/Argentina-aims-to-revive-nuclear-exports/UPI-19101358515289/.

33. Peter C. Frederiksen and Robert E. Looney, "Arms Races in the Third World: Argentina and Brazil," *Armed Forces and Society* 15 (Winter 1989): 263–270.

34. Nuclear Threat Initiative, "Country Profile: Argentina," August 2012, www.nti.org/country-profiles/argentina/.

35. MercoPress, "Argentina Planning a 'Nuclear Powered' Submarine with Conventional Weapons," August 1, 2011, http://en.mercopress.com/2011/08/01/argentina-planning-a-nuclear-powered-submarine-with-conventional-weapons.

case, Argentina would not present as great a loophole threat as Brazil, due to the fact that civilian icebreakers are safeguarded. However, nuclear submarines cannot be ruled out, and if Argentina ever felt significantly threatened by Brazil or the United Kingdom, it could decide to restart its covert weapon program.

Iran is another country that has recently stated its desire to develop nuclear propulsion for submarines and civilian oil tankers. Iran made this announcement immediately before a round of P5+1 talks regarding its nuclear program, leading some to believe that this was a move to gain leverage in bargaining with the world powers and thus was not a serious statement.[36] By those more skeptical, Iran's announcement was seen as a cover to produce HEU for a covert nuclear weapon program, much in the same way as its enrichment program for its research reactors is viewed.[37] Although it would be difficult to imagine a world in which Iran could avoid sanctions and afford to purchase the materials and know-how for NNT, its pursuit of naval nuclear propulsion is still quite troubling given Iran's current noncompliance with its NPT obligations. Additionally, it is highly possible that Iran would proliferate NNT to allies such as Venezuela and North Korea as it has with other forms of nuclear and missile technology.[38,39] Finally, Iran has purportedly designed and constructed two submarines, and although they are not nuclear-powered, Iran has the knowledge and capability to produce them.[40] It should be noted that Tehran managed to produce two submarines while under sanction. Therefore, although it is unlikely that Iran would develop NNT, it is the most worrying potential case because Iran would not need to be successful in building and deploying a nuclear-powered submarine, nor would it need to use the submarine to patrol its coastlines. For a covert nuclear weapon program, Iran only needs to pursue this technology in order to justify the removal of special nuclear material from safeguards as part of the military fuel cycle loophole. Given Iran's noncompliant behavior, this is extremely worrisome.

Of the NNWSs that have openly declared an intention to pursue NNT, Canada is the least likely. Canada first examined this idea in the late 1980s but eventually discarded it due to the high cost and lack of support of the Canadian public. The idea is now being reexamined as a result of Canada's submarine fleet falling into disrepair and the argument that building new submarines would be cheaper than repairing the old submarines purchased from the United Kingdom. Already the repairs on Canada's four diesel submarines

36. The P5+1 talks are a set of diplomatic efforts by the United States, China, Russia, France, Germany, and the United Kingdom to address concerns that Iran is not upholding its NPT obligations and is possibly developing nuclear weapons. The notation of P5+1 is a reference to the five UN Security Council permanent members plus Germany (Kelsey Davenport, "History of Official Proposals on the Iranian Nuclear Issue," *Arms Control* Association, August 2013, www.armscontrol.org/factsheets/Iran_Nuclear_Proposals).

37. Zahara Hosseinian and Fredrik Dahl, "Iran Plans Nuclear-Powered Submarine: Report," Reuters, June 12, 2012, www.reuters.com/article/2012/06/12/us-iran-nuclear-submarine-idUSBRE85B17Q20120612.

38. Norman A. Bailey, "Iran's Venezuelan Gateway," *The American Foreign Policy Council* 5 (February 2012): 1–6.

39. Paul Kerr, "Iran, North Korea Deepen Missile Cooperation," *The Arms Control Association*, January/February 2007, www.armscontrol.org/act/2007_01-02/IranNK.

40. Anup Kaphle, "Iran Shows New Submarines and Warships, Touts Self-Sufficiency in Defense," *The Washington Post*, November 28, 2012, www.washingtonpost.com/blogs/worldviews/wp/2012/11/28/iran-shows-new-submarines-and-warships-touts-self-sufficiency-in-defense/.

total more than $1 billion dollars, with a final cost of repair projected to total more than $3 billion by 2016. However, the arguments that nuclear-powered submarines are too expensive and unnecessary for Canadian defense are still a large part of the public discourse and are still considered valid, thus raising doubts about Canada's serious pursuit of NNT.[41]

POTENTIAL NNT STATES

This next set of case studies will examine states that have not openly declared their pursuit of NNT but have the potential to do so if regimes or policies were to change. The first states to be examined are in Asia and are the most vulnerable to the development of NNT and a subsequent covert nuclear weapon program. This is because of the high concentration of states in the region with nuclear weapons, the growing tension in the area, and the large amount of coastline that gives nearly all Asian countries sea access and therefore the ability to have a navy. States that could possibly seek to obtain NNT include North Korea, South Korea, Japan, and Taiwan. Reasons for developing nuclear propulsion vary between countries: North Korea is intent on increasing its military capabilities and most likely desires additional nuclear weapon delivery platforms and international recognition of its nuclear weapon program; South Korea and Japan both fear a nuclear attack by North Korea and are not entirely convinced by the United States' nuclear umbrella; and Taiwan is threatened by China and similarly doubts the United States' extended deterrence.[42,43,44] These are all convincing reasons for a state to develop or strengthen its military capabilities, and due to the rising tension in the region, it is credible that one of these states might develop NNT, thereby causing a regional domino effect. Because these countries are generally acknowledged as "threshold states" that could break out of the NPT regime and develop nuclear weapons, their acquirement of NNT would be particularly worrisome.

In Europe, Germany may also exploit the military fuel cycle loophole in the future. Although highly unlikely due to the current leadership's aversion to nuclear technology, Germany has a thriving naval industry and exports its diesel submarines to countries such as Israel and Turkey.[45] Germany also has significant nuclear reactor expertise and could indigenously produce nuclear submarines if it came under new leadership who wished to pursue the technology.

The Middle East is the final region that may seek nuclear-powered submarines and a possible exploitation of the military fuel cycle loophole. If one state in the region were to

41. Greg Weston, "Canada May Buy Nuclear Submarines," October 27, 2011, www.cbc.ca/news/politics/story/2011/10/27/submarines-british-nuclear.html.

42. Richard Weitz, "North Korean Threats Deepen Southern Nuclear Insecurities," *The Diplomat*, July 4, 2013, http://thediplomat.com/2013/07/04/north-korean-threats-deepen-southern-nuclear-insecurities/.

43. Richard Halloran, "Doubts Grow in Japan Over US Nuclear Umbrella," *Taipei Times*, May 27, 2009, www.taipeitimes.com/News/editorials/archives/2009/05/27/2003444613.

44. Richard C. Bush, "The U.S. Policy of Extended Deterrence in East Asia: History, Current Views, and Implications," *The Bookings Institute*, February 2011, www.brookings.edu/~/media/research/files/papers/2011/2/arms%20control%20bush/02_arms_control_bush.pdf.

45. Peter L. Hartley, "The German Navy–The Way Forward," *Defense Update*, November 29, 2011, http://defense-update.com/20111129_the-german-navy-the-way-forward.html.

obtain nuclear-powered submarines, others may soon follow with their own NNT and possibly even a covert nuclear weapon program. Israel is currently purchasing six diesel-electric submarines from Germany that are supposedly capable of delivering nuclear payloads, and it is credible that they could obtain nuclear-powered submarines in a method similar to Brazil. However, it should be noted that due to the fact that Israel is generally acknowledged to have a nuclear weapon program and is outside the NPT regime (its only research reactor at Dimona is outside of IAEA safeguards), Israel would not be exploiting an NPT loophole by developing NNT. It is important, however, because other NPT signatories in the region, such as Saudi Arabia and Turkey, may feel pressured to develop similar technology as a result of Israel's decision, especially if Iran were to have NNT.[46]

In summary, there are 11 NNWSs that are developing or could develop NNT, nearly half of which are openly investigating naval reactor technology for prestige, defense, or both. Brazil has shown that with enough money, engineering experience, and a willing supplier of NNT, a nuclear submarine program can be developed in under 15 years; Argentina plans to match or outdo this timeline. Iran managed to produce two submarines while under sanction, and if it truly does have a covert weapon program, a nuclear submarine program would be a credible cover story for stockpiling HEU. Although the actions of these three countries may not seem as immediate a threat as a state giving 90-days' notice of withdrawal from the NPT, NNT development is gradual enough that a state would be able to slowly develop an illicit nuclear weapon program without drawing international attention. The impact of the exploitation of the military fuel cycle by just one or two of the 11 countries would be extremely harmful to the NPT.

Potential Solutions

As a result of the conclusions in the previous section, action must be taken to close the military fuel cycle loophole before a NNWS obtains naval reactor technology, at which point options will become limited. There are several possible methods to do so, with the ability to achieve these recommendations ranging from nearly impossible to relatively straightforward. Possible solutions are elucidated below with corresponding estimates of the likelihood of international support, implementation, and success for each.

AMENDING THE NPT

The most obvious solutions are not always the best solutions. Amending the NPT to close the loophole is the most obvious of the following solutions, but the treaty amendment procedure makes it nearly impossible to do so. Any state may propose an amendment; however, at least one-third of signatories must support the proposal in order to request a conference. Upon being submitted to the conference, the amendment must be passed by a majority of the parties, with unanimity among all of the NWSs and NNWSs on the IAEA

46. Gili Cohen, "Israel Navy Gets Fifth Dolphin-Class Submarine from Germany," *Haaretz*, August 20, 2013, www.haaretz.com/news/national/israel-navy-gets-fifth-dolphin-class-submarine-from-germany.premium-1.518239.

Board of Governors.[47] Although it is conceivable to obtain a majority of votes from NNWSs, it is hard to believe that there would be unanimous approval from the NWSs because such an amendment could affect their existing naval programs if the proposed amendment were to ban HEU in all nuclear submarines. In contrast, if an amendment were brought forward to limit HEU-fueled submarines to only the five NWSs, it is conceivable to obtain unanimous support from the NWSs. However, it would then become difficult to obtain approval from the remaining states on the 35-member Board of Governors, who generally feel that the NWSs already have too many privileges.

BANNING HEU NAVAL REACTOR TECHNOLOGY WORLDWIDE

For many of the same reasons stated above, it is hard to imagine a phasing-out of the use of HEU in submarines being fielded by NWSs, particularly the United States. The use of LEU in U.S. submarines was examined in 1995 by the Director of the Office of Naval Nuclear Propulsion, but it was strongly opposed. The study determined that an LEU core would be larger, thereby requiring a larger submarine, and that it would require more frequent refueling. However, the primary concern in the 1995 report involved the incurred costs for using LEU fuel. Submarines would be overhauled more often, thus costing more money, and with submarines out of service more frequently, four additional submarines would need to be purchased to meet the defense requirements of the 1995 study. However, the report goes on to state that both options are extremely costly (on the order of billions), and neither LEU nor HEU fuel offer a particular technological or strategic advantage over the other.[48] A separate study estimated that a 20 percent-enriched LEU core using French technology could have a core lifetime of 33 years and that with a diameter of 1.4 meters and a height of 1.7 meters, the reactor would fit into the Los Angeles submarine, the Virginia-class submarine's predecessor.[49]

Proponents of HEU-fueled naval reactors also argue that U.S. and Russian submarine reactor hulls must be cut open during each refueling, which substantially weakens the submarine each time this is done. However, during the U.S. and Russian modernization efforts, it would be possible to design a hatch in the submarine that can be opened during refueling, preventing the hull from being weakened. In France, such a modification already reduces the refueling periods from years to months, therefore reducing the number of submarines that must be purchased and operated, consequently reducing cost.[50] Such a

47. International Atomic Energy Agency, *Information Circular 140*.

48. Frank von Hippel, "Preventing Nuclear-explosive Terrorism by Eliminating Fissile Material: A Progress Report," *International Seminar on Nuclear War and Planetary Emergencies,* August 2012, www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCoQFjAA&url=http%3A%2F%2Fwww.federationofscientists.org%2FPlanetaryEmergencies%2FSeminars%2F45th%2FVon%2520Hippel%2520Publication.docx&ei=0lgfUqP2J4O4yQHosoHwCA&usg=AFQjCNEmVKwSQJ66w_uirrkWrEm0uM8uKw&sig2=MwN9HI5EUC6kVohtkPifCg&bvm=bv.51495398,d.aWc&cad=rja.

49. Cole J. Harvey, "At Sea Over Naval HEU: Expanding Interest in Nuclear Propulsion Poses Proliferation Challenges," *Nuclear Threat Initiative*, November 29, 2010, www.nti.org/analysis/articles/expanding-nuclear-propulsion-challenges/.

50. Chunyan Ma and Frank von Hippel, "Ending the Production of Highly Enriched Uranium for Naval Reactors," *The Nonproliferation Review* (Spring 2001): 86–101.

design change was not considered in the 1995 report and could make LEU submarines more feasible.

With it therefore established that it is technically feasible to reduce the enrichment of naval reactor fuel and continue to maintain capabilities and cost levels, it is worth stating that the phasing out of HEU across a range of uses is politically desirable. The international replacement of HEU by LEU in research reactors is already in progress and supported by many states all over the world; to phase out its use in naval reactors parallels and strengthens this effort.[51]

Finally, with submarine modernization efforts just beginning for several NWSs including the United States, now is the time to implement the technology change to LEU fuel. It is disappointing that the U.S. Navy has ignored the 2011 House Armed Services Committee (HASC) directive to the Office of Naval Reactors to submit a report by March 1, 2013, that reexamines the conclusions of the 1995 study. Reasons cited by HASC for revisiting the study include the decline of the Russian threat, the demonstration by France that it is possible to have efficient LEU designs, and the growth of nonproliferation into a national priority.[52]

EXPANDING THE LANGUAGE OF THE FMCT

A third solution to the NPT loophole is to expand the scope of the FMCT to include a peaceful military fuel cycle. Currently, the proposed FMCT aims to prevent the production of fissile material for nuclear weapons. Although it is unclear whether the treaty will apply to future materials production or existing stockpiles of previously-produced fissile material, the proposed treaty would ideally engage all states, including those outside the NPT regime, and apply an effective verification regime equally to both NWSs and NNWSs.[53] However, one major flaw in the current proposed framework is that it will not close the military fuel cycle loophole in the NPT but instead strengthen it through repetition.[54] This loophole is potentially dangerous and it is imperative that the proposed FMCT close the military fuel cycle loophole.

One way to achieve this goal is to have a two-tiered FMCT similar in structure to the "haves" and "have-nots" of the NPT that would allow the NWSs to enrich HEU for their submarines but prevent NNWSs from doing so. This is not very desirable because it does not address the inequalities in the NPT, a common cause of complaint and the very problem that the FMCT is supposed to solve. Another option is to ban all HEU production for all states, no matter the end goal. This, of course, would then necessitate that the United States, the United Kingdom, and Russia use HEU from their weapon stockpiles in their submarines until LEU technology could be adopted.

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51. William Sweet, "Open a Second Diplomatic Front to Contain Iranian Nuclear Ambitions?," *Arms Control and Proliferation*, August 15, 2012, http:// foreignpolicyblogs.com/2012/08/15/open-a-second-diplomatic-front-in-effort-to-contain-iranian-nuclear-ambitions/2/3 (accessed 21 April 2013).

52. Thielmann and Hoffman, "Submarine Nuclear Reactors."

53. Annette Schaper, "Verification of a Fissile Material Cut-Off Treaty," *Fissile Materials: Scope, Stocks, and Verification*, Federation of American Scientists' Disarmament Forum 2 (1999): 45–55.

54. Ford, "Five Plus Three: How to Have a Meaningful and Helpful Fissile Material Cutoff Treaty."

For these two reasons, employing the FMCT to close the military fuel cycle loophole is not seen as feasible. The FMCT is years from being finalized (it has been in discussion since the early 1990s) and the inclusion of the military fuel cycle loophole has been debated for nearly as long. It will be difficult to convince NWSs to preclude the production of HEU for their nuclear navies. A better option would be for NWSs to unilaterally renounce the use of HEU in their submarines. Renouncing the use of HEU eliminates the need for a timely FMCT negotiation and implementation to close the military fuel cycle loophole. Again, however, there is little support for this among NWSs, and a unilateral action conducted without a treaty would not prevent a NNWS from developing a HEU-fueled naval reactor.

CREATING EXPORT CONTROLS ON NAVAL REACTOR TECHNOLOGY

Another proposed solution to address the military fuel cycle loophole is to create an export control regime for naval reactor technology. This could consist of unilateral export controls of NNT or, better still, a regime much like the Missile Technology Control Regime. Currently, there are no controls preventing the lease or transfer of NNT, HEU submarine fuel, and entire nuclear reactor vessels from NWSs to NNWSs. As a result, a treaty establishing export controls in these three areas could have a large impact on closing the loophole. With only five current suppliers of nuclear naval technology, it would be easier to garner unanimous support for an export control treaty and also to enforce it. Additionally, if naval propulsion were only allowed for civilian use (e.g., ice breakers), it could be determined whether states were covertly developing a military use of the technology because these materials would be under NPT safeguards. Finally, NWSs would have an interest in reducing the number of states with strong naval capabilities enhanced by nuclear reactor technology.[55] Of all the options listed so far, this is the most viable, although Brazil might be too advanced at this point for an export control regime to address potential manipulation of the NNT loophole in this case.

INDIVIDUAL SAFEGUARDS AGREEMENTS WITH NNWSS PURSUING NNT

Finally, individual naval reactor safeguards agreements could be established for NNWSs pursuing NNT. Brazil, for instance, could enter into a special agreement with the IAEA that placed its naval reactor facilities under safeguards. This agreement could include prohibitions of HEU-fueled naval reactors for NNWSs and also the requisite verification methods. Although this is theoretically feasible, there is no precedent for this, and for states that have already begun to pursue NNT, there is little incentive to enter into such an agreement. Additionally, individual NNT safeguards agreements would encounter problems similar to the IAEA's AP, which has been accused of being restrictive, classist, and outside of the scope of the NPT. These complaints have prompted some states, like Brazil, to refuse ratification of the AP. Therefore, individual agreements may be a solution that is useful only in conjunction with a modified FMCT or an export controls regime. For instance, an individual naval safeguards agreement could be a condition for sale of NNT. This obligation would

55. James Clay Moltz, "Viewpoint: Closing the Loophole on Exports of Naval Propulsion Reactors," *The Nonproliferation Review* 6.1 (Fall 1998): 108–114.

eliminate most states with dishonest intentions, which would now be required to place the fissile material under IAEA safeguards and would have a much harder time developing a covert nuclear weapon program.

Conclusions

In conclusion, nuclear naval capabilities are highly desirable to states for reasons of deterrence, defense, national pride, and international prestige, thereby filling a role similar to nuclear weapons for nonnuclear weapon states. This is worrisome given the regional tension that may result from the introduction of nuclear-powered submarines, the level of uranium enrichment required by such technology, and the existence of a loophole in the NPT that enables a NNWS to have such material outside of IAEA safeguards. As a result of increased conflict, a NNWS could be highly persuaded to develop a covert nuclear weapon program, drawing from its stockpile of naval fuel.

There are four NNWSs—Brazil, Argentina, Iran, and Canada—that are openly investigating or developing naval nuclear propulsion. Of these four, three are likely to succeed in obtaining NNT. There are an additional six states that would likely develop naval reactor technology if policies change or there is a new political regime, bringing the total to 11 states that could become NWSs through the exploitation of the military fuel cycle loophole.

As a result, this loophole should be closed as soon as possible, with solutions ranging from difficult (amending the NPT, banning HEU naval reactor technology worldwide) to less difficult (individual safeguards agreements with states pursuing NNT, rewording the proposed language of the FMCT) to relatively easy (creating export controls that prevent the sale of NNT to NNWSs). Although all options are not perfect and most are difficult, applying these solutions to the problem at hand remains worthwhile. The best solution to closing the loophole is a combination of export controls for the short term and adding the desired language to the NPT or FMCT in the long term. This is not an easy undertaking and will require much diplomatic effort to affect change. However, it is worthwhile to prevent problems instead of reacting to them, because as time progresses, options become more limited and the consequences more severe. Therefore, in order to bolster the NPT and prevent further proliferation of nuclear weapons, it is necessary that decisive actions be taken to close the military fuel cycle loophole and prevent rogue states from easily acquiring nuclear weapons.

The Zero Straw Man: A Rhetorical Analysis of Nuclear Policy Proposals (2007–2009)

David Thomas[1]

The 2007 Wall Street Journal *op-ed from George Shultz, William Perry, Henry Kissinger, and Sam Nunn, entitled "A World Free of Nuclear Weapons," provoked reemergence of a national nuclear disarmament discussion, and two years later, President Barack Obama took up the nuclear disarmament banner in Prague. Similarities between the "Gang of Four" and the administration proposals include the disarmament vision and modest steps designed to move toward disarmament. Accompanying these two initiatives, three bipartisan panels offered recommendations addressing both the vision and the near-term policy steps. Although agreement seems to exist among all parties about reducing nuclear arsenals and securing nuclear materials, there is disagreement about the utility and possibility of complete nuclear disarmament. Proponents of the vision of a world without nuclear weapons employ rhetorical devices designed to tie the near-term policies to the distant goal. However, critics are not persuaded by this, and although they often agree with near-term policies related to nuclear arsenal reductions and security of nuclear material, their denunciation of the nuclear disarmament vision draws the most prominent attention.*

The Vision

On October 9, 2009, the Norwegian Nobel Committee awarded the Nobel Peace Prize to President Barack Obama, citing the "special importance [of President] Obama's vision of and work for a world without nuclear weapons."[2] This work began with a series of statements made during the 2008 U.S. presidential election season and peaked 75 days into President Obama's administration with a landmark policy speech given in Prague, Czech

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2. Norwegian Nobel Committee, "The Nobel Peace Prize for 2009 to President Barack Obama—Press Release," October 9, 2009, www.nobelprize.org/nobel_prizes/peace/laureates/2009/press.html.

Republic. In this address, the president announced "America's commitment to seek the peace and security of a world without nuclear weapons."[3] Sometimes referred to as the "Road to Zero," the president justified this goal by stating that "the threat of global nuclear war has gone down, but the risk of a nuclear attack has gone up."[4] Yet, as the president accepted the award in Oslo, he conceded that he was "at the beginning" of the journey.[5] Progress on this road was by no means guaranteed.

Although some have wondered if the president's vision of a world without nuclear weapons dated back to his senior year at Columbia,[6] his administration received political cover for promoting it after publication of the surprising *Wall Street Journal* op-ed written by George Shultz, William Perry, Henry Kissinger, and Sam Nunn, entitled "A World Free of Nuclear Weapons."[7] The image of the October 1986 Reykjavik Summit, in which President Ronald Reagan and General Secretary Mikhail Gorbachev briefly pondered the abolition of nuclear weapons, served as catalyst for the ambition. Published one month before Senator Obama announced his candidacy for president, the bipartisan Gang of Four op-ed triggered the reemergence of a nuclear disarmament debate that spread throughout the pages of newspapers and other foreign policy publications. Supporting this debate, three bipartisan panels in 2008 and 2009 offered nuclear policy recommendations germane to those proposed by the administration and the Gang of Four.[8]

The return of this debate has been important to the direction of international security matters, principally the need for U.S. leadership in global arms control, but the administration and Gang of Four may have prematurely evoked the hopes of nuclear disarmament advocates and undermined their own vision. By tying the distant goal of a world without nuclear weapons to important near-term policies related to nuclear arms control and security of the fuel cycle, they may have weakened prospects of achieving both. Critics of nuclear disarmament—many of whom are advocates of nuclear material security and reductions—appraise calls for disarmament as ludicrous and unhelpful, often while voicing support for some of the very policies the administration and Gang of Four proposed. Criticism, however, makes headlines. Thus, rather than appearing to support the administration's goals of warhead reduction and security of nuclear arms, they instead seem only to scorn the nuclear disarmament vision. This has turned potentially

3. Barack Obama, "Remarks by President Barack Obama" (speech, Prague, Czech Republic, April 5, 2009), The White House Office of the Press Secretary, http://www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered/.

4. Ibid.

5. Barack Obama, "A Just and Lasting Peace" (speech, Oslo, Norway, December 10, 2009), www.nobelprize.org/nobel_prizes/peace/laureates/2009/obama-lecture_en.html.

6. William Broad and David Sanger, "Obama's Youth Shaped His Nuclear-Free Vision," *New York Times*, July 5, 2009, www.nytimes.com/2009/07/05/world/05nuclear.html?pagewanted=all&_r=0.

7. George Shultz, William Perry, Henry Kissinger, and Sam Nunn, "A World Free of Nuclear Weapons," *Wall Street Journal*, January 4, 2007.

8. This paper examines recommendations from *World at Risk: The Report of the Commission on the Prevention of WMD Proliferation and Terrorism*, chaired by Bob Graham with Jim Talent as vice-chairman; *U.S. Nuclear Policy: The Council on Foreign Relations Independent Task Force No. 62*, chaired by William Perry and Brent Scowcroft; and *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States*, chaired by William Perry with James Schlesinger as vice-chairman.

influential allies against the movement, or at least given this impression, and has created operating space for the administration's political adversaries to dismiss serious arms control policies as naïve.

Prague-nitive Dissonance

Striking similarities exist between the Gang of Four's 2007 op-ed and the president's speech in Prague. Perhaps most prominent is the contrast between the bold vision of a world without nuclear weapons and the proposed policies designed to make small moves in that direction. Providing further incentive for President Obama's Prague Agenda, the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism (also known as the Graham-Talent WMD Commission) published its final report in December 2008. This report, "addressed to the next President and . . . Congress," recommended a roster of nuclear policies nearly identical to those put forward by the Gang of Four and the administration.[9] Mandated by the 9/11 Commission Act of 2007,[10] the Graham-Talent WMD Commission opened its call to action with this harrowing projection:

> The Commission believes that unless the world community acts decisively and with great urgency, it is more likely than not that a weapon of mass destruction will be used in a terrorist attack somewhere in the world by the end of 2013.[11]

Graham-Talent considered biological weapons to be a more immediate terrorist threat than nuclear, but the Commission emphasized the grave risks associated with nuclear proliferation. Its first recommendation concerning nuclear proliferation trumpeted the emerging dream: "The United States should work internationally toward strengthening the nonproliferation regime, reaffirming the vision of a world free of nuclear weapons."[12]

Along with visionary alignment, the documents each offered a comprehensive slate of recommendations concerning global security of nuclear fuel, both weapon- and reactor-grade, allowing for state access to peaceful nuclear power generation. This thorough treatment of securing nuclear materials addresses specifically the asymmetric peril all three proclaim as a driver for nonproliferation vigilance: nuclear terrorism. Although they also recommended policies designed to reduce the number of nuclear weapons in the world, compared with their efforts to address sensitive material security, the proposals designed to shrink global aggregate nuclear arsenals seem scant. Nonetheless, both Graham-Talent and Prague called for either an extension of the Strategic Arms Reduction Treaty (START) or negotiation of a New START. The Gang of Four did not specifically address START in their 2007 op-ed, but their 2008 follow-up entitled, "Toward a Nuclear-Free World," led with the

9. Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism, *World at Risk: The Report of the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism* (New York: Random House, 2008), xiii.
10. PL. 110–53.
11. Commission on the Prevention of Weapons, xv.
12. Ibid., 46–47.

extension of START as a principle near-term goal.[13] Concerning reductions beyond START, however, the three initiatives become noticeably imprecise. In 2007, the Gang of Four advocates "continuing to reduce substantially the size of nuclear forces in all states that possess them."[14] Graham-Talent proposes the United States and Russia "jointly [encourage] China, Pakistan, and India . . . to reduce existing nuclear . . . stockpiles."[15] And in Prague, the president promised after New START he will "seek to include all nuclear weapons states [in] further cuts."[16] But 29 months since New START entered into force, no specific or realistic proposal has emerged envisioning a political path beyond New START to include other nuclear powers in multilateral arms control agreements.

Despite the disconnect between an optimistic vision for a nuclear free world and the modest proposals designed to arrive at such a goal, the agreement achieved by the three initiatives is noteworthy and was perhaps interpreted by the administration as the "momentum and growing political space" required to carry the vision forward.[17] Only one substantial difference related to nuclear testing emerged among the three. Both the Gang of Four and Senator Obama called for ratification of the Comprehensive Nuclear Test Ban Treaty (CTBT) in 2007,[18] and as president, Obama again echoed this sentiment in Prague. Graham-Talent, however, advocated the United States work "in concert with others to do everything possible to promote and maintain a moratorium on nuclear testing," not straying from the position the United States has maintained for two decades.[19] Days after Prague, the Council on Foreign Relations (CFR) and the Congressional Commission on the Strategic Posture of the United States released two timely reports offering nuclear policy recommendations. Two key similarities characterized both. First, each working group produced a document offering significant agreements among members from diverse policy backgrounds. Second, a less optimistic view regarding nuclear disarmament emerged.

On May 1, 2009, the CFR published *Independent Task Force Report Number 62: U.S. Nuclear Weapons Policy*, called by Richard Haass, CFR President, "a responsible agenda for U.S. nuclear policy."[20] The task force's 23 members were "asked to join a consensus signifying that they endorse 'the general policy thrust and judgments reached by the group, though not necessarily every finding and recommendation.'"[21] Although 6 of the 23 members took the opportunity to offer additional or dissenting views in an appendix, none of these views significantly strayed from the overarching thrust of the document. And several of the report's policy recommendations clearly aligned with the Gang of Four and the

13. George Shultz, William Perry, Henry Kissinger, and Senator Sam Nunn, "Toward a Nuclear-Free World," *Wall Street Journal*, January 15, 2008.

14. Shultz et al.,"A World Free of Nuclear Weapons."

15. Commission on the Prevention of Weapons, 79.

16. Obama, "Remarks by President Barack Obama," April 5, 2009.

17. Shultz et al., "Toward a Nuclear-Free World."

18. Shultz et al., "A World Free of Nuclear Weapons"; Barack Obama, "Renewing American Leadership," *Foreign Affairs* 86, no. 4 (July/August 2007), http://www.foreignaffairs.com/articles/62636/barack-obama/renewing-american-leadership.

19. Commission on the Prevention of Weapons, 47.

20. William Perry and Brent Scowcroft, Chairs, *Independent Task Force Report No. 62: U.S. Nuclear Weapons Policy* (New York: Council on Foreign Relations, 2009), xi.

21. Ibid., v.

president: Negotiation of a follow-on START should lead to a strengthened strategic dialogue between the United States and Russia[22]; fissile material usable for weapons "should be kept as secure as intact weapons," and "all nuclear-armed states [must] continually reevaluate the security of their nuclear weapons and materials"[23]; the United States should "seek to ratify the Comprehensive Test Ban Treaty" and "restart discussions on a Fissile Material Cutoff Treaty (FMCT)."[24]

Five days after CFR publication, The Congressional Commission on the Strategic Posture of the United States released *America's Strategic Posture*, which also offered recommendations aligning with the Gang of Four and the President. This report advises "modest and straightforward" U.S.-Russian arms control measures "to rejuvenate the process and ensure that there is a successor to the START I agreement before it expires at the end of 2009."[25] They caution against overreaching or aggravating a growing imbalance created by major reductions in strategic arms without modification of vast Russian advantages in nonstrategic arms.[26] Like the president and Graham-Talent, the Commission advocates for sustaining U.S. support of the Proliferation Security Initiative and the Global Initiative to Combat Nuclear Terrorism.[27] And like all the groups, they argue for seeking the FMCT, strengthening the International Atomic Energy Agency, and leading conspicuously during the 2010 Non-Proliferation Treaty (NPT) Review Conference.[28] But CTBT ratification stymied the Commission, and recognizing the president's appeal, it advises further deliberations regarding the "benefits, costs, and risks of ratification and entry into force."[29] Undaunted by this setback, Commission Chairman William Perry touts the agreement in his personal Chairman's Preface, stating "our commission was able to reach consensus language on most of the critical issues related to military capabilities, nonproliferation initiatives, and arms control strategies of the United States."[30] Private accounts of the discussions, though, call into question Perry's characterization, implying the Commission merely gave consent to the text of the report but remained "unwilling to unite as a group and . . . advocate the compromise."[31]

Reportedly, the Commission battled over issues more expansive than CTBT, principally the nature of the global security environment and the utility of a nuclear disarmament vision.[32] Despite offering support to many of the Gang of Four and the president's specific policies, these alleged arguments created an undercurrent rippling through the report,

22. Ibid., 4.
23. Ibid., 6.
24. Ibid., xv.
25. Congressional Commission on the Strategic Posture of the United States, *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States* (Washington, DC: U.S. Institute of Peace Press, 2009), 66.
26. Ibid., 71 & 21
27. Ibid., 89–92.
28. Ibid., 73–74, 76.
29. Ibid., 84.
30. Ibid., ix.
31. Clark Murdock, Stephanie Spies, and John Warden, *Forging a Consensus for a Sustainable U.S. Nuclear Posture: A Report of the CSIS Nuclear Consensus Working Group* (New York: Rowman & Littlefield, 2013), 62–63.
32. Ibid., 63.

eroding the foundation of the vision. In his personal remarks, Perry recognizes that "some of the commissioners do not accept the feasibility or even the desirability of seeking global elimination," but strives nevertheless for consensus, saying "all of the commission members believe that reaching [this goal] would require a fundamental change in geopolitics."[33] The Commission's agreed upon language offers these sentiments in a slightly different tone:

> As the Commission has debated its findings and recommendations, it has become clear that we have *very different visions* of what *might be possible* in the long term.
>
> The conditions that *might make possible* the global elimination of nuclear weapons are not present today and their creation would require a fundamental transformation of the world political order.[34] *[Emphasis added]*

The CFR Task Force reached the same conclusions, echoing the conceptual dissonance between the distant vision versus immediate possibilities:

> The geopolitical conditions that would permit the global elimination of nuclear weapons do not currently exist, but this Task Force has identified many steps that are available in the near term that can greatly reduce the danger of nuclear proliferation and nuclear use.[35]

And William Perry and Brent Scowcroft acknowledge in the Chairs' Preface:

> It is not possible now to envision the geopolitical conditions that would permit moving toward the final goal [nuclear disarmament].[36]

Like the Strategic Posture Commission, the CFR Task Force also encountered discord related to the goal of a world without nuclear weapons. Agreed upon language in its report resonates with the Commission: "The Task Force is divided on the practicality or even desirability of a world without nuclear weapons."[37] Richard Haass in the Forward leads with a similar confession, and regarding the distant goal of nuclear disarmament, he adds almost dismissively, "But that vision remains *just a vision*."[38] [Emphasis added]

Qualified Aspirations

The administration may have interpreted the timing of these reports—released days after the Prague speech—as a mixed blessing. Some in the press heard harmony with the administration.[39] But the president's team and the Gang of Four anticipated criticism regarding

33. Congressional Commission on the Strategic Posture, xi–xii.
34. Ibid., 93 & xvi.
35. Perry and Scowcroft, *Independent Task Force Report No. 62*, 3.
36. Ibid., xiv.
37. Ibid., 3. This sentiment is restated on page 20.
38. Ibid., ix.
39. Walter Pincus, "Expert Groups Largely Back Obama's Nuclear Stance," *Washington Post*, May 2, 2009, www.washingtonpost.com/wp-dyn/content/article/2009/05/01/AR2009050103404.html.

the conflict between an aspirational, yet controversial, goal of disarmament and necessary near-term operational policies. Thus, they employed a series of rhetorical gimmicks designed to blunt the looming reproach a vision of nuclear disarmament was certain to draw. These qualifiers attempt to balance distant aspirations with near-term possibilities and to draw in both nuclear disarmament advocates and skeptics.

It is rare to find an administration quote of the president's Prague vision—"I state clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons"—without the vision's ambiguous timeline: "This goal will not be reached quickly—perhaps not in my lifetime."[40] This loosely defined couplet is repeated throughout the *Nuclear Posture Review Report* (NPR).[41] The unbounded period of this pledge seeks to assuage both disarmament believers and doubters alike, but in very different ways. Advocates, such as the Norwegian Nobel Committee, may read the vision, thrilled that the president conspicuously carries the nuclear disarmament banner, while skeptics may point to the indefinite time frame—perhaps not in Obama's lifetime—and read, *perhaps never*. Nuclear disarmament ad infinitum seeks to satisfy both.

Another balance the administration sought addresses the dichotomy unique to U.S. nonproliferation goals: reduce the nuclear arsenal too little, and adversaries call into question U.S. NPT commitments in order to justify breaking their own NPT obligations; reduce the arsenal too much, and allies lose faith in extended deterrence and develop a breakout capability. Hence, Obama offered the following: "Make no mistake: As long as [nuclear] weapons exist, the United States will maintain a safe, secure, and effective arsenal."[42] Here, the administration promises, at least figuratively, that, as part of its disarmament efforts, the United States will be either the last nation with a nuclear weapon or be among the last nations to dismantle their arsenals. The NPR also quotes this statement repeatedly, intending to further qualify the nuclear disarmament vision. Essentially, the United States promises not to win a race on the Road to Zero.

The president's language figures noticeably in the CFR and Strategic Posture Commission reports, primarily to alleviate fears that nuclear disarmament may progress too quickly. William Perry, serving as chairman for the Strategic Posture Commission, incorporates another qualifier—the base camp—into the content of that report via his personal comments.[43] The base camp is an idea Sam Nunn socialized regarding the vision of a world free of nuclear weapons.[44] Using the metaphor of mountain climbers, nuclear disarmament represents the mountaintop, and achieving the nuclear security and reduction policies proposed by the Gang of Four would represent arrival at a base camp at the foot of

40. Obama, "Remarks by President Barack Obama," April 5, 2009.
41. Department of Defense, Nuclear Posture Review Report, April 6, 2010, http://www.defense.gov/npr/.
42. Obama, "Remarks by President Barack Obama," April 5, 2009.
43. Congressional Commission on the Strategic Posture, xi–xii.
44. Sam Nunn, "The Mountaintop: A World Free of Nuclear Weapons" (speech, Washington, DC, June 14, 2007) www.nti.org/analysis/speeches/nunn-mountaintop-free-weapons/; Sam Nunn, "NTI Co-Chairman Sam Nunn speaks at the Chautauqua Institution" (speech, Chautauqua, New York, July 19, 2010), www.nti.org /analysis/speeches/nti-co-chairman-sam-nunn-speaks-chautauqua-institution/.

the mountain. We cannot see the mountaintop from here, but from the base camp, we can. The Gang of Four, in their original op-ed, also sought to connect the vision with the near-term policies in this way: "Without the bold vision, the actions will not be perceived as fair or urgent. Without the actions, the vision will not be perceived as realistic or possible."[45]

Qualifying the vision of a world without nuclear weapons strives to manage expectations on both sides and to connect the aspirational and operational goals through a theoretical pathway. The Prague qualifiers appear in the NPR, CFR, and Strategic Posture reports because these documents allow for analytical depth. But headlines do not. Print captions are challenged to capture the nuances in the president's vision, but the Road to Zero contains sharp and provocative language. Although Sam Nunn's base camp-mountaintop analogy creates a snappy term short enough for a news column, by 2010 he was losing his patience, protesting, "The critics . . . must be challenged not to simply question the vision, but to also consider our current baseline and trajectory."[46]

Critics and Allies

One of the early rebuttals to the Gang of Four's 2007 op-ed came from Harold Brown of the Center for Strategic and International Studies and John Deutch of the Massachusetts Institute of Technology, who published their own op-ed in the *Wall Street Journal*.[47] They call the aspirational goal of eliminating all nuclear weapons "counterproductive," adding that "it will not advance substantive progress on nonproliferation; and it risks compromising the value that nuclear weapons continue to contribute, through deterrence, to U.S. security and international stability."[48] Interestingly, the op-ed supports the near-term thrust of the Gang of Four's effort, offering strong support for nuclear reductions:

> We agree that the strongest possible measures must be taken to inhibit the acquisition of and roll back the possession of nuclear weapons . . . the U.S. can safely reduce . . . to the lowest number needed for the purpose of deterrence. . . . This reduction will harmonize nuclear weapons policy with our attempt to encourage nonproliferation elsewhere.[49]

Despite agreement that nuclear arsenals must be reduced, these concessions fall under a headline that scoffs, "The Nuclear Disarmament Fantasy."[50] John Deutch later played a key role in the CFR report, serving as one of the Task Force members who was "asked to join [the Task Force] consensus."[51] Given the chance to offer a dissenting review in the report's appendixes, Deutch elected instead to add a statement giving broad concurrence to

45. Shultz et al., "A World Free of Nuclear Weapons."
46. Nunn, "NTI Co-Chairman Sam Nunn speaks at the Chautauqua Institution," July 19, 2010.
47. Harold Brown and John Deutch, "The Nuclear Disarmament Fantasy," *Wall Street Journal*, November 19, 2007, http://online.wsj.com/article/SB119542524645797257.html.
48. Ibid.
49. Ibid.
50. Ibid.
51. Perry and Scowcroft, *Independent Task Force Report No. 62*, v.

the report's key points, which, as stated above, largely agree with the Gang of Four and the president's policy proposals, though questioning the validity of the vision.[52]

Another key figure who prominently doubts the vision is Fred Iklé, former director of the U.S. Arms Control and Disarmament Agency and Undersecretary of Defense for Policy. Writing for *The National Interest* in 2009, Iklé argues in an article titled, "Nuclear Disarmament, A Reverie," that disarmament adherents "ignore important facts, forget the lessons of similar arms-control proposals and disregard insurmountable obstacles."[53] Although he does call the vision a "noble cause," he argues that a better goal is maintaining the "tradition of nonuse," that has withstood four wars in which nuclear-armed states accepted defeat or stalemate from a nonnuclear power.[54] He further emphasizes this in a 2010 *Wall Street Journal* debate, arguing the number of nuclear weapons does not matter as much as maintaining the "tradition against the use of [nuclear] weapons."[55] And, as former Undersecretary of Defense for Policy during the Reagan administration, he derides the notion that Reagan endorsed the goal of a nuclear-free world.[56]

One of the most senior critics of the disarmament vision is former Secretary of Defense James Schlesinger, who served as vice-chairman on the Strategic Posture Commission. During U.S. Strategic Command's inaugural Deterrence Symposium in 2009, Schlesinger reportedly mused to the laughter of military officers in attendance, "Are we actually going to see a world without nuclear weapons? This is the vision of many people, and I remind you that the dividing line between vision and hallucination is never very clear."[57] The following year, writing in the *Wall Street Journal*, he repeats this sentiment: "We owe a substantial debt to the Department of Defense and to the military commands for fending off some of the wilder views within the administration and elsewhere."[58] Such advocacy clearly places Schlesinger and Iklé in the crowd opposing the Gang of Four and the president's vision, perhaps at the most hawkish end of the nuclear policy spectrum, yet the Strategic Posture Commission, of which they were key members, offered concurrence on a number of near-term policy initiatives promoted by both the Gang of Four and the president. The administration's attempts to qualify the difference between aspirational visions and political possibilities made little difference to these realists. And although they may agree with efforts to secure nuclear material and cooperate on modest bilateral reductions with Russia, their views of the vision translates into "fantasy," "reverie," and "hallucination" when reported in the press.

52. Ibid., 97.

53. Fred Iklé, "Nuclear Abolition, a Reverie," *National Interest* (September/October 2009), 4–5.

54. Ibid., 6–7.

55. George Shultz, Paul Wolfowitz, James Schlesinger, Fred Iklé, Richard Perle, and Richard Burt, "Debating Obama's New Nuclear Doctrine," *Wall Street Journal*, April 13, 2010, http://online.wsj.com/article/SB10001424052702304222504575174200114028206.html.

56. Iklé, "Nuclear Abolition," 4.

57. Zachary Roth, "Global Zero: Obama's Distant Goal of a Nuclear-free World," *Atlantic Monthly*, September 29, 2011, www.theatlantic.com/politics/archive/2011/09/global-zero-obamas-distant-goal-of-a-nuclear-free-world/245806/.

58. Shultz et al., "Debating Obama's New Nuclear Doctrine."

The ultimate field for this rhetorical game is the U.S. Senate, and recently Jeff Sessions (R-AL), ranking member on the Armed Forces Subcommittee on Strategic Forces, addressed current nuclear policy matters in remarks at a Capitol Hill Breakfast Forum for the Reserve Officers Association, the National Defense Industrial Association, and the Air Force Association. He began by faulting the president for not keeping commitments reportedly made to Republicans during New START negotiations, and he then addressed the president's remarks made the day prior in Berlin.[59] Under New START, the United States agreed to 1,550 weapons, but the president desires further decreases in strategic arsenals "by up to one-third" beyond New START reductions, bringing the total to roughly 1,033.[60] This concerned the senator, who called it "a dangerous policy," adding, "I see no need for us to take that big a reduction in our nuclear arsenal at this time."[61] Naturally, most analysts would consider this boilerplate criticism expected from a member of the opposing political party, but Sessions offered this intriguing confession as part of his remarks:

> George Bush said, I think we can get to 1,100 nuclear weapons and I believe we can still defend America. That's one thing. But when you've got a commander in chief whose repeated, stated goal is a world without nuclear weapons—and we have very little analysis, it seems to me of this—and announce a further one-third reduction, I believe that has destabilizing effects worldwide.[62]

Consequently, Senator Sessions does not seem to believe the 67-warhead difference in the Obama and Bush proposals is destabilizing, but rather, combining reductions with the nuclear disarmament vision is what creates global instability. Of course, supposing Obama never said a word about nuclear disarmament, no one would expect the Senator to give full-throated support to any of the president's strategic policies. Yet time and again, policymakers in the same breath confess their agreements with concrete, near-term reductions the Gang of Four and the president proposed, then mock the notion of a world without nuclear weapons.

A Better Nuclear Disarmament Pledge

The Gang of Four observes in their original op-ed: "Every president of both parties since Richard Nixon has reaffirmed [U.S. NPT] treaty obligations."[63] The significance of this is almost easy to overlook. From a nuclear disarmament perspective, Article VI of the NPT has obligated the United States "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament"

59. Jeff Sessions, "Missile Defense and Nuclear Deterrence Futures: A Senate Perspective" (speech, Washington, DC, June 20, 2013), http://secure.afa.org/HBS/transcripts/2013/June%2020%20-%20Sessions.pdf.
60. Barack Obama, "Remarks by President Obama at the Brandenburg Gate" (speech, Berlin, Germany, June 19, 2013), www.whitehouse.gov/the-press-office/2013/06/19/remarks-president-obama-brandenburg-gate-berlin-germany.
61. Sessions, "Missile Defense."
62. Ibid.
63. Shultz et al., "A World Free of Nuclear Weapons."

since entry into force March 1970.[64] Effectively, there is little daylight between the policy existing four decades through eight administrations and the vision offered by the Gang of Four and the president in Prague. So why alter the rhetoric?

It would have been a challenge for any administration to dismiss the vision after two bipartisan initiatives, the Gang of Four, and the Graham-Talent commission advocated it. By October 2007, candidate Obama had already signed on, remarking in a DePaul University speech, "America seeks a world in which there are no nuclear weapons."[65] By the time the Gang of Four declared "the interest, momentum, and growing political space" had become a global phenomenon, the most conspicuous print rebuttal to the vision had come from Harold Brown and John Deutch, who concur with reductions to the U.S. arsenal.[66] Thus, timing may have informed the president's Prague vision as much as optimism. But after Prague, resistance grew significantly, beginning with the doubts expressed in the CFR and in the Strategic Posture Commission report.

Two observations are useful at this point. First, as discussed above, the five initiatives have in common comprehensive recommendations for strengthening U.S. support for the NPT. Input from dozens of influential policymakers across the political spectrum formed this accord. Second, endorsing a world without nuclear weapons became an increasingly divisive position. The Strategic Posture Commission illustrates these points. Of the five, the Commission's agreed upon language—excluding Chairman Perry's—casts the starkest doubt on both the efficacy and possibility of the vision. Yet the Commission produces the strongest position of the five on U.S. NPT leadership. Consider the following key points from the Commission:

- U.S. leadership on nonproliferation is imperative.
- The president should use his "bully pulpit" to lay out an agenda.
- The United States should prepare to play a leadership role at the 2010 NPT review conference.
- The United States should address Article VI directly and forcefully.
- The United States should define an agenda of specific actions that can be taken at this time and over the next five years in anticipation of the 2015 NPT review conference.[67]

Despite clear similarities between the vision of a world without nuclear weapons and Article VI of the NPT, policymakers do not support them equally. Consequently, it seems that the Gang of Four and the administration already had the four-decade tradition of U.S. support for the NPT, which very few policymakers oppose, but may have overreached rhetorically with the vision of Global Zero.

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64. The Non-Proliferation Treaty, http://www.un.org/en/conf/npt/2010/npttext.shtml.
65. Barack Obama, "Barack Obama's Foreign Policy Speech" (speech, Chicago, IL, October 2, 2007), http://www.cfr.org/elections/barack-obamas-foreign-policy-speech/p14356.
66. Shultz et al., "Toward a Nuclear-Free World"; Brown and Deutch, "The Nuclear Disarmament Fantasy."
67. Congressional Commission, 73–74 & 78–79.

Conclusion

This research presents no position regarding the feasibility of global nuclear disarmament. That assessment has been offered ad nauseum, producing a wide spectrum of views. Some efforts have proposed technical steps to achieve this vision.[68] Few, if any, have proposed the political steps to achieve it. Whether the Gang of Four and the president sincerely believe global nuclear disarmament is a realistic goal is impossible to prove. One interesting muse on this point comes from Thomas Schelling, the noted arms control theorist:

> One can take the position that substantial nuclear disarmament makes sense, and that the abstract goal of a world without nuclear weapons helps motivate reduction as well as presents an appearance of fulfilling the NPT commitment. Maybe some leaders . . . have no more than that in mind.[69]

Schelling's rumination suggests a potential strategy behind the vision: Through an ambiguously timed objective (disarmament ad infinitum), U.S. policy has time to legitimately strengthen the nonproliferation regime and secure nuclear materials globally. It also assumes a bipartisan political atmosphere characterized by rhetorical restraint. In the current environment, critics of nuclear disarmament would rather support strengthening the NPT and leading the global nonproliferation regime, but tying the vision to these policies pollutes the discussion and alienates nuclear policy realists, preventing them from reaching a potentially crucial consensus that could fortify U.S. leadership in global nuclear nonproliferation.

68. Examples include: George Perkovich and James Acton, editors, *Abolishing Nuclear Weapons: A Debate* (Washington, DC: Carnegie Endowment, 2009); Gareth Evans and Yoriko Kawaguchi, co-chairs, *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers* (Tokyo: International Commission on Nuclear Non-proliferation and Disarmament, 2009); Global Zero Commission, *Global Zero Action Plan*, June 29, 2009, www.globalzero.org/files/pdf/gzap_3.0.pdf.

69. Thomas Schelling, "A World Without Nuclear Weapons?" *Daedalus* 138, no. 4 (Fall 2009), 126–127.

Test Results: Surveying U.S. Responses to Nuclear Testing Over Time

Timothy J. Westmyer[1]

Once a country decides to join the nuclear club or move up through its ranks with a nuclear test, the United States faces a pressing question: what to do next? Nuclear tests are technical, military, and political acts that draw global attention and often affect international affairs in profound ways. The immediate U.S. response to nuclear tests has varied over history from swift rebukes and tough sanctions to temporary castigation and tacit acquiescence. This paper surveys U.S. responses to a range of nuclear tests and aims to provide a better understanding of past behavior, which factors determined the U.S. response in specific cases, and how these decisions influenced future testing choices. The paper concludes that the most meaningful nonproliferation work should be done before a state prepares for a nuclear test. Once a country demonstrates its capability through a test, it is already too late. The paper recommends policy options for the United States to manage the political and security fallout immediately after another country—whether ally or rival—initiates a new round of nuclear testing.

Introduction

In the nearly 70 years since the first atomic flash illuminated the early morning Alamogordo sky, the United States has seen several countries join the nuclear club with the detonation of a nuclear device. Some of these nuclear aspirants have been adversaries and others allies. The U.S. foreign-policy response to nuclear tests has varied over time from swift rebukes and advocacy for international sanctions to temporary castigation and tacit acquiescence. Because the United States will likely confront this challenge again in the future, there is a pressing need to reflect upon these past responses.

This paper surveys significant nuclear tests over the years and tracks the immediate U.S. response to provide a better understanding of past behavior, which

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factors determined these responses, and how these decisions influenced subsequent proliferators. The study draws heavily upon historical accounts of nuclear testing and proliferation history, government documents detailing U.S. and international deliberations on emerging nuclear powers, activity in international forums, and public media accounts. Despite these sources, much about the history of nuclear tests and the behind-the-scenes discussion on how to manage these challenges remains unknown.[2] Nevertheless, it is possible to ascertain a reasonable assessment of nuclear testing history and how the United States responded.

The paper is divided into three sections: (1) a brief overview of nuclear testing, its value as a point of analysis, and some broad trends on the international norm against testing; (2) a survey of case studies that represent a range of testing conditions and U.S. responses; and (3) a set of policy recommendations drawn from this analysis.

Brief Overview on Nuclear Testing

WHY TEST?

Before delving into the test cases, it is important to understand why a nuclear test should be a point of reference for studying these issues. Once the first test demonstrated the ability to turn a nuclear chain reaction into an explosive force, nations have tested nuclear devices for a variety of purposes:

1. Testing provides basic acumen on how nuclear materials can be manipulated to produce different yields, radiation levels, and other destructive effects.[3]
2. Testing is used to build and confirm warhead designs that fit a range of operational requirements and delivery systems.
3. Testing is used on occasions to maintain the safety, reliability, and security of an arsenal.
4. Nuclear tests serve political goals at home and abroad by signaling one's nuclear capabilities, putting potential rivals on notice, and declaring oneself a nuclear-capable state.

PROLIFERATION WITHOUT TESTING?

Although nearly all nuclear powers announced their arsenals with a test, the absence of a nuclear test does not preclude a state from acquiring the most rudimentary nuclear weapon. The atomic bomb used against Hiroshima was an untested gun-type weapon that used uranium for fissile material. South Africa developed six gun-type uranium weapons

2. Robert Norris, Andrew S. Burrows, and Richard Fieldhouse, *Nuclear Weapons Databook: Volume V: British, French, and Chinese Nuclear Weapons* (Boulder: Westview Press, 1994), 12.

3. Ola Dahlman, Svein Mykkeltveit, and Hein Haak, *Nuclear Test Ban: Converting Political Visions to Reality* (New York: Springer, 2009), 9–10.

possibly without a full-scale nuclear test. Israel may have also fielded nuclear weapons without nuclear testing, or at least without a publicly acknowledged test. Future aspiring proliferators may decide to advance up to the point of being able to test a nuclear device but never cross that threshold.[4] Established nuclear powers can help others leapfrog past years of work by sharing valuable test data.[5] Nevertheless, many experts consider nuclear testing a prerequisite to fielding advanced thermonuclear or plutonium implosion-type devices.[6] Nuclear testing also allows a proliferator to confirm that warheads are adequate for long-range missile delivery systems and to deter those who might challenge a state with an untested deterrent.[7]

INTERNATIONAL NORM AGAINST NUCLEAR TESTING

An international norm against nuclear testing has gradually emerged over the past six decades, though certainly not without hiccups along the way. George Bunn, former U.S. ambassador and chief negotiator on the Nuclear Non-Proliferation Treaty (NPT), contends that this norm influences the actions of all nuclear powers in unique ways.[8] After nuclear tests by India and Pakistan in 1998, Bunn argued that the norm—reflected in treaty texts, UN resolutions, condemnations after nuclear tests in the 1990s, and elsewhere—would likely survive these tests in South Asia, but a resumption of testing by NPT nuclear weapon states will impede the "international cooperation [necessary] . . . to prevent the acquisition of nuclear weapons by other count[r]ies."[9]

Although some have been more widely adopted than others, there has been a progressive series of bans on nuclear testing, including formal treaties and informal testing moratoriums:

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4. Wolfgang Panofsky, "Capability Versus Intent: The Latent Threat of Nuclear Proliferation," *Bulletin of Atomic Scientists,* June 14, 2007, http://thebulletin.org/capability-versus-intent-latent-threat-nuclear-proliferation-0; Juan Cole, "Does Iran Really Want the Bomb?" *Salon*, October 7, 2009, www.salon.com/2009/10/07/iran_nuclear/.

5. Some argue that advanced simulation capabilities reduce the value of nuclear tests to the point where only less developed countries require real detonations to build and modernize an arsenal. However, a full-scale test where the device undergoes a critical chain reaction may still be necessary to both calibrate those simulation technologies and prove new warhead designs. For more, see Bruce D. Larkin, *Nuclear Designs: Great Britain, France, and China in the Global Governance of Nuclear Arms* (London: Transaction Publishers, 1996), 60–61; "Japan Raps U.S. Subcritical Nuclear Test," *Xinhua*, December 7, 2012, http://news.xinhuanet.com/english/world/2012-12/07/c_132026699.htm; Ludwina Joseph, "A Subcritical Fallout," *Outlook India*, April 23, 1997, http://www.outlookindia.com/article.aspx?203431; Anthony H. Cordesman, "Red Lines, Deadlines, and Thinking the Unthinkable: India, Pakistan, Iran, North Korea, and China," *Center for Strategic and International Studies,* April 16, 2013, http://csis.org/publication/red-lines-deadlines-and-thinking-unthinkable-india-pakistan-iran-north-korea-and-china.

6. The political motive of nuclear tests further warrants their focus in this paper.

7. Dahlman, Mykkeltveit, and Haak, *Nuclear Test Ban*, 15; Linton Brooks, "CTBT Ratification Issues and Options," *Aspen Strategy Group*, September 9, 2009 (revised October 11, 2009), www.aspeninstitute.org/sites/default/files/content/images/CTBT%20Post%20Conference%20Paper-%20revised%20final.pdf; Jozef Goldblat and David Roxbee Cox, *Nuclear Weapon Tests: Prohibition Or Limitation?* (New York: Oxford Univ Press, 1988), 326; Richard Garwin, "The Future of Nuclear Weapons Without Nuclear Testing," *Arms Control Today,* November/December 1997, www.armscontrol.org/act/1997_11-12/garwin.

8. George Bunn, "The Status of Norms Against Nuclear Testing," *The Nonproliferation Review* 6, no. 2 (1999), 23–25.

9. Ibid., 30.

- 1959–1960 Testing Moratorium: voluntary agreement by the United States, Soviet Union, and United Kingdom to not test. It was broken after France's 1960 test.
- 1963 Limited (Partial) Test Ban Treaty (LTBT or PTBT): banned nuclear testing in the atmosphere, in space, and underwater. The treaty entered into force on October 10, 1963.
- 1968 NPT: non-nuclear weapon states are prohibited from manufacturing or acquiring nuclear weapons, which would in turn prevent a manufactured device from being tested. The treaty entered into force on March 5, 1970.
- 1974 Threshold Test Ban Treaty (TTBT): banned underground nuclear weapon tests having a yield greater than 150 kilotons. The treaty entered into force on December 11, 1974.
- 1976 Peaceful Nuclear Explosions Treaty (PNET): extended TTBT limit to peaceful nuclear explosions.[10] The treaty entered into force on December 11, 1990.
- 1996 Comprehensive Nuclear Test Ban Treaty (CTBT): prohibits nuclear tests in any environment. As of December 2013, the treaty has not entered into force.
- Specific Country Moratoriums: various nations have announced testing moratoriums, including the United States (since 1992), China (1996), India (1998), and Pakistan (1998); France, Russia, and the United Kingdom have ratified the CTBT.

There are several justifications given for why U.S. leaders have gradually become more resistant to U.S. testing and more sensitive to testing by others. Realists, such as T.V. Paul, suggest that the "horrendous effects of nuclear attack" generate reputation costs that self-deter a country from using nuclear weapons for anything other than existential deterrence.[11] Although it is possible to separate resistance to the wartime use of nuclear weapons and peacetime nuclear testing, Paul notes that the U.S. public "witnessing, first-hand, the material effects of nuclear weapon use and testing" after media attention on Hiroshima victims and nuclear testing accidents "was essential for increased global opposition to nuclear arms."[12] Paul cites the example of the Eisenhower administration being "forced to engage in a public relations campaign in order to quell the opposition, which it did by proposing a partial test ban agreement." Constructivists, such as Nina Tannenwald, argue that hydrogen bomb tests by the United States (1954) and the Soviet Union (1955) "did much to stoke public anxieties about nuclear weapons."[13] A growing antinuclear movement emerged in North America, Western Europe, and Japan concerned with the environmental,

10. Peaceful nuclear explosions use the explosive force of a nuclear device for nonmilitary purposes in massive construction projects such as digging canals, stimulating oil and gas deposits, and creating underground cavities.

11. T. V. Paul, *The Tradition of Non-Use of Nuclear Weapons* (Stanford: Stanford University Press, 2009).

12. Ibid., 57–58.

13. Nina Tannenwald, *The Nuclear Taboo: The United States and the Non-Use of Nuclear Weapons Since 1945* (New York: Cambridge University Press, 2007), 157, http://blogs.unpad.ac.id/desyamaliayusri/files/2012/05/The-Nuclear-taboo.pdf.

security, and moral implications of the use and testing of nuclear weapons.[14] When CASTLE BRAVO, a 15-Mt hydrogen-bomb test conducted by the United States in March 1954, accidently caused radioactive fallout and showered a Japanese tuna boat, *The Lucky Dragon*, the antinuclear movement intensified the debate over the possible dangers of nuclear weapons testing and use. Indian Prime Minister Jawaharlal Nehru called for a global ban on nuclear testing. Tannenwald suggests that these efforts "stigmatized nuclear weapons" and shifted the preference of many world leaders to be more sensitive on nuclear testing matters.[15] Similar efforts—notably the Global Zero movement—continue today and have expanded their ranks to include former senior defense officials and other international figures.[16]

With this basic overview of nuclear testing, it is now possible to survey the immediate U.S. responses to a series of test cases where a country tested a nuclear device or was discovered in the midst of preparations for a test. These test cases represent a meaningful sample of nuclear test events that prompted a range of responses by the United States. The cases cover countries with differing relationships with the United States: rivals (Soviet Union/Russia, China, North Korea), close allies (United Kingdom, France), emerging partners (India, Pakistan), and possible tests of an uncertain origin (Vela Incident). They also represent countries at various stages of nuclear development and countries with varying involvement with the NPT, both those inside (United Kingdom, China, France, Soviet Union/Russia) and those outside (India, Pakistan, North Korea) the regime.

When Our Allies Test

France and the United Kingdom allied with the United States after WWII through the formation of the North Atlantic Treaty Organization (NATO) but ultimately determined they could not solely rely on the U.S. security guarantee for their own independent defense.[17] Fluctuating from initial concern and hostility to a gradual acceptance of these countries' place in the nuclear club, the U.S. responses to Britain and France had some similarities for both countries, but also some striking differences.

UNITED KINGDOM

The United Kingdom has conducted 45 nuclear tests since its first, code-named HURRICANE, at Monte Bello in October 1952. As a close ally of the United States, the two countries

14. Lawrence S. Wittner, *Resisting the Bomb: A History of the World Nuclear Disarmament Movement, 1954–1970* (Stanford: Stanford University Press, 1998).

15. Tannenwald, *The Nuclear Taboo*, 156–188.

16. Global Zero: World Without Nuclear Weapons, "Movement Leaders," http://www.globalzero.org/our-movement/leaders; for more on the evolution of disarmament views held by Henry Kissinger, George Shultz, William Perry, Sam Nunn, and Sidney D. Drell, see Philip Taubman, *The Partnership: Five Cold Warriors and Their Quest to Ban the Bomb* (New York: Harper, 2012).

17. Avery Goldstein sees these decisions based in "fear of abandonment rooted in anarchy, reinforced by bipolarity, and exacerbated by the advent of nuclear weapons." For more, see Avery Goldstein, *Deterrence and Security in the 21st Century: China, Britain, France, and the Enduring Legacy of the Nuclear Revolution* (Stanford: Stanford University Press, 2000), 139–216.

collaborated on the Manhattan Project.[18] After the end of WWII, however, there was a period of relative independence between the programs during which the United States offered only tepid support for the indigenous British arsenal. The United States and Britain resumed closer cooperation on nuclear issues in the late-1950s and remain close today.

Period of Relative Independence

Washington chose to "keep the atomic secret" to itself once hostilities in WWII ended.[19] The McMahon Act passed Congress in April 1946 and placed limits on U.S. nuclear assistance to other countries.[20] These constraints forced the Joint Chiefs of Staff in 1950 to deny the United Kingdom's request to use the U.S. test site at the Enewetak Atoll.[21] After repeated British requests, the United States offered a joint test in Nevada, but required conditions—full details of the weapon, examined by U.S. officials—that were unacceptable to UK scientists and government leaders.[22] If London wanted a nuclear arsenal, it needed to move forward on its own, including through independent testing.[23] Still, British scientists benefited from witnessing several early U.S. nuclear tests, including the CROSSROADS series of atmospheric tests at Bikini Atoll in the summer of 1946, which were similar to the UK test six years later.[24]

Gradual Cooperation

Initial tensions eased as Washington and London gradually increased their nuclear cooperation in the late 1950s. The United Kingdom did not see its nuclear arsenal as a substitute for the NATO alliance. Britain's nuclear force would hedge against possible abandonment by the United States in a crisis, but the NATO alliance would represent the foundation of London's defensive strategy.[25] One of London's primary concerns was balancing its desire to sustain U.S. support for the NATO alliance while at the same time maintaining a degree of strategic autonomy. To sustain U.S. support for the alliance, the UK displayed a willingness to accept some level of "constraints on Britain's freedom of action."[26]

The British testing program started with a flurry of activity (21 tests in the first six years) but cooled off in later years (only 24 more since then). Some scholars explain this

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18. Sir John Cockcroft, British physicist, noted that UK scientists left Los Alamos with "an almost complete knowledge of [the bomb's] technology." For more, see Ferenc Morton Szasz, *British Scientists and the Manhattan Project: The Los Alamos Years* (New York: St. Martin's Press, 1992), 44.

19. Stephen M. Meyer, *The Dynamics of Nuclear Proliferation* (Chicago: University of Chicago Press, 1984), 168; Goldstein, *Deterrence and Security*, 156–157.

20. Goldstein, *Deterrence and Security,* 156–157.

21. The McMahon Act (Atomic Energy Act of 1946) sought to control scientific information on the bomb after a number of spying operations were uncovered. For more, see Norris et al., *Nuclear Weapons Databook*, 24.

22. Ibid., 24–25; Goldstein, *Deterrence and Security*, 160.

23. UK officials made the official decision to start the United Kingdom's nuclear weapon program on January 8, 1947. For more, see Larkin, *Nuclear Designs*, 32.

24. Britain publicly announced on February 19, 1952 that it would conduct a nuclear test later that year. For more, see Norris et al., *Nuclear Weapons Databook*, 19.

25. John Baylis, *British Defense Policy* (New York: St. Martin's Press, 1989), 61.

26. Ibid., 60.

pace by arguing that the United Kingdom felt less of a need to test over time due to U.S. assistance, with some UK warheads based largely on proven U.S. designs.[27] The McMahon Act was amended to allow more flexibility in U.S. nuclear assistance to countries with existing advanced indigenous programs, including collaboration on design, testing, and fabrication of nuclear weapons.[28] The legislation was further amended to allow the transfer of equipment and material—not just information—to the United Kingdom.[29] Later, the United States helped the United Kingdom advance the thermonuclear stage of its nuclear program. British scientists collected air samples after the U.S. series of CASTLE tests in early 1954, which aided the United Kingdom's hydrogen bomb GRAPPLE tests in 1957.[30] When the United Kingdom conducted a series of "minor trial" experiments during the November 1958–September 1961 U.S.-UK-Soviet testing moratorium, the United States argued that these activities did not violate the agreed upon moratorium.[31]

1990s Moratorium

The United Kingdom supported efforts to create a comprehensive ban on nuclear testing, though it tried to maintain the ability to test in the short term.[32] However, because most UK nuclear tests since 1962 were conducted at the U.S. test site in Nevada, the 1992 U.S. moratorium became a *de facto* moratorium for the United Kingdom as well.[33] Nevertheless, British officials tried unsuccessfully to lobby the United States to allow a "minimal testing program."[34] The U.S. push for successful negotiations on the CTBT prevented Washington from fulfilling its close ally's request.

FRANCE

France has conducted around 210 nuclear tests since its first, code-named GERBOISE BLEUE, in Algeria in February 1960.[35] General Charles de Gaulle contended that a national nuclear deterrent was "the only effective way of ensuring [France's] territorial integrity and political independence."[36] Similar to the U.S. response to the United Kingdom, the U.S. reaction to the French testing program started with strong initial concerns. Unlike the British case, U.S. qualms with the French program lasted much longer due to France's insistence on an independent nuclear strategy. The French testing program featured more

27. Norris et al., *Nuclear Weapons Databook, 12–13;* Goldstein, *Deterrence and Security*, 155.

28. The Suez Crisis (1956) and the launching of Sputnik (1957) brought the UK and U.S. programs closer together during the Cold War. For more, see Norris et al., *Nuclear Weapons Databook*, 43; Goldstein, *Deterrence and Security*, 161–165.

29. Norris et al., *Nuclear Weapons Databook*, 49–50.

30. Ibid., 33.

31. Ibid., 30–31.

32. Larkin, *Nuclear Designs,* 94.

33. Ibid., 85.

34. *The Guardian*, November 25, 1992, cited in Ibid., 95.

35. The French decision was made in late 1956 and capitalized on research France had been conducting for some time, including work on plutonium production reactors and an extraction plant. For more, see Stephen M. Meyer, *The Dynamics of Nuclear Proliferation*, 169; Larkin, *Nuclear Designs*, 23; Lawrence Scheinman, *Atomic Energy Policy in France Under the Fourth Republic* (Princeton: Princeton University Press, 1965), 94, 210.

36. Charles de Gaulle, cited in David S. Yost, "France's Deterrent Posture and Security in Europe: Capabilities and Doctrine," *Adelphi Papers* 25, no. 194 (1984), 5.

"trial and error" than the UK program due to a lack of initial U.S. support, until cooperation resumed in the 1970s.[37] U.S. administrations expressed frustration at the continuation of French testing even during CTBT negotiations.

Uneasy Start

The United States expressed initial unease at French nuclear ambitions and requests for assistance. The Fourth Republic's internal political turmoil, tolerance of communist party activities within France, and pursuit of an independent nuclear strategy contributed to this stance.[38] According to a Stanford Research Institute study, U.S. nonproliferation policy during the 1960s tried to persuade France to abandon its nuclear plans and then to "thwart" these ambitions once France continued ahead.[39] French leaders expected U.S. assistance and were disappointed when Washington held back.[40]

During the 1960s, nuclear cooperation further eroded. The Kennedy administration was more interested in centralizing control of U.S. nuclear forces and less on facilitating emergent nuclear programs.[41] De Gaulle spurned President Kennedy's offer to help the French nuclear program if Paris would stop testing in the atmosphere.[42] Unlike the United Kingdom, which made concessions on its nuclear program to maintain the NATO alliance,[43] de Gaulle reoriented French foreign policy on NATO and suggested a U.S.-UK-French tripartite decisionmaking body on nuclear issues. When the United States rebuffed this proposal in 1966, France dramatically reduced its NATO role.[44] France pursued a more independent nuclear force during the Johnson administration. In response to French withdrawal from NATO, the United States no longer supported these formerly NATO forces with the U.S. nuclear arsenal.[45]

Toward Trepid Cooperation

Despite these public tensions, however, the United States progressed toward "quiet" and "sometimes highly secret" coordination with France once its nuclear program advanced past first generation devices.[46] After de Gaulle's departure, tensions eased and the United

37. Scheinman, *Atomic Energy Policy*, 13–14.
38. Norris et al., *Nuclear Weapons Databook*, 7–8.
39. Stanford Research Institute, *New Perspectives in U.S.-French Nuclear Relations*, Research Memorandum SSC-RM-8974-2, August 1972, partially declassified and released under the Freedom of Information Act, cited in Norris et al., *Nuclear Weapons Databook*, 190–191.
40. Goldstein, *Deterrence and Security*, 192.
41. Ibid., 194.
42. France argued it was not bound to the LTBT and had not advanced to the point where its testing program could move underground. For more, see Bertrand Goldschmidt, "The Origins of the French Nuclear Programs," lecture at The Wilson Center, Smithsonian Institution Building, Washington, DC, June 12, 1986, cited in Norris et al., *Nuclear Weapons Databook*, 206.
43. Goldstein, *Deterrence and Security*, 147–148.
44. Scheinman, *Atomic Energy Policy*, 187–188.
45. U.S. Air Force (USAFE Historical Division), *FRELOC: The Withdrawal from France, April 1966–April 1967*, vol. 1, 1; Jean Lacouture, *DeGaulle: The Ruler 1945–1970* (New York: W.W. Norton & Co., 1992), 363–386.
46. This included a 1961 agreement for indirect assistance on nuclear designs that ended after the French pullout from NATO. For more, see Scheinman, *Atomic Energy Policy*, 189–190; Goldstein, *Deterrence and Security*, 194.

States gradually came to accept the reality of the French arsenal, and informal coordination started in 1972. Until a formal agreement in 1985, this assistance was "under the table" and helped France catch up in the arms race.[47] The Nixon administration considered past U.S. opposition to France's nuclear program as ineffective and counterproductive to broader foreign policy goals during the Cold War.[48] The Soviet Union had reached relative parity with the U.S. nuclear force, and U.S. troop withdrawals from Europe necessitated a renewed U.S.-Western European alliance.

One of the major types of assistance the Nixon administration offered France was "negative guidance" on its nuclear program.[49] Although U.S. scientists were prohibited from transferring weapon design information, they would confirm or deny French hypotheses on nuclear questions, for example those relating to multiple independently targetable reentry vehicles or advanced missile systems.[50] Later, this cooperation became a two-way street. For example, France shared data on atmospheric tests the United States was prohibited from conducting after the LTBT.[51] U.S.-French nuclear cooperation finally reached the levels of U.S.-British cooperation (e.g., exchange of classified information, nonnuclear material, and equipment) after a formal Agreement for Cooperation was completed in 1985.[52]

The United States would often have to defend French testing activities when concerns were raised by others. The Soviet Union, for example, threatened to resume nuclear testing after French nuclear experiments during the 1960s. Soviet negotiator Semyen Tsarapkin called on the United States and United Kingdom to rein in their ally, stating that the Soviet Union was "not prepared to accept inferiority in regard to NATO."[53] In response, U.S. officials argued Washington "has not encouraged the French tests" and "has no power to stop them."[54]

1990s Moratorium

During CTBT negotiations in the 1990s, U.S. officials expressed frustration at continued French testing. The United States urged France to extend its 1992 moratorium, but France was concerned test detonations may have been necessary to calibrate its PALEN test simulation equipment. These apprehensions caused Paris to hesitate on an indefinite extension.[55]

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47. Norris, Burrows, and Fieldhouse argue this cooperation was illegal; no formal cooperation agreements were in place. For more, see Norris et al., *Nuclear Weapons Databook*, 190–191.

48. Richard H. Ullman, "The Covert French Connection," *Foreign Policy* 75 (1989), 3–33; Goldstein, *Deterrence and Security*, 198.

49. Goldstein, *Deterrence and Security*, 199.

50. Norris et al., *Nuclear Weapons Databook*, 192.

51. Ibid., 193.

52. Ibid., 193–195; Charles Mohr, "U.S. Secretly Helped France Develop Nuclear Weapons, an Expert Writes," *New York Times*, May 28, 1989, http://www.nytimes.com/1989/05/28/world/us-secretly-helped-france-develop-nuclear-weapons-an-expert-writes.html.

53. "Stop French Tests, Russia Warns," *Los Angeles Times*, May 19, 1961, 18.

54. Ibid.

55. French President Mitterrand said in May 1994 that France would not resume testing during his term, predicting his successor would follow suit "for fear of offending the whole world." For more, see Larkin, *Nuclear Designs*, 92, 88.

When France conducted a round of testing from 1995–1996, antinuclear movements organized a boycott of French goods, and international pressure helped convince France to significantly constrain its testing activities.[56]

Although France supported nonproliferation efforts when CTBT talks began in 1994, Paris nonetheless rejected any treaty meant to start a process of "denuclearization" without participation of all "threshold countries."[57] Ambassador Thomas Graham, Jr., former head of the Arms Control and Disarmament Agency and senior arms control negotiator, wrote that French tests in the 1990s, however, "were one of the best things that happened in the CTBT negotiation. As a result of this experience, the French really got religion . . . and they became one of the strongest supporters of CTBT, having been one of the most recalcitrant."[58]

When Our Rivals Test

Unfortunately for the United States, more than just its allies have decided to join the nuclear club through nuclear testing. Rivals such as the Soviet Union, China, and North Korea have tested over the years. U.S. responses to these developments have varied over the years and since the end of the Cold War. After tests by Russia and China, the United States largely focused on practical responses to manage the consequences of a test—reassuring allies on their defense needs, discouraging proliferation in response, and adapting U.S. defense strategies—rather than seeking to entirely rollback their emerging nuclear programs. Although denuclearization was a primary initial goal after North Korea's tests, the U.S. response has gradually turned to these similar crisis management activities.

SOVIET UNION/RUSSIA

The Soviet Union conducted its first nuclear test—code-named RDS-1—at the Semipalatinsk Test Site in Kazakhstan in August 1949.[59] Joseph Stalin formally approved the initial Soviet bomb project in summer 1942, though the effort became a priority after the successful conclusion of the Manhattan Project in 1945.[60] The Soviet Union conducted 715 nuclear tests in total. The U.S. response initially focused on enhancing its defense capabilities and strategy to manage nuclear deterrence and the concerns of allies. Later, arms control and nonproliferation efforts tried to mitigate the environmental and security consequences of nuclear testing. During the Cold War, U.S. responses took place within a

56. Gail Russell Chaddock, "Firestorm of Protest Radiates From Pacific," *Christian Science Monitor*, August 11, 1995, 1, http://www.csmonitor.com/1995/0811/11014.html; Philip Hay, "Pacific Critics Use a Megaphone Against Chirac: Amplified Denunciations May Finally Get France to Stop its Nuclear Testing," *Christian Science Monitor*, November 7, 1995, 18, http://www.csmonitor.com/1995/1107/07181.html.

57. Statement of the French representative to the Conference on Disarmament, Geneva, February 7, 1994.

58. Thomas Graham, Jr., *Disarmament Sketches: Three Decades of Arms Control and International Law* (Seattle: Washington University Press, 2002), 248.

59. RDS-1 was an acronym for the phrase "Russia makes (or does) it by itself." For more, see Thomas Cochran, Robert S. Norris, and Oleg A. Bukharin, *Making the Russian Bomb: From Stalin to Yeltsin* (Boulder: Westview Press, 1995), 13.

60. Meyer, *The Dynamics of Nuclear Proliferation*, 168–169.

superpower rivalry that necessitated consideration of both military and diplomatic factors in decisionmaking.

Early Days

The United States learned about the first Soviet nuclear tests after a weather reconnaissance plane on a routine patrol picked up telltale radiological debris.[61] When the Truman administration publicly announced the Soviet test on September 23, 1949, it claimed the event had been long anticipated. U.S. intelligence services, however, were surprised because they predicted the Union of Soviet Socialist Republics (USSR) was several years away from nuclear weapons capability.[62] One of the first major U.S. responses to the test was an interagency report in April 1950, NSC 68, which recommended greater defense spending and the reorganization of the U.S. defense and intelligence services to counter the USSR breaking the nuclear monopoly.[63]

Truman further responded by seeking guidance from his scientific and military advisers on whether to accelerate development on a thermonuclear or hydrogen fusion bomb.[64]

In 1954, some scientists proposed an international moratorium on nuclear testing that aimed to "prevent the development of much larger yield weapons," including the hydrogen bomb.[65] President Eisenhower, however, rejected the idea because he doubted that the Soviet Union would ultimately adhere to the freeze. On August 12, 1953, the USSR claimed it broke the U.S. H-bomb monopoly. Thermonuclear tests were also successful in November 1955.

Throughout the Cold War, the United States and the Soviet Union conducted not only nuclear tests but also public propaganda campaigns to justify their own experiments and delegitimize others. During LTBT negotiations, for example, the USSR blamed the United States, the United Kingdom, and France for having "torpedoed" a global moratorium on testing, which justified a resumption of Soviet testing.[66] Secretary of State John Foster Dulles warned Russia that if it continued testing during negotiations, it would face "worldwide condemnation" in the hearts and minds of member states of the United Nations.[67] These events demonstrate the use of ongoing test ban and nonproliferation negotiations as sources of legitimacy to denounce the testing activities of others. In other cases, for

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61. Kenneth Condit, *History of the Joint Chiefs of Staff: The Joint Chiefs of Staff and National Policy, Volume II, 1947–1949* (Washington, DC: Office of Joint History, Office of the Chairman, Joint Chiefs of Staff, 1996), 279–280, http://www.gwu.edu/~nsarchiv/nukevault/ebb286/doc01.pdf.

62. William Burr, "U.S. Intelligence and the Detection of the First Soviet Nuclear Test, September 1949," *National Security Archive Nuclear Vault,* September 22, 2009, www.gwu.edu/~nsarchi/nukevault/ebb286/.

63. Ibid.; "A Report to National Security Council—NSC 68," April 12, 1950, *Truman Library*, President's Secretary's File, Truman Papers, www.trumanlibrary.org/whistlestop/study_collections/coldwar/documents/pdf/10-1.pdf.

64. Richard Rhodes, *Arsenals of Folly: The Making of the Nuclear Arms Race* (New York: Vintage Books, 2008), 75.

65. Thomas E. Murray, *Nuclear Policy for War and Peace* (New York: World Publishers, 1960), 75–76.

66. "Russia Blames West for Nuclear Test Renewal," *Los Angeles Times*, January 4, 1962, 5.

67. Joseph Hearst, "Dulles Warns Russia on New Nuclear Tests," *Chicago Daily Tribune*, November 8, 1958, 3.

example late-1970s negotiations on a comprehensive test ban, nuclear powers used pending treaties as excuses to finish a planned series of nuclear tests before their window of opportunity closed.[68] Although the U.S. government would often publicly announce information on Soviet testing activities through official statements and the press, other times it would only raise public concerns on tests with special interest "because of their size, their special character or some other unusual fact."[69] These responses indicate the United States valued flexibility in how to respond to Soviet tests, especially during periods where U.S. testing ambitions were fervent.

Squabbling over Peaceful Nuclear Explosions

During the 1960s and 1970s, the United States and the Soviet Union conducted experiments on Peaceful Nuclear Explosions (PNEs) and their possible nonmilitary applications.[70] Proponents suggested PNEs could use the explosive force of a nuclear device in massive construction projects such as digging canals, stimulating oil and gas deposits, and creating underground cavities. Advocates also contended that PNEs could help the United States earn diplomatic leverage by offering PNE technology or services to nonnuclear weapon states as a reward for nonproliferation. After a number of these detonations, both countries exchanged diplomatic inquiries on the event and whether they violated the recent PTBT. For example, after the USSR conducted a PNE on January 15, 1965, the State Department sent an Aide-Mémoire to the Soviet Embassy who expressed concern that future experiments that release debris outside Russian borders "could jeopardize the very existence of the Treaty, a consequence which the United States would view as extremely serious."[71]

According to Tannenwald, the U.S. effort (Project Plowshare) and other PNE activities eventually fell out of favor due to three major factors: (1) conflict with arms control objectives, (2) harmful environmental effects, and (3) uncertain economic benefits.[72] Nevertheless, the promised benefits of these devices—and their similarity to nuclear weapons—encouraged nations such as India to explore PNEs.

Accusations during the 1990s

Even after the CTBT, nations accused each other of resuming nuclear testing. The Clinton administration suspected that Russia conducted a nuclear test near Novaya Zemya in

68. Gaylord Shaw, "Nuclear Tests Flourish in U.S., Russia: Both Seem in Rush to Get Data Before Ban Blasts," *Los Angeles Times*, September 1, 1978, B14.

69. "U.S. Reveals New Nuclear Test by Russia," *Chicago Daily Tribune*, March 10, 1957, 14; Robert C. Toth, "Underground Nuclear Test Reported in Russia," *Los Angeles Times*, November 17, 1964, 11; "Russia Resumes Tests of Nuclear Weapons," *Los Angeles Times*, August 5, 1955, 7.

70. Scott Kirsch, *Proving Grounds: Project Plowshare and the Unrealized Dream of Nuclear Earthmoving* (New Brunswick, NJ: Rutgers University Press, 2005); Cochran et al., *Making the Russian Bomb,* 45; Glenn Seaborg and Benjamin Loeb, *Stemming the Tide: Arms Control in the Johnson Years* (Lexington, KY: Lexington Books, 1987), 321, 346–350.

71. "Aide-Mémoire From the Department of State to the Soviet Embassy," *Foreign Relations of the United States, 1964–1968, Vol. XI,* Arms Control and Disarmament, Document 76, May 18, 1965, http://history.state.gov/historicaldocuments/frus1964-68v11/d76.

72. Tannenwald, *The Nuclear Taboo*, 268–273.

August 1997.[73] After accusing Russia of nuclear test preparations in May 2002, the Bush administration's Nuclear Posture Review suggested it was necessary to shorten the time necessary for the United States to resume tests of its own.[74] Russia denied both allegations, but these events underline the difficulties facing U.S. responses when evidence of nuclear tests may be limited.

CHINA

China conducted 48 nuclear tests since its first—code-named 596—in the Taklamakan desert in October 1964.[75] This was followed by a thermonuclear weapon test in June 1967 and then a regular schedule of testing in the following decades until its last detonation in July 1996.[76] U.S. responses to China's nuclear testing ranged from initial deliberations on a preemptive military strike to managing the concerns of India and others that might have then felt the need to respond with arsenals of their own.

1964 Test: "Strangling the Baby in the Cradle"

China justified its nuclear test as a way to maintain peace and protect its security. Through a secret Soviet-Chinese nuclear sharing agreement in 1957, the Soviet Union provided several years of training and technical assistance in nuclear science and engineering before the arrangement ended by 1960.[77]

The U.S. government debated a range of policy approaches in response to China's emerging nuclear force. U.S. intelligence picked up signs that China was about to test and leaked the information to reduce any panic that a surprise test might cause.[78] Air Force planners suggested the United States disperse nuclear weapons to its allies and other potential partners in the region, including India.[79] A few years before the 1964 test, the State Department undertook an overt and covert public information campaign to mold

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73. Britain and Norway disagreed with this assessment. For more, see Steven Lee Myers, "U.S. Suspects Russia Set Off Nuclear Test: Asks for Explanations of a 'Seismic Event,'" *New York Times*, August 29, 1997, http://www.nytimes.com/1997/08/29/world/us-suspects-russia-set-off-nuclear-test.html.

74. Thom Shanker, "Administration Says Russia is Preparing Nuclear Tests," *New York Times*, May 12, 2002, www.nytimes.com/2002/05/12/world/administration-says-russia-is-preparing-nuclear-tests.html; John Diamond, "U.S. Plans to Revamp Nuclear Strategy," *Chicago Tribune*, January 10, 2002, http://articles.chicagotribune.com/2002-01-10/news/0201100260_1_nuclear-weapons-nuclear-testing-nuclear-posture-review.

75. "596" referred to June 1959, the year and month that Khrushchev denied Chairman Mao a nuclear weapon prototype.

76. Larkin, *Nuclear Designs*, 84.

77. John W. Lewis and Xue Litai, *China Builds the Bomb* (Stanford: Stanford University Press, 1988), 41, 61.

78. On September 29, 1964, U.S. Secretary of State Dean Rusk announced that the United States believed China would conduct an atmospheric nuclear test in the near future. For more, see George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation* (Berkeley: University of California Press, 1999), 65.

79. Memorandum from Lt. General John K. Gerhart, Deputy Chief of Staff, Plans & Programs, U.S. Air Force, to Air Force Chief of Staff Thomas White, "Long-Range Threat of Communist China," February 8, 1961, National Security Archive, Washington, DC, www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB38/document1.pdf.

world opinion, especially in Asia, before China's test became a reality.[80] Secretary of State Dean Rusk and other planners advocated reassuring existing allies of U.S. treaty commitments, communicating to India "public declarations of willingness to provide nuclear defense," offering to "deploy nuclear weapons in the event of nuclear threats," and undertaking possible U.S.-Soviet collaboration to encourage China to join a test ban.[81] Finally, some sources indicate that the Kennedy and Johnson administrations briefly deliberated possible military action against Chinese nuclear facilities to "strangle the baby in the cradle" before Beijing acquired a nuclear weapon.[82] Coordination of these attacks with Chinese Nationalists on Taiwan was also discussed.[83]

The Johnson administration ultimately decided against military action once China finally tested in October 1964 unless China first launched an aggressive act against others in the region.[84] The Soviet Union rebuffed U.S. proposals to jointly respond to the test.[85] Contrary to the expectations of China's leaders, the nuclear test did not prompt the United States to immediately support its bid to take over Taiwan's seat at the United Nations Security Council. It was not until the United States recognized benefits of greater Sino-U.S. ties to counter the Soviet Union that Washington stopped blocking this transfer of power.[86]

India was a major target of U.S. diplomatic efforts after the 1964 test. Indian Prime Minister Lal Bahadur Shastri said the detonation had come to the whole world as "a shock and danger to the maintenance of peace."[87] Internal debate within New Delhi examined

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80. Memorandum from Undersecretary of State for Political Affairs George McGhee to Assistant Secretary of State for Public Affairs Robert Manning, "Program to Influence World Opinions with Respect to a Chicom Nuclear Detonation," National Security Archive, Washington, DC, September 24, 1962, www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB38/document4.pdf.

81. Memorandum from Secretary of State Rusk to President Johnson, "Items for Evening Reading," May 1, 1964, enclosing W.W. Rostow, Chairman, Policy Planning Council to the President, "The Implications of a Chinese Communist Nuclear Capability," National Security Archive, Washington, DC, April 30, 1964, www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB38/document12.pdf; Letter from Undersecretary of State for Political Affairs W. Averell Harriman to President John F. Kennedy, Library of Congress, W. Averell Harriman Papers, January 23, 1963, www.gwu.edu/~nsarchiv/NSAEEB/NSAEBB38/document5.pdf; Memorandum from Deputy Under Secretary of State Llewellyn E. Thompson to Secretary of State Dean Rusk, "Review of Non-Proliferation Policy," cover attachment to Defense Department staff study, "U.S. Nuclear Assistance to Pacific-Asian Countries," National Security Archive, Washington, DC, December 4, 1964, 1.

82. Gordon Chang, "JFK, China, and the Bomb," *Journal of American History* 74, no. 4 (1988), 1289–1310; William Burr and Jeffrey T. Richelson, "Whether to 'Strangle the Baby in the Cradle': The United States and the Chinese Nuclear Program, 1960–64," *International Security* 25, no. 3 (2000), 78, http://belfercenter.ksg.harvard.edu/files/burr_and_richelson_winter_00_01.pdf.

83. Memorandum for McGeorge Bundy, "Meeting of General Chiang Ching-kuo with the President," *JFK Library*, National Security Files, Countries, box 24, China General, September–October 1963, September 10, 1963, www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB38/document9.pdf.

84. U.S. intelligence was surprised that the device contained Uranium-235 rather than the expected use of plutonium as a fuel, which prompted questions on the source of the uranium. For more, see Glenn T. Seaborg, Chairman, Atomic Energy Commission, Diary Entry for 20 and 21 October 1964, *Journal of Glenn Seaborg*, vol. 9 (Lawrence Berkeley Laboratory, University of California, 1979), www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB38/document19.pdf.

85. Burr and Richelson, "Whether to '*Strangle the Baby in the Cradle,*" 56.

86. Goldstein, *Deterrence and Security*, 119.

87. U.S. Embassy in New Delhi to State Department, cable no. 1203, October 17, 1964, 1, National Security Archive, Washington, DC, http://nsarchive.chadwyck.com/nsa/documents/NP/01002/all.pdf.

the relative benefits of an Indian bomb, but Indian leaders remained cautious of moving ahead on military applications of nuclear science.[88] Shastri looked for security guarantees from the United States and the Soviet Union against the Chinese nuclear threat.[89] President Johnson tried to reassure India by offering vague assurance for nonnuclear weapon countries to count on "strong [U.S.] support" if nonnuclear weapon states faced "some threat of nuclear blackmail."[90] After controversy within India, China, and elsewhere in reaction to the request, Shastri walked back the suggestion, and neither the United States nor Soviet Union fully embraced the idea.[91]

Another U.S. proposal aimed at India involved U.S. Atomic Energy Commission (AEC) officials offering to help nonnuclear countries with PNE projects to discourage indigenous proliferation efforts and offset the impact of China's 1964 test. According to George Perkovich, Vice President for Studies at the Carnegie Endowment for International Peace, some evidence suggests that the Indian AEC requested blueprints for a U.S. PNE device.[92] The U.S. AEC circulated a "discussion paper" that figured if the United States offered its Plowshare device for use in India, "it could help deter India from embarking on an independent device development program of its own."[93] In the end, however, these exchanges were abandoned because they conflicted with broader official U.S. nonproliferation goals. Instead of acquiescing to India's request for security guarantees or technical assistance, Washington pressed ahead on negotiating the eventual NPT.[94] India continued to request help on PNEs,[95] and its 1964 test detonation claimed to be a peaceful nuclear device.

1990s Testing before CTBT

China conducted 13 nuclear tests during the 1990s as negotiations on the CTBT ramped up. China's neighbors pushed Beijing to stop testing, including Japan, which froze some of its economic assistance to China.[96] The treaty was a priority for the Clinton administration, which tried to create an international environment more conducive to the talks by encouraging a halt to testing during this period. In terms of China, one example of this approach was an offer in October 1994 to assist China with test simulation equipment.[97] U.S. Secretary of Defense William Perry suggested to Chinese Defense Minister Chi Haotian that these advanced simulation technologies could take the place of nuclear

88. Perkovich, *India's Nuclear Bomb*, 64–65.
89. A.G. Noorani, "India's Quest for a Nuclear Guarantee," *Asia Survey* 7, no. 7 (1967), 490–502.
90. Seaborg and Loeb, *Stemming the Tide*, 115–116.
91. Perkovich, *India's Nuclear Bomb*, 87–88.
92. Ibid., 90–91.
93. United States Atomic Energy Commission, "Discussion Paper on Prospects of Intensifying Peaceful Atomic Cooperation with India," forwarded to Ambassador Llewellyn E. Thompson, National Security Archive, Washington, DC, November 23, 1964, 4, http://nsarchive.chadwyck.com/nsa/documents/NP/02643/all.pdf.
94. Perkovich, *India's Nuclear Bomb*, 99.
95. Ibid., 92–93, 96.
96. Matin Zuberi, "Soviet and American Technological Assistance and the Pace of Chinese Nuclear Tests," *Strategic Analysis* 24, no. 7 (2000), 11–12.
97. Agence France Presse, October 18, 1994 cited in Larkin, *Nuclear Designs*, 61.

tests. Similar technology has been used in the United Kingdom, France, and Russia.[98] China ultimately declined the offer, indicating that the technology was not "politically feasible" because it could be viewed as a proliferation risk by nonnuclear weapon states.[99]

China scholar Hua Di reasoned that "foreign opposition to China's [1996] nuclear tests helped consolidate the Chinese people around the government."[100] Justified by a need to further miniaturize China's warhead stockpile before the CTBT opened up for signature, Hua Di argued that the Chinese "people understand that other nuclear powers have developed and deployed many more generations of nuclear missiles."[101] This experience highlights the difficulty U.S. officials may face in balancing long-term nonproliferation objectives with the need to respond immediately after a test.

NORTH KOREA

North Korea is the most recent country to test a nuclear device after detonations in 2006, 2009, and 2013. The tests were picked up by the United States as well as the CTBT's emerging International Monitoring System.[102] After North Korea's most recent test in 2013, the Institute for Science and International Security assessed that Pyongyang has yet to miniaturize a nuclear warhead capable of delivery by an intercontinental ballistic missile or detonate a thermonuclear device.[103] The U.S. response has been (1) to reassure allies that their security needs will be met after North Korean tests, (2) to encourage China to put pressure on its contacts in Pyongyang, (3) to institute a sanction regime that will change the decision calculus for North Korean leaders, (4) to reduce the threat of sensitive exports out of North Korea, and (5) to bring North Korea back to the negotiation table.

First Impressions: The 2006 Test

North Korea announced its intentions to conduct a nuclear test on October 3, 2006, and made good on that promise with a detonation six days later at its Punggye-ri Nuclear Test

98. David Fishlock, "Vulcan and Helen: Lasers of Unusual Power," *Financial Times*, March 5, 1981; "Nuclear Weapon Testing," Federation of American Scientists, last modified July 9, 2000, www.fas.org/nuke/intro/nuke/test.htm.

99. *Los Angeles Times*, October 21, 1994 cited in Larkin, *Nuclear Designs*, 62.

100. Hua Di, "China's Security Dilemma to the Year 2010," Center for International Security and Arms Control, October 1997, updated version of a paper presented to a conference on "China and World Affairs in 2010," sponsored by Stanford University's Institute for International Studies, February 25–26, 1996, http://www.ciaonet.org/wps/dih01/; Chang, "JFK, China, and the Bomb," 1304.

101. Hua, "China's Security Dilemma to the Year 2010."

102. Tom Z. Collina, "Possible North Korean Nuke Test Shows Power of CTBT Monitoring System," *Arms Control Now*, February 3, 2013, http://armscontrolnow.org/2012/02/03/possible-north-korean-nuke-test-shows-power-of-ctbt-monitoring-system/.

103. David Albright and Andrea Stricker, "ISIS Statement on North Korean Nuclear Test," Institute for Science and International Security, February 12, 2013, http://isis-online.org/isis-reports/detail/isis-statement-on-north-korean-nuclear-test/; for more, see Mary Beth Nikitin, *North Korea's Nuclear Weapons: Technical Issues* (Washington, DC: Congressional Research Service, 2013), http://www.fas.org/sgp/crs/nuke/RL34256.pdf.

Site in the northeast area of the country. U.S. intelligence services, which picked up preparations for a test, questioned whether the device had misfired because its yield was less than one kiloton.[104]

The United Nations Security Council quickly and unanimously adopted Resolution 1718 on October 14; it imposed economic sanctions on Pyongyang, including bans on the export of heavy weapons, dual-use items, and luxury goods to North Korea.[105] The resolution called on North Korea to not conduct any further nuclear tests or ballistic missile launches and to abandon its ballistic missile and nuclear programs in a "complete, verifiable, and irreversible manner."[106] Although the sanctions were the strongest rebuke by the UN Security Council since the Korean War, China blocked more severe measures proposed by the United States and Japan that included possible military enforcement action.[107] Marcus Noland, senior fellow at the Peterson Institute for International Economics, concluded that there was no evidence the sanctions had "any effect on either North Korean's trade in luxury goods with its largest trade partner, China, nor any indirect effect on North Korea's aggregate trade with its two principal partners."[108]

North Korea sought to mitigate the negative reaction to its test by announcing the test ahead of time, professing a no-first use policy, pledging to not transfer nuclear weapons, and promising to test under "safe" conditions.[109] North Korea also agreed to return to the six-party talks—an effort by the United States, South Korea, Japan, China, and Russia to engage with North Korea on its nuclear program—on October 31 after talks in Beijing with the United States and China. Scott Snyder noted that the U.S. delegation "put forward its most explicit pledges to date"—including sanctions relief, security guarantees, and a framework toward permanent peace on the Korean Peninsula—to demonstrate to China and the international community that Washington "had done everything possible to induce North Korea back to diplomacy."[110]

Encore: The 2009 Test

North Korea conducted its second underground nuclear test near its original test site on May 25, 2009. On June 12, 2009, the UN Security Council unanimously passed Resolution 1874, which expanded sanctions, intensified the inspection regime, prohibited future

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104. Robert Burns and Anne Gearan, "U.S.: Test Points to N. Korea Nuke Blast," Associated Press, October 13, 2006, www.washingtonpost.com/wp-dyn/content/article/2006/10/13/AR2006101300576.html.

105. This effort followed Resolution 1695, which targeted sanctions on missile proliferation after North Korea's July 2006 missile test.

106. UN Security Council Resolution 1718, October 14, 2006.

107. Marcus Noland, "The (Non) Impact of UN Sanctions on North Korea," Peterson Institute for International Economics, Working Paper (December 2008), 3, www.iie.com/publications/wp/wp08-12.pdf; "North Korea's Nuclear Test: The Fallout," *Asia Briefing,* November 13, 2006, www.crisisgroup.org/en/regions/asia/north-east-asia/north-korea/B056-north-koreas-nuclear-test-the-fallout.aspx.

108. Noland, "The (Non) Impact of UN Sanctions on North Korea," 9.

109. Scott Snyder, "Chinese-Korea Relations: Political Fallout from North Korea's Nuclear Test," *Comparative Connections*, January 2007, 116, http://csis.org/files/media/csis/pubs/0604qchina_korea.pdf.

110. Ibid., 117.

missile tests, demanded enhanced financial restrictions against North Korea, and banned most conventional arms exports to the country.[111]

The Obama administration pushed for a "unified response" to the test, sending delegations to Singapore, Beijing, Seoul, and Moscow to coordinate views on the event.[112] President Obama also sought to reassure U.S. allies—especially South Korea and Japan—that the United States remained committed to their defense.[113] The Republic of Korea announced that it would join the Proliferation Security Initiative, a U.S.-led effort to interdict suspected transfers to and from states and non-state actors of proliferation concern. On June 17, U.S. naval forces sought to enforce the resolution by tracking a North Korean flagged ship reportedly carrying weapons bound for Myanmar.[114]

Latest Feat: The 2013 Test

On January 24, 2013, North Korea announced its intention to test a nuclear device, which it did near its original test site on February 12. On March 7, the UN Security Council unanimously passed Resolution 2094, which expanded the scope of materials covered by existing sanctions and added further financial sanctions, including blocking bulk cash transfers and identifying additional individuals/entities for asset freezes.[115] The United States has pushed for additional missile defense deployments in Asia and Alaska in response to North Korea's nuclear and missile tests.[116]

Current U.S. strategy, which the administration calls "strategic patience," advocates increasing pressure on Pyongyang through multilateral sanctions while encouraging its leaders to return to the negotiation table.[117] The six-party talks have stalled since April 2009. There are some reports that Chinese leaders are growing increasingly frustrated with North Korean leaders and are considering applying additional pressure relative to the 2006 and 2009 tests.[118]

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111. UN Security Council Resolution 1874, June 12, 2009.

112. "North Korea's Nuclear Test and its Aftermath: Coping with the Fallout," Monterey Institute of International Studies, June 25, 2009, www.nti.org/analysis/articles/north-koreas-nuclear-test-aftermath/.

113. "Obama Vows to Defend Japan with U.S. Nuclear Umbrella," *Agence France Presse,* February 13, 2013, www.defensenews.com/article/20130213/DEFREG03/302130022/Obama-Vows-Defend-Japan-U-S-Nuclear-Umbrella; "Remarks by President Obama and President Lee Myung-bak of the Republic of Korea in joint press availability," *White House Office of the Press Secretary*, June 16, 2009, www.whitehouse.gov/the-press-office/remarks-president-obama-and-president-lee-republic-korea-joint-press-availability.

114. Jay Solomon and Yochi J. Dreazen, "U.S. Keeps Close Eye On North Korean Ship," *Wall Street Journal*, June 24, 2009, http://online.wsj.com/article/SB124571192210838865.html.

115. UN Security Council Resolution 2094, March 7, 2013.

116. "U.S. Beefs Up Missile Shield Against North Korea," *The Japan Times*, March 17, 2013, www.japantimes.co.jp/news/2013/03/17/world/u-s-to-boost-missile-defense-to-counter-north-korea-threat/; Tom Z. Collina, "U.S. Pushes Missile Defense Globally," *Arms Control Today*, November 2012, http://www.armscontrol.org/act/2012_11/US-Pushes-Missile-Defense-Globally%20.

117. Kelsey Davenport, "North Korea Conducts Nuclear Test," *Arms Control Today,* March 2013, www.armscontrol.org/act/2013_03/North-Korea-Conducts-Nuclear-Test.

118. Jia Qingguo, "Shifting Emphasis: Beijing's Reactions to North Korea Nuclear Test," *East Asia Forum*, March 3, 2013, http://www.eastasiaforum.org/2013/03/03/shifting-emphasis-beijings-reactions-to-north-korea-nuclear-test/; Choe Sang-Hun and Chris Buckley, "North Korean Leader Supports Resumption of Nuclear Talks, State Media Say," *New York Times*, July 26, 2013, http://www.nytimes.com/2013/07/27/world/asia/north-korean-leader-said-to-support-nuclear-talks.html; Benjamin Kang Lim, "China Tried to Convince North Korea to Give Up Nuclear Test," Reuters, June 4, 2013, www.reuters.com/article/2013/06/04/us-korea-north-china-idUSBRE95305H20130604.

Aspiring Partners in South Asia

Nuclear weapon tests by India and Pakistan in 1998 offered the first real test of the emerging international norm against testing and the recently negotiated CTBT. The United States has sought at various times to forge partnerships with India and Pakistan. Nuclear tests in May 1998 complicated these efforts and are worth further examination.

INDIA

India conducted a so-called peaceful nuclear explosion in 1974—code-named Smiling Buddha—and a series of nuclear weapon tests in May 1998 at its Pokhran test site. Until these full-scale tests in 1998, India publicly denounced nuclear testing by established nuclear weapon states, which possibly contributed to the widespread negative international response once New Delhi's nuclear activities were discovered.[119] After publicly condemning the tests, the U.S. response to both events established a pattern: (1) seek assurances from India that it would constrain its nuclear activities, (2) attempt to discourage Pakistan from following suit, (3) eventually ease sanctions after modest Indian nonproliferation pledges, and (4) resume normal relations.

Peaceful Disruption: 1974 Test

In the lead-up to India's 1974 PNE detonation at Pokhran, the United States faced a stark choice: (1) encourage proliferation in friendly countries such as Japan and India to counter China and the Soviet Union, (2) provide an expanding nuclear umbrella over allies through a multilateral force or similar arrangement, or (3) pursue a broader nonproliferation agenda. The Gilpatric Committee, a secret panel commissioned by the Johnson administration to study future nuclear weapons policy, unanimously concluded that, "preventing the further spread of nuclear weapons is clearly in the national interest despite the difficult decisions that will be required."[120] Ultimately, the United States went forward on its nonproliferation objectives while making efforts to maintain an extended nuclear deterrent over allies such as NATO, Japan, and South Korea. After a long and contentious NPT negotiation, India announced that it would not join the treaty.[121]

The Gilpatric Committee report also highlighted a central belief of U.S. nonproliferation policy that has operated to this day: "[A]s additional nations obtained nuclear weapons, our diplomatic and military influence would wane, and strong pressures would arise to retreat to isolation to avoid the risk of involvement in nuclear war."[122] This tenet of

119. India and Pakistan supported the 1962 UN General Assembly Resolution "condemning" nuclear tests. For more, see Bunn, "The Status of Norms Against Nuclear Testing," 25, http://iis-db.stanford.edu/pubs/22336/Bunn_Status_of_Norms_Against_Nuclear_Testing.pdf.

120. Roswell L. Gilpatric, Chairman, "A Report to the President by the Committee on Nuclear Proliferation," National Security Archive, Washington, DC, January 21, 1965, 1, http://nsarchive.chadwyck.com/nsa/documents/NP/01104/all.pdf.

121. G.G. Mirchandani, *India's Nuclear Dilemma* (New Delhi: Lancer International, 1992), 149.

122. Gilpatric, "A Report to President by Committee on Nuclear Proliferation," 2.

nonproliferation convention helps explain the growing resistance of the United States to additional countries, including allies, joining the nuclear club.

Despite initially considering sharing PNE technology, India's rising interest in PNEs finally prompted U.S. officials to demarche New Delhi that Washington would see an Indian PNE detonation—if it used plutonium taken from the U.S.-supplied CIRUS reactor—as a violation of the U.S.-India nuclear cooperation agreement.[123] Canada echoed this position on the Canadian-supplied CANDU reactor.[124] India publicly disputed the notion that PNEs were equivalent to an actual weapon.

The United States was surprised by India's 1974 PNE despite a general awareness of its moves in that direction. The official U.S. response to India, drafted by Henry Kissinger, took a relatively neutral tone to avoid adding "to U.S.-Indian bilateral problems and reduc[ing] the influence Washington might have on India's future nuclear policy."[125] Kissinger's immediate goals after the test were two-fold: (1) prevent India from exporting sensitive nuclear materials, technology, or information to countries outside International Atomic Energy Agency (IAEA) safeguards, and (2) discourage future Indian nuclear tests, at least until after the 1975 NPT Review Conference. According to Perkovich, this strategy assumed that overt public pressure on India would inspire additional tests, so the White House focused on offering U.S. nuclear experts to help India with safety and security issues.[126] Kissinger was also concerned that unilateral U.S. export controls would be insufficient and only serve to harm the U.S. nuclear industry.[127] The U.S. Congress, however, took a harsher approach and enacted the 1976 Symington Amendment to the Foreign Assistance Act, which prohibited U.S. economic or military assistance to any country importing enrichment or reprocessing technology outside the IAEA safeguard regime.[128]

Beyond the immediate U.S. response, international efforts looked to tighten the emerging nonproliferation regime and close loopholes that may have aided India's PNE. In the late-1970s, the Zangger Committee—a group of 20 nations who coordinate export controls on sensitive dual-use items—agreed to tougher supply conditions,[129] and the Nuclear Suppliers Group (NSG) emerged out of these deliberations.[130] The United States favored this

123. U.S. Aide-Memoire, August 16, 1970, declassified by the Bureau of Oceans and International Environmental and Scientific Affairs, September 19, 1980, cited in Brahma Chellaney, *Nuclear Proliferation: The U.S.-Indian Conflict* (New Delhi: Orient Longman, 1993), 350–351.

124. Roberta Wohlstetter, *The Buddha Smiles: Absent-Minded Peaceful Aid and the Indian Bomb* (Los Angeles, CA: Pan Heuristics, 1977), 348, http://www.strategicstudiesinstitute.army.mil/pdffiles/PUB893.pdf.

125. Dennis Kux, *Estranged Democracies: India and the United States* (New Delhi: Sage Publications, 1994), 315.

126. Ibid, 185; Perkovich, *India's Nuclear Bomb*, 183–185.

127. Roland Timerbaev, *The Nuclear Suppliers Group: Why and How It Was Created* (Moscow: Center for Policy Studies, 2000), 24–27, http://mercury.ethz.ch/serviceengine/Files/ISN/54944/ipublicationdocument_singledocument/fdcfddb4-b626-4824-ba71-0c19d2442f79/en/nuclear+suppliers+group.pdf.

128. *Foreign Assistance Act of 1961, U.S. Code*, vol. 22, sec. 669 (1976).

129. Robert Beckman, *Nuclear Non-Proliferation* (Boulder: Westview Press, 1985), 229; Perkovich, *India's Nuclear Bomb*, 191.

130. Timerbaev, *The Nuclear Suppliers Group*, 8–11.

multilateral approach as it posed less of a risk to U.S. nuclear industry than unilateral export controls.[131] Canada, however, cut off its nuclear cooperation with India. [132]

The United States tried to prevent Pakistan from following suit and moving toward its own nuclear test. In 1975, the United States offered to sell up to $100 million in conventional arms to Pakistan in an effort to deter Islamabad from feeling bound to go nuclear to meet its security needs.[133] Pakistani officials felt that although the international community stopped short of condemning India for its action, ultimately it was Pakistan that paid the price after the NSG tightened export controls for non-NPT countries.[134] The United States also pressured France to restrain its nuclear exports to Pakistan, including a planned plutonium reprocessing plant that was cancelled in 1978.[135]

The international response to India's 1974 test could be considered a success in one aspect: no additional tests occurred until 1998. Indian scientists involved in the project assumed more tests would follow,[136] but the less than enthusiastic international response, the perceived lack of promised domestic benefits from the PNE, and the national security risks convinced Indian leaders to pause.[137]

Aborted Tests: Mid-1990s

India's nuclear testing decisions tracked a rollercoaster trajectory in the mid-1990s. In the lead up to elections, Prime Minister P.V. Narasimha Rao authorized preparations for nuclear tests to avoid looking "soft" on nuclear issues and national security. The United States, however, discovered these plans, and a "nongovernmental nonproliferation expert" leaked the news in December 1995.[138] Congressional leaders warned that a test would automatically trigger sanctions.[139]

Other U.S. policies, however, pushed India in a countervailing direction. The March 1995 NPT Review and Extension Conference and ongoing CTBT negotiations hinted that India would soon face strong international pressure to denounce nuclear testing and fissile material production.[140] India also responded negatively to the Brown Amendment in September 1995, which authorized the release of previously withdrawn military equipment to Pakistan,

131. Ibid., 24–27; Perkovich, *India's Nuclear Bomb*, 191.

132. Perkovich, *India's Nuclear Bomb*, 63.

133. Ibid., 194–195.

134. Pakistan argued before the IAEA Board of Governors in June 1974 that India's PNE was too similar to a nuclear weapon. For more, see Feroz Khan, *Eating Grass: The Making of the Pakistani Bomb* (Stanford: Stanford Security Studies, 2012), 121.

135. Perkovich, *India's Nuclear Bomb*, 195–196.

136. G.K. Reddy, "India Explodes Nuclear Device Underground," *Hindu*, May 19, 1974, 1.

137. Perkovich, *India's Nuclear Bomb*, 188.

138. Some U.S. officials cautioned against officially leaking the preparations or else stoke nationalist uproar in India that would force Rao's hand. For more, see Perkovich, *India's Nuclear Bomb*, 353, 368; Tim Weiner, "World/U.S. Suspects India Prepares to Conduct Nuclear Test," *New York Times*, December 15, 1995, A9, http://www.nytimes.com/1995/12/15/world/us-suspects-india-prepares-to-conduct-nuclear-test.html.

139. Perkovich, *India's Nuclear Bomb*, 368.

140. C. Uday Bhaskar, "India and the True Spirit of NPT," *Times of India*, March 2, 1995, 10; Goldstein, *Deterrence and Security*, 254.

and India ramped up its test site preparations.[141] Although India publicly denied the accusation, Rao finally decided testing a nuclear weapon at that time was not in India's interest.[142]

Rao's Congress Party lost the elections and a short-lived Bharatiya Janata Party (BJP) government secretly approved and then quickly rescinded authorization for a new round of testing.[143] These preparations were again discovered by the United States in the spring of 1996, prompting the Clinton White House to urge the Hindu Nationalist BJP to restrain its nuclear activities.[144] The coalition government which followed delayed the decision to resume testing, which was advocated by India's nuclear scientists.[145]

New Delhi's support for universal nuclear disarmament notwithstanding, India chose to decline U.S. requests for India to join the CTBT. India was one of three countries to vote against the treaty, and its desire to keep testing options open further isolated it from the international community. The Clinton administration sought to improve U.S.-Indian relations and create a security environment where India would be more inclined to join the test ban.[146] Prime Minister Gujral criticized the treaty in 1997 as a "charade."[147] Nevertheless, Gujral fought against further nuclear testing in favor of focusing on broader Indian security needs.[148]

Breaking a 24-Year Moratorium: The 1998 Test

On May 11, 1998, India simultaneously detonated three nuclear devices at its Pokhran test facility in the Thar Desert. These were followed by two more on May 13.[149] A select group of recently elected BJP leaders had secretly made the decision to test.[150] This time, however, U.S. intelligence failed to detect preparations and ended up learning about the tests from India's official media announcements.[151]

President Clinton said the test "recalls the very worst events of the 20th century."[152] India's follow up detonations on May 13 occurred as the United States started to implement sanctions against India based on the 1994 Nuclear Proliferation Prevention Act.[153] On June

141. Perkovich, *India's Nuclear Bomb*, 366.

142. Rao's economic advisers suggested that the international response to a nuclear test could significantly harm India's fragile economy. For more, see Ibid., 370.

143. Perkovich, *India's Nuclear Bomb*, 374–375.

144. Mark Hibbs, "Indians Deny New Regime Will Lead to Bomb Test, Access Freeze," *Nucleonics Week* 38, no. 49, December 4, 1997, 10; Perkovich, *India's Nuclear Bomb*, 375.

145. Perkovich, *India's Nuclear Bomb*, 376.

146. Ibid, 386.

147. Christopher Bellamy, "India Could Block Nuclear Test Treaty," *The Independent*, June 21, 1996, www.independent.co.uk/news/world/india-could-block-nuclear-test-treaty-1338031.html.

148. Perkovich, *India's Nuclear Bomb*, 401.

149. The quick turnaround time between tests surprised even Indian diplomats and indicated scientists hoped to finish their experiments before the international community could react. For more, see Perkovich, *India's Nuclear Bomb*, 420.

150. Ibid., 412.

151. Ibid., 417; Kamran Khan and Kevin Sullivan, "Indian Blasts Bring World Condemnation; Arch-Rival Pakistan Considers Staging Nuclear Test of Its Own," *The Washington Post*, May 13, 1998, A1.

152. Brian Knowlton, "U.S. Penalties on India Get Scant Support," *New York Times*, May 14, 1998, www.nytimes.com/1998/05/14/news/14iht-policy.t_1.html.

153. Perkovich, *India's Nuclear Bomb*, 420.

18, the United States announced further sanctions that would terminate new commitments of U.S. help for export financing and investments. According to the State Department, U.S. goals were to: (1) send a strong message to other would-be testers around the globe, (2) maximize influence on Indian and Pakistani behavior, (3) halt further testing, and (4) encourage South Asian nations to not deploy or test missiles or nuclear weapons.[154] These efforts, along with sanctions established by Japan, Canada, and others, produced tremendous economic pressures on India.[155] U.S. strategy sought to use this leverage to induce changes in South Asia's nuclear policies and to continue its "strategic dialogue" effort that began the previous year.

PAKISTAN

U.S. officials debated the possibility of a Pakistani nuclear test for decades before it finally happened. For example, a 1981 paper by an official at the Arms Control and Disarmament Agency questioned whether Pakistan could be convinced to not test a weapon, and it suggested Washington encourage a no-first-use-pledge, limitations on deployment, and possible confidence-building measures with India.[156] In 1979, Anthony Lake, Director of the State Department Policy Planning Staff, wrote a memo to Secretary Vance urging a "carrot and stick" approach to Pakistan in pursuit of a "no-test, no-transfer" assurance.[157] Nevertheless, the United States scrambled to respond once Pakistan tested in 1998, acting with initial indignation and eventual tacit acceptance.

The 1998 Test: Following One's Neighbor

After Pakistan conducted a reported five nuclear tests near Chagai in Baluchistan on May 28, 1998, Prime Minister Nawaz Sharif professed that "today, we have settled the score."[158] This was followed by another test detonation on May 30. Pakistan justified its tests to demonstrate its previously opaque nuclear deterrent, to match India, and to act before the CTBT forever closed its window of opportunity.[159] The quick turnaround after India's 1998 tests suggests that preparation had been underway for some time.[160]

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154. "Fact Sheet: India and Pakistan Sanction," *USIS Washington File*, June 18, 1998, cited in Barbara Leitch LePoer, Jonathan Medalia, Dianne Rennack, and Richard Cronin, *India-Pakistan Nuclear Tests and U.S. Responses* (Washington, DC: Congressional Research Service, 1998), 5.

155. For example, India's currency fell six percent against the dollar between mid-May and June 9, its stock index fell 400 points, its credit rating dropped, and $1.17 billion in international lending to India was postponed. For more, see Perkovich, *India's Nuclear Bomb*, 436–437.

156. Lewis Dunn, Arms Control and Disarmament Agency, "Implications for U.S. Policy of a Pakistani Nuclear Test," National Security Archive, Washington, DC, June 11, 1981, https://www.documentcloud.org/documents/347019-doc-6-6-11-81.html; Bureau of Intelligence and Research, U.S. Department of State, "Pakistan and the US: Seeking Ways to Improve Relations," Report 97-PA, National Security Archive, Washington, DC, March 23, 1981, https://www.documentcloud.org/documents/347017-doc-4-3-23-81-inr-report.html.

157. Memorandum from Anthony Lake, Policy Planning Staff, to Secretary Vance, "The Pakistan Strategy and Future Choices," National Security Archive, Washington, DC, September 8, 1979, www.documentcloud.org/documents/347013-doc-2-9-8-79.html.

158. "Pakistan Flexes N-muscle," *Associated Press*, May 28, 1998, www.deseretnews.com/article/632561/Pakistan-flexes-N-muscle.html.

159. Goldstein, *Deterrence and Security*, 255.

160. LePoer et al., *India-Pakistan Nuclear Tests and U.S. Responses*, 4.

After India's 1998 test, U.S. attention immediately turned to Pakistan. According to Perkovich, Sharif waited to "consider Pakistan's options and evaluate how the United States and the international community would punish India and offer rewards for Pakistani restraint now."[161] The Clinton administration—imploring that test restraint "would be a great act of statesmanship"—sent Deputy Secretary of State Strobe Talbott to convince Sharif to not follow India's example.[162] Pakistan was offered a repeal of the Pressler Amendment, restoring military and economic aid.[163] When Pakistan pressed Talbott on the public's desire for tests to match India, he retorted that "the Pakistani public would protest if they didn't have jobs."[164] The delegation also warned any Pakistani nuclear tests would trigger automatic sanctions under the Glenn Amendment.

Despite these overtures, Sharif told President Clinton that the choice "was out of my hands," which some observers took to imply that the Pakistani military high command was ultimately responsible for the nuclear tests.[165] Some scholars argue that the United States could have better empowered Sharif to take on testing advocates within Pakistan if U.S. officials: (1) made its offers/threats in a transparent fashion so the public could better weigh Pakistan's decision, and (2) succeeded in imposing a stronger sanctions regime against India. Pakistani officials were not swayed by the Glenn Amendment because Pakistan had been subject to similar sanctions since 1990.[166] Feroz Khan, a retired Pakistani army general, concluded that given "Pakistan's experience of U.S. abandonment in times of extreme crisis, U.S. offers of aid in exchange for forgoing the opportunity to prove [Pakistan's] nuclear capability appeared no more than a hollow promise and ruse to stop Pakistan from doing the obvious."[167]

Even though there was no formal UN Security Council Resolution calling for a multilateral sanctions regime against India and Pakistan, several countries formed an ad-hoc coalition to inflict economic pressure. The Pakistani economy—dependent on foreign currency flows to service its imports and growing debt—suffered as sanctions on credits and loans from the World Bank and the International Monetary Fund constrained these activities. Pakistan also experienced diplomatic isolation as China and several traditional allies in the Middle East remained on the sidelines.

EFFECT OF INTERNATIONAL RESPONSE ON INDIA AND PAKISTAN

India and Pakistan made modest efforts toward meeting U.S. preconditions. In terms of India, the government announced on May 21 that it would voluntarily follow a testing moratorium, pledge to not transfer nuclear material and weapons, and join confidence-building

161. Perkovich, *India's Nuclear Bomb*, 418–419.
162. LePoer et al., *India-Pakistan Nuclear Tests and U.S. Responses*, 1.
163. Samina Ahmed, "Pakistan's Nuclear Weapons Program: Moving Forward or Tactical Retreat," Joan B. Kroc Institute for International Peace Studies, University of Notre Dame - Occasional Paper Series, vol. 18, no. 2 (February 2000).
164. Khan, *Eating Grass*, 276.
165. Ibid., 11–12; Michael Hirsh and John Barry, "Nuclear Jitters," *Newsweek*, June 8, 1998, 22.
166. Ahmed, "Pakistan's Nuclear Weapons Program," 12.
167. Khan, *Eating Grass*, 277.

measures with Pakistan.[168] The Clinton administration moved to selectively lift a number of sanctions after India and Pakistan met certain conditions laid out in a series of high-level meetings: (1) cessation of further nuclear tests, (2) ratification of the CTBT, (3) a moratorium on weapons-grade fissile material production, (4) a halt on missile flight-tests, (5) assurances against exporting sensitive nuclear material and technology, and (6) a commitment to not deploy missiles and nuclear weapons.[169]

Pakistani officials signaled a willingness to join India on nuclear restraint measures.[170] Sharif announced a unilateral moratorium on testing in September 1998.[171] The White House announced in November 1998 that it would ease sanctions against both countries "in response to positive steps both countries have taken to address our non-proliferation concerns following their nuclear tests."[172] The Bush administration waived most of the remaining sanctions on September 21, 2001.[173] The United States also signed a nuclear-cooperation agreement with India in 2005 and sought waivers for India to receive nuclear fuel exports through the Nuclear Suppliers Group despite its status outside the NPT.[174] The United States, however, has not negotiated similar agreements with Pakistan.

Perkovich concluded that despite these modest concessions, the United States was "unable or unwilling to offer the kinds of inducements" that would encourage India to accept major limitations on its nuclear program, such as a cap on warhead stockpiles, halting work on advanced delivery systems, and joining the CTBT.[175] Indian scientists and weapon designers were eager to move ahead on larger stockpiles and a range of delivery systems. Missile tests continue on both sides.[176] India and Pakistan remain outside of the CTBT. Pakistan has blocked consensus on a work plan to negotiate a fissile material cutoff treaty,[177] remains outside the CTBT, and is continuing to stockpile plutonium at an increasing rate.[178] In recent years, U.S. policy toward Pakistan's nuclear arsenal has focused on more safety and security

168. Perkovich, *India's Nuclear Bomb*, 423; LePoer et al., *India-Pakistan Nuclear Tests and U.S. Responses*, 13.

169. Perkovich, *India's Nuclear Bomb*, 437; LePoer et al., *India-Pakistan Nuclear Tests and U.S. Responses*, 4–5.

170. Ahmed, "Pakistan's Nuclear Weapons Program," 13.

171. Mohammad Nawaz Sharif, "Address by H.E. Mohammad Nawaz Sharif, Prime Minister of the Islamic Republic of Pakistan, to the 53rd Session of the UN General Assembly," September 23, 1998, www.fas.org/news/pakistan/1998/09/12980923.html.

172. "Easing of Sanctions on India and Pakistan," *Office of the White House Press Secretary,* November 7, 1998, www.fas.org/news/india/1998/11/981107-wh1.htm.

173. Alex Wagner, "Bush Waives Nuclear-Related Sanctions on India, Pakistan," *Arms Control Today,* October 2001, http://www.armscontrol.org/act/2001_10/sanctionsoct01.

174. Jayshree Bajoria and Esther Pan, "The U.S.-India Nuclear Deal," *Council on Foreign Relations,* Backgrounder, November 5, 2010, www.cfr.org/india/us-india-nuclear-deal/p9663.

175. Perkovich, *India's Nuclear Bomb*, 438.

176. "India, Pakistan Conduct Missile Tests," *Arms Control Today,* November 2002, www.armscontrol.org/node/2890; John Newland and Fakhar Rehman, "Pakistan Test-Fires Nuclear-Capable Missile that Could Hit Deep Within India," *NBC News*, April 10, 2013, http://worldnews.nbcnews.com/_news/2013/04/10/17685030-pakistan-test-fires-nuclear-capable-missile-that-could-hit-deep-within-india; Heather Timmons and Jim Yardley, "Signs of an Asian Arms Buildup in India's Missile Test," *New York Times*, April 19, 2012, http://www.nytimes.com/2012/04/20/world/asia/india-says-it-successfully-tests-nuclear-capable-missile.html.

177. Peter Crail, "Pakistan Nuclear Buildup Vexes FMCT Talks," *Arms Control Today,* March 2011, www.armscontrol.org/act/2011_03/Pakistan.

178. David Albright and Paul Brannan, "Pakistan Doubling Rate of Making Nuclear Weapons: Time for Pakistan to Reverse Course," *Institute for Science and International Security,* IISS Reports, May 15, 2011, http://isis-online.org/uploads/isis-reports/documents/Fourth_Khushab_Military_Reactor_16May2011_1.pdf.

issues (e.g., protecting Pakistan's arsenal from theft or diversion) and preventing further illicit proliferation export activities such as the A.Q. Khan network.[179]

The response to India and Pakistan's nuclear tests could be considered a success in one aspect: no additional tests occurred since 1998. According to a Congressional Research Service report released soon after the tests, "the historical experience of the five declared nuclear weapon states strongly implies that several tests are needed to develop a single weapon type and turn it into a deployable weapon, and India said it is developing several weapon types."[180] The report also notes that Pakistan could have gained technical advantage by continuing testing.

Tests of an Uncertain Origin: Vela Incident

The United States does not always have the luxury of knowing the origin of a possible nuclear test before deciding its response. On September 22, 1979, a U.S. *Vela Hotel* satellite picked up a "double flash" signal near the Prince Edward Islands off Antarctica. U.S. intelligence debated the possible source of this signal, which some claimed to be a telltale sign of an atmospheric nuclear test denotation. The White House hesitated to release information on the possible nuclear test in fear of starting a public uproar.[181]

The presidential panel that was convened to investigate the matter concluded in 1980 that a micrometeoroid caused a disturbance, citing a lack of radiological debris.[182] Several now declassified national laboratory studies, Defense Intelligence Agency reports, and outside expert opinions argue against this conclusion.[183] A 1980 study by the Stanford Research Institute gave odds of between one billion and one hundred billion to one that the sequence described by the presidential panel occurred.[184]

If it was a nuclear test, then who pushed the button? Scholars have pointed to a possible test by South Africa, Israel, or a joint test between the two nations. Journalist Seymour Hersh quoted former Israeli government officials who told him "that the warhead test that Saturday morning was a low-yield nuclear artillery shell," the third in a series of tests in

179. For an account of U.S. assistance on nuclear security to Pakistan, see Paul Kerr and Mary Beth Nikitin, *Pakistan's Nuclear Weapons: Proliferation and Security Issues* (Washington, DC: Congressional Research Service, 2013), www.fas.org/sgp/crs/nuke/RL34248.pdf.

180. LePoer et al., *India-Pakistan Nuclear Tests and U.S. Responses*, 12.

181. Richard Rhodes, *The Twilight of the Bombs: Recent Challenges, New Dangers, and the Prospects for a World Without Nuclear Weapons* (New York: Vintage Books, 2010), 210.

182. Office of Science and Technology Policy, *Ad Hoc Panel Report on the September 22 Event*, National Security Archive, Washington, DC, May 23, 1980, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB190/09.pdf.

183. Guy Barasch, Los Alamos Scientific Laboratory, *Light Flash Produced by an Atmospheric Nuclear Explosion*, National Security Archive, Washington, DC, November 1979, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB190/02.pdf; Henry G. Horak, Los Alamos Scientific Laboratory, *Vela Event Alert 747*, National Security Archive, Washington, DC, May 1980, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB190/07.pdf; Seymour Hersh, *The Samson Option: Israel's Nuclear Arsenal and American Foreign Policy* (New York: Random House, 1991), 280–281.

184. George N. Oetzel and Steven C. Johnson, "Vela Meteoroid Evaluation," *SRI International*, January 29, 1980, http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB190/05.pdf.

the Indian Ocean, and part of a joint South Africa-Israel test.[185] Assuming Hersh is correct that Israel and South Africa were the source of this event, the apparent response to the nuclear test was denial.[186]

ISRAEL

According to intelligence assessments by U.S. officials, Israel's operational capability emerged around 1971–1972.[187] Israel is an outlier case, however, because it is the only country thought to possess nuclear weapons that has avoided demonstrating its capability through an overt test. Avery Goldstein advances several reasons to explain why Israel eschewed testing: (1) greater confidence in its arsenal's reliability, (2) perceived benefits in having an opaque nuclear posture, and (3) a manageable security environment.[188] Others have suggested that nonnuclear component tests, computer simulations, and assistance from outside parties diminished the necessity of the detonation of a nuclear warhead.[189]

In the 1960s, the United States expressed disagreement on Israel's refusal to join the NPT and its emerging nuclear development.[190] This tension ended, however, when Israeli Prime Minister Golda Meir and President Nixon agreed on a policy of nuclear opacity, which included an Israeli pledge not to test a nuclear device.[191] The United States no longer overtly pressures Israel to join the NPT or give up its arsenal, though Tel Aviv signed the CTBT in 1996.[192]

SOUTH AFRICA

Although South Africa never acknowledged a nuclear test, Pretoria ordered preparations in 1976 on a site in the Kalahari Desert.[193] Plans were made for first a cold test (no chain reaction) of its uranium gun design and later a full-scale test. The Soviet Union discovered these preparations and notified President Carter. After the information leaked to the press, South Africa quickly removed evidence at the site and called off the test.

The Carter White House proceeded to exert pressure on France to end its nuclear energy assistance for South Africa.[194] Carter also privately pressured South African officials

185. Hersh, *The Samson Option*, 271–272; Chris McGreal, "Brothers in Arms: Israel's Secret Pact with Pretoria," *The Guardian (UK),* February 7, 2006.

186. Rhodes, *Twilight of the Bomb*, 211.

187. Avigator Haselkorn, "Israel: An Option to a Bomb in the Basement," in *Nuclear Proliferation: Phase 2*, eds. Robert Lawrence and Joel Larus, (Lawrence: University Press of Kansas, 1974), 149–182; Joseph Cirincione, Jon Wolfsthal, and Miriam Rajkumar, *Deadly Arsenals: Nuclear, Biological, and Chemical Threats* (Washington, DC: Carnegie Endowment for International Peace, 2005), 221–235.

188. For more, see Goldstein, *Deterrence and Security*, 253.

189. Cirincione et al., *Deadly Arsenals*, 225–226; "Israel: The Covert Connection," *Frontline*, PBS Network, May 16, 1989, www.pbs.org/wgbh/pages/frontline/foreign-affairs-defense/.

190. Avner Cohen, *Israel and the Bomb* (New York: Columbia University Press, 1999), 293–320; for more, see Leonard Spector, *The Undeclared Bomb* (Cambridge: Ballinger, 1988).

191. Cohen, *Israel and the Bomb*, 336–338.

192. Cirincione et al., *Deadly Arsenals*, 227.

193. Rhodes, *Twilight of the Bomb*, 203–206.

194. Jeffrey Richelson, *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea* (New York: W.W. Norton, 2006), 281.

against a nuclear arsenal. South Africa ultimately abandoned its nuclear program, dismantled its warheads, and joined the NPT.[195]

Policy Options and Considerations

This paper draws on the surveyed case studies to offer policy options and considerations for the United States to consider should nuclear testing recur. Some reports indicate that North Korea may not yet be out of the nuclear testing game.[196] The United States is closely watching the Iranian nuclear program.[197] If Iranian leaders decide to move ahead on a military program, this decision may require a nuclear test.[198] Several U.S. allies have also been a source of study on whether they might proliferate in the future, including Saudi Arabia,[199] Turkey,[200] Egypt,[201] Jordan,[202] the United Arab Emirates,[203] Japan,[204] and South Korea.[205]

The paper offers the following policy options and considerations:

1. The most meaningful work on nonproliferation is done before test preparations even begin. If the United States waits until after a nuclear test, it is already too late. No country that publicly tested a nuclear device has so far completely rolled back its arsenal.

2. U.S. priorities immediately after a test should focus on preventing additional tests, managing the security concerns of allies and other interested parties, discouraging the transfer of newly acquired nuclear materials and testing data to other aspiring proliferators, and rallying international support for efforts to contain the negative security implications.

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195. Nuclear Threat Initiative, "South Africa Country Profile," February 2013, http://www.nti.org/country-profiles/south-africa/nuclear/.

196. Benjamin Kang Lim, "North Korea Tells China of Preparations for Fresh Nuclear Test," Reuters, February 15, 2013.

197. Nuclear Threat Initiative, "Iran: Country Profile," June 2013, http://www.nti.org/country-profiles/iran/nuclear/.

198. Anthony Cordesman warns, however, that there is "no unclassified way to know how much design and test data Iran has received from the outside, and how much it can hide its efforts and leap frog to some form of weapons deployment." For more, see Cordesman, "Red Lines, Deadlines, and Thinking the Unthinkable"; Beth Duff-Brown, "Hecker Takes Hard Look at North Korea's Nuclear Test," *CISAC*, February 14, 2013, http://cisac.stanford.edu/news/hecker_takes_hard_look_at_north_koreas_nuclear_test_20130214/.

199. Cordesman, "Red Lines, Deadlines, and Thinking the Unthinkable."

200. Rizwan Ladha, "A Regional Arms Race?: Testing the Nuclear Domino Theory in the Middle East," *Al Nakhlam* (Spring 2012).

201. Ibid.

202. Eric Edelman, Andrew Krepinevich Jr, and Evan Braden Montgomery, "The Dangers of a Nuclear Iran: The Limits of Containment," *Foreign Affairs* (January/February 2011): 69.

203. Ibid.

204. Mike Mochizuki, "Japan Tests the Nuclear Taboo," *Nonproliferation Review* 14, no. 2 (2007); Marc Erikson, "Japan Could 'Go Nuclear' in Months," *Asia Times*, January 14, 2003.

205. David Sanger, "In U.S., South Korean Makes Case for Nuclear Arms," *New York Times,* April 9, 2013; Martin Fackler and Choe Sang-Hun, "South Korea Flirts With Nuclear Ideas as North Blusters," *New York Times*, March 10, 2013.

3. Occasionally these priorities may conflict. For example, sanctions and public shaming may harm efforts to use positive inducements and diplomatic entreaties. Likewise, competing U.S. policy goals (e.g., containing a rival) may push some to call for a strong new nuclear power in the region to counter the testing nation. The Obama administration's disarmament goals and the existing international norm against nuclear testing, however, would clash with prospective nuclear ambitions of allies such as Turkey or Japan. Should the international security environment radically change, this aversion to allied proliferation may shift, likely prompting an entirely different set of U.S. responses.

4. The United States should coordinate with its partners early and often after a nuclear test. Ensuring the credibility of U.S. deterrence commitments requires understanding the views of U.S. allies and the internal pressures driving an ally's response to a testing event. Even if the United States is unable to convince an ally to remain outside the nuclear club, steady consultation and listening closely to an ally's concerns may help Washington shape the ally's emerging nuclear force toward the least terrible situation. Consultation also helps prevent U.S. officials from misinterpreting the domestic debate within an allied country during a crisis.

5. Policymakers should seriously consider the sequencing of sanctions and the conditions for their removal. Officials must decide whether to immediately implement the full range of possible sanctions or to gradually ramp up sanctions. Furthermore, setting vague public goals about "reducing tension" or "pledging to constrain nuclear activities" offers flexibility to U.S. responses, but may not result in the specific nonproliferation objectives sanctions are designed to achieve.

6. Diplomatic efforts, even if futile at first, can pay dividends in the end. The experience after North Korean and South Asian tests shows that every effort toward diplomacy must be made as a precondition to achieving international support for stronger sanctions.

7. The CTBT's verification system and the rising capabilities of foreign and private intelligence-gathering tools no longer let the United States decide whether or when to announce tests to the world. Nevertheless, U.S. officials still need to consider whether to release information on test preparations the United States may discover before anyone else. Leaking this information may cause a would-be tester to back down, or it could place tremendous pressure on its leadership to follow through.

8. The most common U.S. approach to reassure allies that their security needs will be met without indigenous nuclear capabilities is to offer advanced U.S. conventional arms and missile defense systems. These offers were made to Pakistan, Japan, South Korea, and other allies over the years and will likely serve as a foundation for future U.S. responses.

9. The United States should consider whether there are opportunities to shore up the nonproliferation regime after a test. The ultimate impact on the NPT regime depends

on who pushed the button. If an NPT outlier such as India, Pakistan, or North Korea tests, the damage might be contained if appropriate efforts are made (e.g., promoting universal adoption of the IAEA Model Additional Protocol, reforming the NPT's withdrawal clause to prevent countries from leaving the treaty after acquiring nuclear assistance, developing new structures such as the Proliferation Security Initiative or NSG). If an NPT mainstay such as Japan or a member of the P-5[206] test, however, the damage may be too great.

10. Finally, whether or not the United States resumes its own nuclear testing will have profound implications for its leverage in responding to future tests by others. Some policymakers and experts contend the United States may need to test again to reassure allies under U.S. security guarantees that the reliability of the U.S. nuclear force remains strong.[207] Recent studies, including one by the National Academy of Sciences, conclude that the arsenal can be maintained without nuclear testing, but this debate will likely come up again in the future.[208] As Ambassador George Bunn notes, the "United States would be singularly unpersuasive in attempting to prevent others from testing if it resumed itself."[209]

Conclusion

Nuclear tests may serve a variety of technical, military, and political goals, but once the device goes critical, U.S. policymakers are compelled to make important strategic and tactical decisions about how to respond. At times in the past, U.S. intelligence services were able to detect test preparations and then put the full force of U.S. diplomatic, military, and economic statecraft to use in protecting U.S. interests. Other times, however, officials were caught surprised and ill prepared.

Although the immediate U.S. response to testing events has changed over time and circumstances, it is clear that policymakers would benefit from readying themselves now for possible future testing aspirants. The most meaningful nonproliferation work should be done before a state prepares for a nuclear test. This is true for how the United States should reply to tests by its rivals as well as possible nuclear aspirations held by its closest allies. Once a country demonstrates its nuclear weapons capability through a test, it may already be too late.

206. The P-5 are the five permanent members of the UN Security Council and also the five nuclear weapons states recognized by the NPT: China, France, Russia, the United Kingdom, and the United States.

207. Jon Kyl, "Why We Need to Test Nuclear Weapons," *Wall Street Journal*, October 21, 2009; Baker Spring, "U.S. Should Reject Ratification of the Comprehensive Test Ban Treaty," *Heritage Foundation*, WebMemo #3272, May 26, 2011, http://www.heritage.org/research/reports/2011/05/us-should-reject-ratification-of-the-comprehensive-test-ban-treaty.

208. National Research Council, *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty* (Washington, DC: The National Academies Press, 2002).

209. George Bunn, "The Status of Norms Against Nuclear Testing," 29.

The Feasibility of Uranium-233 as a Proliferation Pathway for Nuclear Aspirant States

Craig J. Wiener[1]

This paper provides a technical discussion of Uranium-233 (U-233) and will seek to dispel portions of the conventional wisdom regarding the unsuitability of U-233 as a weapons-grade material. This will principally be accomplished through discussion of the Thorium-232 (Th-232)–U-233 fuel cycle, the existing reactor technology that can make use of the thorium cycle, and the proven steps that can be taken to synthesize U-233 while minimizing gamma emitters that are typically thought of as showstoppers for nuclear aspirant states. The paper also provides a broad-based comparative feasibility analysis of nuclear aspirant states that possess baseline capabilities to exploit Th-232 to create U-233 based on indigenous natural resources, existing country-specific civilian reactor technologies, recorded violations of International Atomic Energy Agency agreements, and refusal to sign the Non-Proliferation Treaty Additional Protocols. This country information is cross-referenced against a list of nuclear alliances, military alliances, and technology transfer agreements with states possessing nuclear weapons. The goal is first to clearly outline prima facie concerns that counter-proliferation policymakers and the intelligence community must take into account when evaluating the risk of U-233 as a fissile material, and second to provide a starting point upon which intelligence collection and verification activities may best be focused.

Technical Discussion of the U-233 Pathway

Established nuclear weapons proliferation pathways typically follow two courses of action: (1) time consuming concentration of naturally occurring 0.7 percent Uranium (U)-235[2] to 90-plus percent purity levels, or (2) the complicated chemical separation of Plutonium

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2. U.S. Nuclear Regulatory Commission, *Fact Sheet on Uranium Enrichment,* Office of Public Affairs, (U.S. Government Printing Office, October 2011).

(Pu)-239[3] from spent uranium fuels rods used in nuclear power plants. Both methods are well known to the national security community and sensitized portions of the general public, and they receive ongoing attention in the press. However, there is a third nuclear weapons pathway that receives less attention and cannot be discounted by the nonproliferation and intelligence communities. Creation of U-233 from Thorium (Th)-232 provides an alternative path to acquiring weapons-grade nuclear fissile material for a nation state with an appropriate level of political will, natural resources, existing civil nuclear reactor technology, foreign technical assistance, and indigenous systems engineering capabilities.

There are conflicting views regarding the likelihood of a U-233 nuclear weapons pathway being pursued as opposed to U-235 or Pu-239. Conventional wisdom questions the feasibility of its utilization due to the potential for deadly gamma ray exposure resulting from an associated contaminating isotope, U-232, and its daughter product, Thallium (Tl)-208.[4] Recent research, which appears below, partially addresses this concern. Furthermore, additional evidence points to the viability of this pathway in the modern era. Despite a variety of impediments to traditional technology transfers, imposition of export controls, lack of access to uranium ore, and technological choke points, India was able to develop an indigenous nuclear weapons capability. Other countries may be equally inclined to do the same over time, despite their international treaty obligations.[5]

The implications of reactivated international interest in the thorium fuel cycle requires closer examination in light of evolving technological capabilities, previously declassified technical documents, and recent technology transfer and military sales agreements with and among nonnuclear weapons-possessing states. However, this confluence of factors does not exist in a vacuum. There is an additional salient fact to consider. The failure of a handful of nation states to sign the International Atomic Energy Agency's (IAEA) Non Proliferation Treaty (NPT) Additional Protocols underscores a troubling pattern of unwillingness to increase on-site verification and confidence-building activities; various rationales continue to be proffered to explain this resistance.[6] Unfortunately, many of the states that have refused to sign the Additional Protocols (APs) are the same states that have significant thorium reserves, existing reactor technology, and technical know-how or alliances with

3. U.S. Nuclear Regulatory Commission, *Fact Sheet on Plutonium,* Office of Public Affairs, (U.S. Government Printing Office, October 2003).

4. Jungmin Kang and Frank N. von Hippel, "U-232 and the Proliferation-Resistance of U-233 in Spent Fuel," *Science & Global Security* 9, 1–32.

5. According to the UK National Nuclear Laboratory, "India was until recently prevented from accessing international nuclear technology, including uranium ore and fuel supply and was forced to develop its own technology . . . thorium fits very well with India's goals of wanting to utilise their indigenous reserves and develop indigenous flagship technology." UK National Nuclear Laboratory, *The Thorium Fuel Cycle: An independent assessment* (Warrington, UK: August 2010), www.nnl.co.uk/media/27860/nnl__1314092891_thorium_cycle_position_paper.pdf.

6. Egypt, for example, has explicitly stated that it will not accept additional NPT inspection obligations. "It's necessary to adhere to the principle of not linking the provision of nuclear energy with the acceptance of obligations not specified in treaties and agreements. . . . Egypt will not accept any additional obligations in this matter." "Egypt Refuses to Sign Nonproliferation Protocol," *Global Security Newswire,* December 12, 2007, www.nti.org/gsn/article/egypt-refuses-to-sign-nonproliferation-protocol/.

nations that possess this expertise. Furthermore, a subset of members from the non-AP signatory states and their associated technology transfer relationships have shown a willingness to violate NPT agreements in the past.

There are two main sections to this paper. The first section is a technical discussion of U-233 and the thorium fuel cycle, drawn from existing open source information, which will seek to dispel portions of the conventional wisdom regarding the unsuitability of U-233 as a weapons-grade material. This will principally be accomplished through discussion of the Th-232–U-233 fuel cycle, the existing reactor technology that can make use of the thorium cycle, and the proven steps that can be taken to synthesize U-233 while minimizing gamma emitters that are typically thought of as showstoppers for nuclear aspirant states. The second section provides a broad-based comparative feasibility analysis of nuclear aspirant states that possess baseline capabilities to exploit Th-232 for enrichment to U-233 based on natural resources, existing civilian reactor technologies, violations of IAEA agreements, and refusal to sign the NPT APs. The goal is to clearly outline prima facie concerns counter-proliferation policymakers and the intelligence community must take into account when evaluating the risk of U-233 as a fissile material. This requires an analysis of which nuclear weapons aspirant states may be able to pursue this pathway within their existing infrastructure, how they might be able to acquire threshold quantities for a simple weapon, and where intelligence collection and verification activities may best be focused.

TECHNICAL DISCUSSION OF U-233 AS A WEAPONS-GRADE MATERIAL

Since its discovery in 1942, U-233 has provided a third, well-defined pathway toward the creation of a nuclear explosive device. International attention, safeguards and security programs, and voluntary export control regimes primarily focus on monitoring centrifuge based U-235 enrichment cascades or monitoring the facilities that chemically separate Pu-239 from spent uranium fuel rods harvested from U-235-based nuclear reactor programs. However, the United Kingdom's National Nuclear Laboratory (NNL):

> . . . believes that U-233 should be regarded as posing a comparable level of proliferation risk to High Enriched Uranium (HEU) and comparable with the U-Pu fuel cycle at best; this view is consistent with the IAEA, who under the Convention on the Physical Protection of Nuclear Materials, categorise U-233 on the same basis as plutonium.[7]

There is good reason for the NNL to make this pronouncement in its 2010 analysis of the thorium fuel cycle. The gross weight of a "significant quantity" (SQ) of purified U-233 required for a nuclear device is three times less than the more publicized U-235 isotopic variant. The IAEA defines a SQ relevant to construction of a nuclear weapon to be 25 kilograms of U-235 in HEU; the SQ value for plutonium is set at eight kilograms, as is the SQ for

7. UK National Nuclear Laboratory, *The Thorium Fuel Cycle*, 6.

U-233.[8] The U.S. government is less conservative in its estimates of minimum quantities necessary for the weaponization of U-233, acknowledging sufficiency levels for plutonium and U-233 at the 4 kilogram (kg) level.[9]

U-233, like U-235 (but unlike Pu-239), is viable in both gun-type and implosion weapons designs. The fast critical mass of U-233 is almost identical to that of Pu-239 although the spontaneous fission rate is much lower, reducing to negligible levels the possibility of a spontaneous fission neutron prematurely initiating a chain reaction.[10] U-233 was reportedly used in the 1950s as a viable weapons-grade material during the Operation Teapot Shot Military Effects Test (MET) as part of implosion device testing.[11] A simple gun-type design that brings together two hemispheres of uranium at high speed would probably not need to be tested based on historical evidence.[12] South Africa was sufficiently confident in the principle that it elected to build seven nuclear weapons using a gun-type design.[13]

BACKGROUND ON THORIUM

U-233 does not exist in nature; it is synthetically derived from Th-232. Therefore, a brief discussion of Th-232 is important as background for U-233 proliferation issues. Thorium is a naturally occurring, slightly radioactive metal that was discovered in 1828 by the Swedish chemist Jons Jakob Berzelius, who named the element after Thor, the Norse god of thunder. Thorium exists in nature in a single isotopic form, Th-232, which decays very slowly (its half-life is calculated to be 14.05 billion years).[14] The most common source of thorium is the rare earth phosphate mineral monazite, which contains an average of six to seven percent of the metal but can reach levels as high as 12 percent. Two-thirds of the earth's monazite resides in heavy mineral sand deposits on the south and east coasts of India.[15] Thorium is found in four distinct types of deposits: carbonatite-hosted, placer,

8. National Academy of Sciences, *Monitoring Nuclear Weapons in Nuclear-Explosive Materials* (Washington, DC: The National Academies Press, 2005), 109–182. The IAEA definition of SQ reads: "the approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded. Significant quantities take into account unavoidable losses due to conversion and manufacturing processes and should not be confused with critical masses." International Atomic Energy Agency, *IAEA Safeguards Glossary* (Vienna: International Atomic Energy Agency, 2002), 23, Appendix A.

9. National Nuclear Security Administration, Office of Mission Support, Classification and Controlled Information Division, interviewed by author.

10. Kang and von Hippel, "U-232 and the Proliferation-Resistance of U-233 in Spent Fuel."

11. Defense Threat Reduction Agency, *Operation TEAPOT Fact Sheet* (Ft. Belvoir, VA: Office of Public Affairs, 2007), 5, www.dtra.mil/documents/ntpr/factsheets/teapot.pdf. For a declassified video of the MET test, see www.youtube.com/watch?v=wdORlFLUX9k. Reportedly, the MET test was a tactical weapons test utilizing a mixed core of U-233 and plutonium in a spherical implosion design with a suboptimal yield of 22 kilotons when a 33-kiloton yield was expected. See "Operation Teapot," last modified October 15, 1997, nuclearweaponarchive.org/Usa/Tests/Teapot.html.

12. The "gun-type" Little Boy design used for the U-235 Hiroshima bomb was not tested prior to its use.

13. "Types of Nuclear Weapons," Comprehensive Test Ban Treaty Organization, 2012, http://www.ctbto.org/nuclear-testing/types-of-nuclear-weapons/.

14. "Thorium," U.S. Environmental Protection Agency, March 6, 2012, www.epa.gov/radiation/radionuclides/thorium.html#discovered.

15. "Thorium," World Nuclear Association, June 2013, http://world-nuclear.org/info/Current-and-Future-Generation/Thorium/#.UcWa25rD_IV.

vein-type, and alkaline rock-hosted, although lesser deposit types do exist.[16] One estimate of countries with sufficiently large, reasonably assured reserves and estimated additional reserves of thorium includes the following: India, Australia, United States, Turkey, Venezuela, Brazil, Norway, Egypt, Russia, Greenland, Canada, and South Africa.[17] All told, Th-232 is roughly three to four times more common than uranium and of sufficient geographic diversity to be a concern.[18]

CREATING THORIUM METAL (THORIUM DIOXIDE) AS A PRECURSOR FERTILE MATERIAL

The process for converting monazite to thorium metal is as old as its initial elemental identification and chemical isolation in 1828. A now rudimentary laboratory method for producing high purity thorium metal was discovered and characterized in the open literature in 1925 by Anton Eduard van Arkel and Jan Hendrik de Boer. Using this method, thorium iodide was decomposed on a white-hot tungsten filament creating a crystal bar of pure thorium.[19] In the late 1950s, well after it was publicly acknowledged that fissile U-233 could be derived from Th-232, a U.S. government pilot production plant in Oak Ridge, Tennessee, was able to produce 175 pounds of pure thorium oxide per batch. The thorium oxide at this pilot plant was formed by the calcination of thorium oxalate precipitated under controlled conditions. The methodology and equipment described in the technical report as well as the size of the building used to house the processes lends itself to a small physical footprint.[20] It is likely that the efficacy of chemical engineering methods in this regard have progressed significantly since 1959. Parallel processing of small quantities of thorium oxide or thorium metal, even using the 1950s technology as described in the open source literature, could quickly add up to a significant enough quantity to provide seed stock for U-233 production.

CREATING U-233 AND PROTACTINIUM (PA)-233 IN MODERN THORIUM-BASED REACTOR TECHNOLOGIES

Once monazite is converted into a fertile metal oxide, Th-232 can be used in a variety of reactor technologies as a fuel source that will ultimately generate U-233. This process involves Th-232 absorbing a neutron in the reactor to become Th-233, which quickly decays to Pa-233 and then ultimately becomes U-233. There are up to seven types of reactors that can utilize Th-232 as fuel source. Currently, five varieties exist while two other designs are

16. International Atomic Energy Agency and the OECD Nuclear Energy Agency, *Uranium 2011: Resources, Production and Demand* (OECD, 2012), 34.

17. Ibid, 34.

18. Ibid.

19. M. S. Wickleder, B. Fourest, and P. K. Dorhout, "Thorium," in *The Chemistry of the Actinide and Transactinide Elements Volume 1*, eds. N. M. Edelstein, J. Fuger, J. J. Katz, and L. R. Morss (Netherlands: Springer, 2010), 61.

20. K. O. Johnson and R. H. Winget, *Pilot Plant Preparation of Thorium and Thorium Uranium Oxide*s, ORNL-2853 (Oak Ridge, TN: Union Carbide Corporation, 1959), 6–9, http://web.ornl.gov/info/reports/1959/3445603510742.pdf.

in development.[21] This paper briefly discusses three types of thorium-fueled reactors that can be used to create U-233. The selection of these reactor types for analysis is due to their open fuel source design. An open fuel source design lends itself to the possibility of making U-233 with low levels of U-232, which then can be removed on a rolling basis before the levels of U-232 increase to an undesirable level. An open fuel source design can also facilitate or even require Pa-233 bleed off, which then naturally decays over a 27-day half-life into a pure form of U-233. Whether the bleed off would occur as a U-233 or Pa-233 isotope depends on the type of reactor being used.

OPEN FUEL SOURCE REACTOR TYPES CAPABLE OF FACILITATING THE CREATION OF U-233

Pressurized-Heavy-Water Reactors

Pressurized-heavy-water reactors (PHWRs) typically use unenriched natural uranium as fuel and heavy water (deuterium oxide) as both coolant and moderator. However, the neutron economy of heavy water moderation and precise control of online refueling allow Canada Deuterium Uranium (CANDU) reactors to use a great range of fuels other than enriched uranium, including thorium.[22] CANDU reactors are a type of pressurized-heavy-water reactor first created in the late 1950s. The reactor design allows it to be refueled at full power, a capability provided by the subdivision of the core into hundreds of separate pressure tubes.[23] On-power refueling is one of the unique features of the CANDU system. Due to the low excess reactivity of its fuel cycle, the core is designed to be continuously "stoked" with new fuel, rather than completely changed in a batch process (as in other types of reactor technology).[24,25]

Aqueous Homogenous Reactors

Aqueous Homogenous Reactors (AHRs) utilize thorium salts that are dissolved in a heavy water moderator. The U.S. government investigated this technology in 1955 and generated a detailed design report. According to the report, the reactor system requires only thorium as a fuel supply to generate U-233; start-up would need an initial neutron-producing nuclear material. Although not without technical impediments, including corrosion issues, the design was viable.[26] Current designs use uranyl nitrate to eliminate corrosion problems in stainless steel, a technical impediment referenced in the 1955 report.

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21. They are Heavy Water Reactors, High-Temperature Gas-Cooled Reactors, Boiling (Light) Water Reactors, Pressurised (Light) Water Reactors, Fast Neutron Reactors, Molten Salt Reactors (MSRs), and Accelerator Driven Reactors (ADS). Both MSRs and ADS are developmental. "Thorium," World Nuclear Association.

22. "What fuel cycles can CANDU reactors adapt to?," Canadian Nuclear FAQ, 2011, http://www.nuclearfaq.ca/cnf_sectionA.htm#e.

23. Ibid.

24. Ibid.

25. For a detailed description of CANDU technology, see R.A. Chaplin, "Pressurized Heavy Water Reactors," in *Nuclear Energy and Materials, Volume 1,* ed. UNESCO-EOLSS, http://www.eolss.net/Sample-Chapters/C08/E3-06-02-03.pdf.

26. H. G. Carson and L. H. Landrum, "Preliminary Design And Cost Estimate For The Production Of Central Station Power From an Aqueous Homogenous Reactor Utilizing Thorium-Uranium-233," NPG-112 (Washington, DC: Office of Technical Services, 1995), 26, 73, http://www.osti.gov/bridge/servlets/purl/4351373-e3BsgA/4351373.pdf.

Currently, there are very few AHRs operating in the world, however this may soon change. This reactor type is being considered for the commercial production of molybdenum-99, a fission product and a precursor for technetium-99, an isotope that is used in thousands of medical diagnostic tests daily.[27] Although the particular AHR design under review is intended to use low-enriched uranium as a fuel source to hedge against nonproliferation concerns,[28] the propagation of a modernized AHR design would clearly allow a country to create U-233 from a thorium cycle. Notably, AHRs used for medical isotope production would require hot cells or glove boxes to manipulate the output material. The presence of these items would be easily explainable under export control standards.[29]

Liquid Fluoride Thorium Reactors

Reactor designs specifically for the Th-232–U-233 fuel cycle using fluoride salts are termed Liquid Fluoride Thorium Reactors (LFTRs).[30] LFTRs are a subset of Molten Salt Reactors (MSRs), a technology pioneered in the United States during the 1940s, 1950s, and 1960s. LFTRs utilize thorium fuel and a liquid salt coolant that allows for online refueling and reprocessing. Modern MSRs are in the process of being designed and built by a known exporter of nuclear technology with a spotty record of export control adherence.[31]

MINIMIZING U-233 CONTAMINANTS AND ASSOCIATED GAMMA RADIATION RISKS

A review of the literature for U-233 often reveals authors who state that the gamma radiation emitted as a result of the cocreation of U-232 makes its use as a fissile material for weapons undesirable. Typically, U-232 and Th-228 are formed in the Th-232 fuel cycle, which results in the generation of daughter products Bismuth (Bi)-212 and Tl-208. Both Bi-212 and Tl-208 are energetic gamma emitters and can make U-233 too hot to use when they are present at certain levels. However, there are a variety of methods that can minimize the amount of U-232 and associated daughter products from the decay chain produced by the reactor technologies above.

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27. Stephen Bajork et al., "Aqueous Homogenous Reactor Technical Panel Report," BNL-94462-2010 (Upton, NY: Brookhaven National Laboratory, 2010), 2, http://www.bnl.gov/isd/documents/74698.pdf.

28. Ibid.

29. Typical operations carried out in hot cells include the examination of irradiated fuel and canning materials, experimental chemical reprocessing of spent fuel and irradiated targets, metallurgical research, radioisotope production, and other high-level radiation research work. *Manual on Safety Aspects of the Design Equipment of Hot Laboratories* (Vienna, Austria: International Atomic Energy Agency, 1969), 14, http://gnssn.iaea.org/Superseded%20Safety%20Standards/Safety_Series_030_1969.pdf.

30. David LeBlanc, "Molten salt reactors: A new beginning for an old idea," *Nuclear Engineering and Design* 240 (2010): 1644–1656.

31. Richard Martin, "China Takes Lead in Race for Clean Nuclear Power," *Wired Magazine*, February 1, 2011, www.wired.com/wiredscience/2011/02/china-thorium-power/.

U-232 Minimization in PHWRs

According to researchers it is "practical to use heavy-water reactors (CANDU PHWRs) to produce U-233 containing only a few parts per million (ppm) of U-232 if the thorium is segregated in 'target' channels and discharged a few times more frequently than the natural-uranium 'driver' fuel."[32] This type of fuel cycle can be used to minimize U-232 contaminants with a proper geological analysis of natural thorium ore that is minimally contaminated with Th-230 from intermixed or nearby natural uranium. The presence of Th-230 affects the development of the U-232/U-233 concentration ratio in thorium. This ratio depends upon the fraction of the neutron fluence above six megaelectron volts (MeV) in the thorium target material.[33]

Removal of Pa-233 from a Research Reactor

Removal of Pa-233, an intermediate isotope created during the thorium fuel cycle, offers another way to obtain U-233 with limited U-232 contamination. A recent article in the journal *Nature* outlined a method to irradiate Th-232 with slow neutrons in a research reactor to create Pa-233. This method describes a process that removes irradiated thorium from a small research reactor after one month and chemically separates out Pa-233, which then naturally decays into weapons useable grade U-233 over the course of several months.[34] The analysis in this article calculates that 200 grams (g) of thorium metal could produce 1g of U-233 after the 27-day half-life period. This chemical separation is accomplishable by at least two methods: (1) acid-media techniques and (2) liquid bismuth reductive extraction utilizing standard nuclear-lab equipment and hot cells[35] (not necessarily subject to IAEA safeguards). The acid media techniques described in the article were applied at Oak Ridge National Laboratory in 1964. [36,37] However, follow-on experiments were even more successful in creating almost pure U-233.

Recovery of Pa-233 from Thorium Oxide Rods

Using irradiated pure thorium oxide fuel rods, a series of 10 hot-cell experiments to recover Pa-233 were conducted by the United States in 1967 and were deemed suitable for full scale production. "[The] hot-cell experiments demonstrated the practicability of recovering Pa-233 from nitric acid solutions by adsorption on unfired, powdered Vycor.

32. Kang and von Hippel, "U-232 and the Proliferation-Resistance of U-233 in Spent Fuel."
33. Ibid.
34. Stephen F. Ashley, Geoffrey T. Parks, William J. Nuttall, Colin Boxall, and Robin W. Grimes, "Nuclear Energy: Thorium fuel has risks," *Nature* 492 (2012): 31–33, www.nature.com/nature/journal/v492/n7427/full/492031a.html?WT.mc_id=PIN_NPG.
35. Hot cells can be used to work with nuclear fuel rods or items that are high-energy gamma ray emitters, including some of the chemical extraction steps described in this paper. Different types of hot cells include research and development cells, stack mini cells, and production and dispense cells.
36. Ashley et al., "Nuclear energy," 31–33.
37. J. W. Codding, J. R. Berreth, R. P. Schuman, W. H. Burgus, and R. A. Deal, "Separation and Purification of a Gram of Protactinium 233," IDO-17007 (Washington, DC: Office of Technical Services, U.S. Department of Commerce, 1964), 24.

The U-233 present after the decay of the protactinium would contain only 0.1 to 0.5 ppm of U-232.[38]

Recovery of Pa-233 from AHRs

According to a knowledgeable source, AHRs' ability to facilitate the creation of highly pure U-233 gives the capability to monitor the concentration of Pa-233 in the coolant/fuel in real time as the thorium source is exposed to a neutron flux.[39] This would potentially allow for precise timing of the bleed off of Pa-233 from the primary loop of the reactor system. It is relatively easy to move fuel into and out of the reactor as well as control neutron fluxes; it is one of the more stable core designs.[40] Again, once Pa-233 is precipitated out, it naturally decays into weapons-grade U-233 over the course of several months.

Recovery of Pa-233 from LFTRs

Interestingly, early Oak Ridge designs planned to separate and store Pa-233 every 10 days so it could decay to U-233 without further reactions by neutrons in the reactor. One manner in which Pa-233 can be removed from LFTRs is to use columns of molten bismuth with lithium dissolved in it. The lithium selectively reduces protactinium salts to protactinium metal, which is then extracted from the cycle.[41]

Application of Technical Discussion to Nuclear Weapons Aspirant States

The previous technical section establishes the manner by which U-233 can be created and dispels the typical assumptions regarding U-232 contamination in typical thorium fuel cycles. Based on 1960s technology, U-233 can be created with only 0.1 to 0.5 ppm of U-232 by-products. The creation of U-233 with a minimal level U-232 contamination can be pursued through the use of existing PHWRs.[42] This information, when combined with the radiation exposure data detailed by Kang and von Hippel,[43] clearly establishes the feasibility

38. J. H. Goode and J. G. Moore, "Adsorption of Protactinium on Unfired Vycor: Final Hot Cell Experiments," ORNL 3950 (Oak Ridge, TN: Union Carbide Corporation, 1967), 1, 3, 16, http://web.ornl.gov/info/reports/1967/3445605482064.pdf. Note, Vycor is a brand name of glass.

39. A neutron flux is "a measure of the intensity of neutron radiation, determined by the rate of flow of neutrons." U.S. NRC, "Neutron flux," www.nrc.gov/reading-rm/basic-ref/glossary/neutron-flux.html.

40. July 2013, interview of nuclear engineer by author.

41. Tsuyoshi Nakajimȧ and Henri Groult, *Fluorinated Materials For Energy Conversion* (Oxford, UK: Elsevier, 2005), 562–564.

42. Kang and von Hippel, "U-232 and the Proliferation-Resistance of U-233 in Spent Fuel," 1–32.

43. In 2001, researchers considered a scenario in which a fresh sample of U-233 contained one part per million (ppm) of U-232 with an in-growth of Tl-208. The researchers indicated that a one-year-separated sample of U-233 containing 5 ppm would allow a worker about 80 unshielded contact hours, while a sample U-233 containing 1 ppm would allow 380 working hours to accumulate a 5 rem dose. (A rem, an acronym for *Roentgen equivalent man*, is a measure of an ionizing radiation dosage in humans. A 5 REM accumulated dose of ionizing radiation per year is typically considered the annual limit on intake for radiological worker safety in the United States.) Although typical radiological worker standards in the United States allow for a 5 rem

for a team of workers to manufacture a useable 4 kg fissile core from U-233 without the risk of short-term operator lethality.

However, based on the preceding technical facts, a more effective method might make use of AHR or LFTR designs. Based on the Oak Ridge production data, which synthesized thorium oxide, and the possibility of Pa-233 removal during the open fuel cycle combined with other techniques cited above, about 0.8 tons of thorium metal would be required to produce the 4 kg of U-233 with minimal U-232 contamination required for a simple gun-type weapons design. A 0.8-ton thorium dioxide threshold is achievable through the equivalent of six batches (175-pound yield per batch) under production conditions as described in the Oak Ridge technical report from 1959. Even if the quantity required was one ton of thorium oxide, 11 to 12 batch runs would be needed. This methodology is applicable to AHRs, LFTRs, and Material Testing Reactors (MTRs). MTRs, which are not analyzed in this paper, would also offer a direct creation of Pa-233 from Th-232.

NATIONS THAT MAY BE ABLE TO ACQUIRE NUCLEAR WEAPONS THROUGH A U-233 PATHWAY

This portion of the paper applies a feasibility analysis to a selected set of potential nuclear aspirant states that possess baseline capabilities to exploit the Th-232 fuel cycle.

Creating a list of nuclear weapons aspirant states capable of producing close to pure U-233 requires the application of both objective and subjective analytic processes. The goal of the foregoing analysis is to determine where it may be beneficial for counter-proliferation organizations to apply heightened scrutiny for this nuclear weapons pathway. Although this type of analysis is ostensibly part of the IAEA's mission, the organization has not had an optimal level of success in executing its safeguards operations over the years. Critics state that the "IAEA failed to find existing covert reactors and fuel-making plants . . . [and] still cannot assure the continuity of inspections for spent and fresh reactor fuels that could be processed into bomb usable materials at roughly two-thirds of the sites that it currently inspects."[44] The conclusions in this section provide a reasonable basis for further monitoring.

The objective factors considered in formulating a prima facie list of nuclear aspirant states capable of producing U-233 is based on the following criteria: the possession of significant Th-232 deposits, the possession of operational open fuel cycle reactor technologies identified in the technical review section, and existing military or technology transfer agreements with countries that are known nuclear weapons states or nuclear aspirant states.

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dose per worker per year, India's Bhabba Atomic Research Center was willing to accept a 6.7 person-rem summed dose incurred by workers fabricating a research-reactor core containing 0.6 kg "clean" U-233 containing 3 ppm U-232. Kang and von Hippel, "U-232 and the Proliferation-Resistance of U-233 in Spent Fuel."

44. Henry Sokolski, *Reviewing the Nuclear Nonproliferation Treaty* (Carlisle, PA: Strategic Studies Institute, 2010), 3–4, www.strategicstudiesinstitute.army.mil/pdffiles/PUB987.pdf.

Two additional factors are considered in formulating the list: willful violations of baseline IAEA safeguards agreements and a refusal to sign the NPT APs (or suspension of their agreement). Recent history has shown that baseline safeguards agreements are insufficient to dissuade or detect the creation of a clandestine nuclear weapons program. APs were initiated as a response to the discovery of Iraq's clandestine nuclear weapons program, North Korea's hidden plutonium reprocessing facility, and a loophole that shielded undeclared facilities from IAEA verification. These protocols include environmental sampling, use of no-notice inspections at key measurement points within declared facilities, and an expansion of IAEA's ability to visit any suspect facility as well as investigate questions or inconsistencies in a state's nuclear declarations.[45] A country that possesses Th-232, has the reactor technology and hot cells necessary to create U-233, and is not subject to AP inspections faces a lower chance of IAEA detection of a covert reactor than a country subject to APs. Similarly, siphoning off Pa-233 from an open fuel cycle reactor in a declared facility is more feasible for a country that has not signed the APs agreement.

Analysis of Nations under Consideration as Aspirants Due to Existing Thorium Reserves, Reactor Technology, and Political Intent

The following countries have significant thorium reserves (in ranked order): India, Australia, the United States, Turkey, Venezuela, Brazil, Norway, Egypt, Russia, Greenland, Canada, and South Africa.

A search of the IAEA powered reactor and research reactor databases was conducted to identify countries that possess PHWRs, AHRs, and LFTRs. There are no LFTRs currently in operation. An additional cross check was performed for additional reactors that could be used to create U-233, resulting in the addition of MTRs to the analysis. MTRs that are designed to perform isotopic enrichment were added to the list of PHWRs and AHRs and then compared to the list of nation-states that have not signed the APs agreement. Countries that meet these criteria are Argentina, Brazil, Venezuela, Egypt, and Iran, although to varying degrees across all categories of reactor types.

Countries that have significant nuclear activities and have not signed the APs include Argentina, Brazil, Egypt, Iran, Syria, and Venezuela. Iran signed the APs but later elected to suspend them.[46]

NPT safeguards arrangements are a series of inspections and reports for detecting and deterring the diversion of fissile material for use in nuclear weapons.[47] Since the APs were approved, the IAEA has found that in the past Egypt, Iran, Libya, South Korea, and

45. *International Atomic Energy Agency: Safeguards*, (Washington, DC: Center for Nonproliferation Studies, 2013), 1–2, http://cns.miis.edu/inventory/pdfs/iaea_dept_of_safeguards.pdf.

46. Ibid.

47. For nonnuclear weapon state parties to the NPT, the model agreement can be found in Information Circular 153; "Information Circular 153: The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons," INFCIRC/153 (Austria: International Atomic Energy Agency, 1972), www.fas.org/nuke/control/npt/text/inf153.html.

Syria failed to declare all their nuclear activities as required by their NPT safeguards agreements.[48]

NATIONS EXCLUDED FROM CONSIDERATION

The subjective portion of the country selection process comes from the elimination of certain countries that already have nuclear weapons program experience, whether or not they ultimately succeeded in their efforts. The existing nuclear weapon states and nuclear-armed states were eliminated,[49] as well as nations that either voluntarily disclosed and dismantled their programs or were interdicted through unilateral measures in the recent past.[50] The down selection process must address the potential for some additional states to produce a nuclear weapons breakout capability, based on current capability sets.

Nation States Eliminated from the U-233 Pathway Analysis on the Basis of Near-Term Probability Considerations

South Korea and Japan have the reactor technology, nuclear fuel, and the technical sophistication to build nuclear weapons from plutonium sources; however, they are included in the U.S. policy of extended deterrence and, for now at least, are relying on this agreement despite provocative North Korean behavior. Neither country possesses significant thorium reserves, and as such, neither are good candidates for a U-233 pathway when other more immediate avenues are available. Both countries are NPT members and have signed the APs.

Turkey is an NPT member and has signed the APs. Furthermore, Turkey is an active member of the North Atlantic Treaty Organization and as a result enjoys the benefits of extended nuclear deterrence. Although Turkey possesses significant thorium reserves and

48. Mark Hibbs, "The Unspectacular Future of the IAEA Additional Protocol," *The Carnegie Endowment for International Peace*, April 26, 2012, http://carnegieendowment.org/2012/04/26/unspectacular-future-of-iaea-additional-protocol/ahhz.

49. The nonproliferation literature divides states that possess nuclear weapons into two categories. Category I is comprised of the nuclear weapon states, as defined under the NPT. These countries are China, France, Great Britain, Russia, and the United States. Category II is comprised of nuclear-armed states: India, North Korea, and Pakistan; Timothy McDonnell, "Nuclear Pursuits: Non-P5 nuclear armed states, 2013," *Bulletin of the Atomic Scientists* 69 (2013): 62.

50. The list of excluded countries based on this criterion include Syria, South Africa, Iraq, Libya, and Myanmar. Syria reportedly started to build an unexplained heavy water reactor based on a North Korean plutonium reactor design after the turn of the century. This reactor met an untimely end in 2007 after a targeted air raid. The recent civil war in Syria makes the current regime's ability to reconstitute this program highly unlikely. In 1993, South Africa announced it voluntarily dismantled its nuclear weapons program, and there are no indicators that it is likely to resume those activities. Iraq, whose weapons program was dismantled in the 1990s and who was unable to reconstitute it prior to the 2003 Gulf War, is unlikely to pursue nuclear weapons technology any time soon in light of the recent history of international interdiction. Libya voluntarily abandoned its nuclear weapons program in 2004, has signed the NPT APs, and is currently experiencing considerable domestic strife in the aftermath of the Arab awakening. Myanmar signed a Comprehensive Safeguards Agreement and a Small Quantities Protocol with the IAEA in 1995, and although it has not yet signed the APs, it announced its intention to do so, and therefore is excluded from the analysis.

is technologically sophisticated, it is not considered a nuclear aspirant candidate at this time, despite the political tensions in the Middle East.

Iran, which cannot successfully explain the apparent military dimensions of its nuclear program, is pursuing U-235 enrichment technology and has the precursor capabilities to pursue a Pu-239 pathway as well. As a result of Tehran's large investments in centrifuge technology and increasing public dialogue about pre-emptive strikes against Iran's facilities, Iran would not seem a legitimate candidate for a U-233 pathway. Although this possibility cannot be entirely ruled out, it does not pass a feasibility test at this time.

Technology Transfer Agreements with Known Nuclear Weapons States or Nuclear Aspirant States

Some of the states removed as candidates from this analysis are considered possible enablers for nuclear aspirant states through various technological cooperation agreements. North Korea, Syria, Libya, and Pakistan are considered to be salient and worthy of strict scrutiny based on their capability and, in some cases, their demonstrated willingness to retransfer nuclear weapons knowledge. Russia, China, France, and India cannot be excluded as inadvertent enablers based on economically motivated behavior with regard to nuclear technology transfers. Furthermore, it should be noted that "Argentina, Brazil, Iran, Iraq and Pakistan successfully acquired not only nuclear materials and specially designed or prepared nuclear equipment and components for enrichment and reprocessing, but also dual-use items relevant to enrichment and reprocessing. In some of these cases, they were able to obtain such items from states that did not have adequate export control laws to regulate the transfer of such dual-use items."[51]

PRIMA FACIE ANALYSIS

The remaining countries on the list possess the necessary thorium reserves, reactor technology, know-how, and technology transfer agreements to pursue the U-233 proliferation pathway. Additionally, they have shown a lack of adherence to IAEA safeguards and have refused to sign the APs. Thus, these states are the highest probability candidates to utilize the U-233 proliferation pathway. Table 1 displays key indicators for each potential aspirant state.

Egypt

A review of Egypt's capabilities indicates that the state possesses one of the reactor types that can make use of Cairo's thorium reserves. When combined with the country's ongoing refusal to sign the APs and its existing cooperative agreements with nations willing to export or facilitate nuclear technologies and enabling equipment, a breakout capability

51. Fred McGoldrick, *Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options* (Cambridge, MA: Belfer Center for Science and International Affairs, 2011), 11, http://belfercenter.ksg.harvard.edu/files/MTA-NSG-report-color.pdf.

Table 1. Nuclear Aspirant States' Capabilities to Exploit Th-232 for Enrichment to U-233

Potential Aspirant State	*Possesses Appropriate Level of Thorium Reserves*	*Reactors with Appropriate Technology for Thorium Based U-233 Creation*	*Additional Protocol Status*	*Previous Violations of IAEA Safeguards Requirements Under NPT*	*Nuclear Technology Transfer Agreements or Cooperation with Known Nuclear Weapons States or Potential Nuclear Aspirant States*
Argentina	Yes	EMBALSE PHWR (CANDU) ATUCHA-1 PHWR (CANDU) AHR RA-4 (EX. SUR-100) MTR (RA-3)	Not Signed	No	Iran India China Russia Brazil Egypt
Brazil	Yes	ANGRA-1 PHWR ANGRA-2 PHWR MTR (IEA-R1) (IPEN/MB-01)	Not Signed	No; however limited IAEA inspection of U-235 centrifuge technology in 2004	North Korea India China Russia France Argentina
Venezuela	Yes	PHWR (CANDU)	Not Signed	No	Iran North Korea Russia Argentina
Egypt	Yes	MTR ETRR-2	Not Signed	Violated Safeguards Agreement	India Russia Argentina

must be considered as a possibility. Furthermore, in February 2005, the IAEA reported that Egypt failed to declare 67 kg of imported uranium tetrafluoride, 3 kg of uranium metal, 9.5 kg of imported thorium compounds, and unirradiated fuel rods containing 10 percent enriched U-235. Egypt also failed to declare irradiation of uranium and thorium targets that were dissolved at three laboratories.[52] Egypt's possession of an MTR theoretically allows it to irradiate thorium dioxide to Pa-233. Although Egypt violated the NPT requirements in 2005, the current political turmoil in the country leaves a reasonable doubt as to the current state of political will and state capacity to leverage Egypt's thorium reserves toward pursuit of a U-233 pathway.

Argentina

A review of Argentina's capabilities indicates that the nation possesses PHWRs, an AHR, and an MTR. Argentina's refusal to sign the APs, ongoing cooperative agreements with nations willing to export or facilitate nuclear technologies and enabling equipment, and the presence of large thorium reserves makes this country the most viable nation on the U-233 pathway feasibility list. Argentina is technologically sophisticated enough to leverage a thorium fuel cycle to create U-233 with less than one ppm of U-232 contamination. Interestingly, Argentina also has the most interaction with the other members of the potential U-233 pathway list for the transfer of nuclear technology. Clearly, Argentina has the technological and systems engineering expertise within its borders to pursue a U-233 pathway. Although a bilateral inspection agreement exists between Argentina and Brazil,[53] neither is subject to short notice inspections for the other, although both have refused to approve the APs. The political dynamic between the two states could drive one or the other to pursue weaponization despite being signatories to the NPT and other regional nuclear nonproliferation agreements. A U-233 weapons capability may be seen an intermediate stepping-stone to a more ambitious U-235 or Pu-239 program, especially in light of a political calculus based on fears of Brazilian intentions.

Brazil

A review of Brazil's capabilities indicates that the state possesses PHWRs and an MTR. When combined with large thorium reserves, its refusal to sign the APs, and ongoing cooperative agreements with nations willing to export or facilitate nuclear technologies and enabling equipment, Brazil's viability to pursue a U-233 pathway cannot be discounted. Brazil's bilateral inspection agreement with Argentina[54] does not include short notice inspections, and the tense relationship between the two countries could theoretically motivate Brazil to pursue a military nuclear program. As an emerging world power, the

52. Pierre Goldschmidt, "The IAEA Reports on Egypt: Reluctantly?" *The Carnegie Endowment for International Peace*, June 2, 2009, http://m.ceip.org/2009/06/02/iaea-reports-on-egypt-reluctantly/8fq2.

53. "Agreement between Argentina and Brazil for the Exclusively Peaceful Use of Nuclear Energy (Bilateral Agreement)," Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials, www.abacc.org.br/?p=4143&lang=en.

54. Ibid.

only member of the "BRIC" nations[55] lacking nuclear weapons, and a state in pursuit of a nuclear powered submarine program for power projection, Brazil would only need to make an affirmative political decision to pursue nuclear weapons to actuate its capabilities. Brazil could use a U-233 weapons capability to jump-start a subsequent U-235 or Pu-239 program.

Venezuela

A review of Venezuela's capabilities indicates that the nation possesses a PHWR that could leverage a thorium fuel cycle to create U-233 with a few ppm of U-232 contamination. When combined with large thorium reserves, its refusal to sign the APs, and ongoing cooperative agreements with nations willing to export or facilitate nuclear technologies and enabling equipment, Venezuela's ability to pursue a U-233 pathway cannot be discounted, although it is likely a longer-term proposition. Venezuela, although possessing the fewest reactor types and gross numbers of reactors across all categories, may benefit from its participation in an indirect technology transfer alliance between North Korea and Iran, each of whom has a history of utilizing illicit proliferation networks in furtherance of nuclear programs with military dimensions. The establishment of these relationships, when considered alongside additional military agreements being executed between Venezuela and Russia, seems to require heightened scrutiny from the international community. Due to the ideological stance of the Hugo Chavez government prior to his death and the concomitant antipathy displayed by the regime toward the U.S. government and its allies, Venezuela may have a strong geopolitical motivation to acquire force projection capabilities. Whether the new Venezuelan leader, Nicolas Maduro, continues to pursue a leftist nationalistic agenda with a policy of antipathy toward the United States may be an indicator of whether the international community should apply stricter scrutiny through a variety of intelligence collection methodologies. A rudimentary U-233 weapons capability might be seen internally as a hedge against future U.S. military action.

Conclusion

At least four of the states that have refused to sign the APs to the NPT have sufficient thorium reserves and the appropriate existing reactor technology to pursue a U-233 weapons pathway. Therefore, cooperative international intelligence-gathering efforts may be necessary to determine the praxis between capability and intent as deemed necessary to uncover diversion of Pa-233 or U-233 from an open fuel cycle. There is also the possibility that a country may leverage its technological experience to build a small-footprint, clandestine thorium-fueled facility that would be able to create sufficient amounts of U-233 to build a gun-type nuclear device, akin to South Africa's program. This information can be shared with members of the Proliferation Security Initiative and other existing export control regimes who are encouraged to provide renewed attention to the viability of the U-233 pathway.

55. The BRIC countries are Brazil, Russia, India, and China. They are often grouped together as a class of states in a similar phase of advanced economic growth.

Between the Lines: The B61 Life Extension Program

Lauren Wilson[1]

Plans for the B61 Life Extension Program (LEP) are generating controversy with respect to current U.S. declaratory policy. The most recent modification to the B61 nuclear bomb, the mod-12, will include the addition of a guided tailkit. Critics of the mod-12 argue that the tailkit fits the definition of a "new military capability" and is in defiance of declarations made in the 2010 Nuclear Posture Review (NPR). Proponents argue that the LEP is consistent with declaratory policy, offering numerous benefits for sustainment of the Nuclear Weapons Complex. This analysis aligns the plans of the B61 LEP with the five core objectives of the 2010 NPR, as well as those of current international laws and treaties. The LEP offers improved nuclear surety, 2 effective deterrence and assurance, long-term cost savings, and reduced collateral damage, all while maintaining the course for minimizing U.S. nuclear dependence. Additionally, the definition of "new capability" is explored. As a capability currently utilized on conventional weapons offering no additional destructive capacity, identifying the tailkit as a "new capability" with any degree of certainty is unsound. This paper concludes that the B61 LEP is consistent with the intended path of U.S. and international nuclear policy.

Introduction

Following the end of the Cold War, the cessation of U.S. nuclear warhead production, and the start of a self-imposed nuclear weapons testing moratorium, LEPs became necessary to maintain the nuclear deterrent while pursuing the long-term goal of nuclear disarmament. The LEP approach consists of the refurbishment, reuse, or replacement of aging nonnuclear and nuclear components in the U.S. nuclear arsenal. Nuclear components are only replaced with components that have been tested in previously designed systems.[3] The 2010 NPR

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2. Nuclear weapons *surety* refers to the safety, security, and use control of the weapon.

3. U.S. Department of Defense, Office of the Assistant Secretary of Defense, "DOD News Briefing with Secretary Gates, Navy Adm. Mullen, Secretary Clinton, and Secretary Chu from the Pentagon," April 6 2010, www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=4599.

states that LEPs "will not support new military missions or provide for new military capabilities."[4] This objective has sparked a debate regarding the LEP for the B61 nuclear bomb. Fixation on the "no new capabilities" policy with a "black and white" outlook neglects LEP benefits, while embracing the LEP requires deeper understanding of nuclear policy objectives. This paper assesses the consistencies and benefits of the B61 LEP with respect to current declaratory policy and international law.

THE B61

The B61 nuclear bomb, a Los Alamos National Laboratory design, became part of the U.S. nuclear stockpile in the late 1960s.[5] This weapon has had the longest production run of any U.S. nuclear weapon and has a family consisting of 12 modifications[6] (mods) to date. One of the most recent mods, the B61-11, was a modification to the B61-7 and includes an added earth-penetrating capability; it officially entered into the U.S. stockpile in January of 1997.[7] Today, five variants of the B61 are part of the enduring stockpile, each with varying capabilities. The nonstrategic mods include the B61-3, the B61-4, and the B61-10, while the B61-7 and the B61-11 are strategic bombs.[8] As the oldest design in the U.S. nuclear stockpile and one near the end of its service life, the B61 requires an LEP to ensure the safety, security, and effectiveness of the U.S. nuclear arsenal, a goal declared by the Obama administration in the 2010 NPR.

LEP: SPECIFICS OF THE MOD-12

The plans for the B61 mod-12 combine four existing mods (i.e., -3, -4, -7, and -10) into one strategic weapon. The Nuclear Weapons Council[9] instructed the B61 Project Officers Group to revise the military characteristics (MCs) of the bomb to accommodate the plan to combine both the strategic and nonstrategic variants of the B61, "which currently have different requirements based on their mission,"[10] and ensure that production of the refurbished bomb begin "no later than 2017."[11] Additionally, the Department of Defense (DOD) and North Atlantic Treaty Organization (NATO) established that the core MCs of the B61-12 would include free-fall delivery, the capability to achieve desired accuracy requirements when delivered from modern aircraft, the option for both ground and midair detonations, and utilization of a guided tailkit.[12]

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4. U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review Report*, April 2010, 39.
5. James Norris Gibson, *The History of the US Nuclear Arsenal* (Greenwich: Brompton Books Corp, 1989), 97.
6. Only 9 of the 12 modifications became part of the U.S. nuclear stockpile.
7. Hans Kristensen, "Scrapping the Unsafe Nuke," *FAS Strategic Security Blog,* Federation of American Scientists, October 18, 2010, http://blogs.fas.org/security/2010/10/b53dismantlement/.
8. For information on strategic versus nonstrategic, refer to Amy F. Woolf, "Nonstrategic Nuclear Weapons," *Congressional Research Service,* RL32572, December 19, 2012, 5–7, www.fas.org/sgp/crs/nuke/RL32572.pdf.
9. By 10 U.S.C. § 179 (6) & (7), the Nuclear Weapons Council has the responsibility to give adequate consideration to potential trade-offs between design, performance, and cost for nuclear weapons programs and to give guidance on priorities for nuclear weapons research, 117, www.gpo.gov/fdsys/pkg/USCODE-1997-title10/pdf/USCODE-1997-title10-subtitleA-partI-chap7-sec179.pdf.
10. U.S. Government Accountability Office, *Nuclear Weapons: DOD and NNSA Need to Better Manage Scope of Future Refurbishments of and Risks to Maintaining U.S. Commitments to NATO*, GAO-11-387 (Washington, DC: U.S. United States Government Printing Office, May 2011), 16, www.gao.gov/new.items/d11387.pdf.
11. Ibid.
12. Ibid., 13.

According to a May 2011 report by the Government Accountability Office (GAO), there were various objectives in mind when laying out plans for the current B61 LEP. The consolidation of the four mods was meant to "reduce the risks and costs of maintaining the bomb, improve the safety and security of the weapon, eliminate the need to conduct a life extension on multiple B61 versions, and reduce expenses by prolonging the interval for replacing key limited-life components."[13] The resulting B61-12 will have a lower yield, added surety measures, capabilities for both strategic and nonstrategic scenarios, and—according to the B61 Lifecycle Sustainment Plan—a stockpile life of 20 to 30 years.[14]

IMPLICATIONS OF THE GUIDED TAILKIT

The addition of the guided tailkit to the B61-12 is considered by some to be a new military capability, about which the 2010 NPR explicitly states: "Life Extension Programs . . . will not support new military missions or provide for new military capabilities."[15] The uproar from the public and nonproliferation advocates is not solely due to the perception that the tailkit is a new capability but also due to the implications of that perception. A lower yield coupled with the increased accuracy achieved by the tailkit produces a bomb that could be interpreted as a more usable U.S. nuclear weapon—a weapon that could be used on a target set not previously feasible.[16] The cumulative implication is that modernizing nuclear weapons undermines nuclear nonproliferation and creates an obstacle on the path to nuclear disarmament.[17]

B61 LEP and Nuclear Policy

Should the addition of the guided tailkit truly be considered a "new military capability" and subsequently a violation of official nuclear policy? Or should the tailkit be seen as consistent with nuclear policy, simply an adjustment to a bomb, allowing it to achieve the military effectiveness of one of the variants it replaces? Although the foundation of the controversy begins in one dictate of the NPR, the B61 LEP remains consistent with the overall goals of current nuclear policy.

The 2010 NPR notes that the five overarching objectives governing the direction of U.S. nuclear weapons policy and posture are:

"1. preventing nuclear proliferation and nuclear terrorism;

2. reducing the role of U.S. nuclear weapons in U.S. national security strategy;

13. Ibid., 11.
14. Air Force Nuclear Weapons Center, *B61 Lifecycle Sustainment Plan (Version 1.2)*, January 1, 2013, 7.
15. U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review Report*, 39.
16. Hans Kristensen, "The B61 Life Extension Program: Increasing NATO Nuclear Capability and Precision Low-Yield Strikes," *FAS Strategic Security Blog*, Federation of American Scientists, June 15, 2011, http://blogs.fas.org/security/2011/06/b61-12/.
17. Lawrence Wittner, "Is the Obama Administration Abandoning Its Commitment to a Nuclear-free World?," *HuffPolitics Blog*, Huffington Post, February 5, 2013, www.huffingtonpost.com/lawrence-wittner/obama-nuclear-free-world_b_2616701.html.

3. maintaining strategic deterrence and stability at lower nuclear force levels;
4. strengthening regional deterrence and reassuring U.S. allies and partners; and
5. sustaining a safe, secure, and effective nuclear arsenal."[18]

It was also noted that "any successful strategy for achieving these objectives must be *balanced*, with movement in one area enabling and reinforcing progress in other areas."[19] Dissecting the plans of the B61 LEP reveals that none of the NPR objectives are undermined by the LEP, thus allowing for the continued progress of each objective.

PREVENTING NUCLEAR PROLIFERATION AND NUCLEAR TERRORISM

Widespread terrorism and national threats have become prevalent in today's society. The National Security Strategy declares that "there is no greater threat to the American people than weapons of mass destruction, particularly the danger posed by the pursuit of nuclear weapons by violent extremists and their proliferation to additional states."[20] Consequently, limiting access to and securing nuclear material has become vital. At the macro level, the Nuclear Security Summit has made large strides by directly addressing, multilaterally and on an international stage, the threat of nuclear terrorism and various measures of prevention. However, making significant developments on a micro level is just as important.

One of the main design elements of the B61 LEP, as agreed upon by the DOD and the National Nuclear Security Administration (NNSA), is that the B61-4 variant will act as the design epicenter. The GAO report states that "because the B61-4 has the lowest yield among the different versions, consolidating the versions in this manner [around the variant with the lowest yield] would also remove significant quantities of nuclear material from the deployed B61 bombs."[21] The reduction of nuclear material frees up volume and mass of the weapon for extra surety measures, to include use control. Should the weapon ever be lost or stolen, these extra measures decrease the likelihood of potential nuclear terrorism by preventing unauthorized access. Additionally, reducing the amount of nuclear material upon which our nuclear arsenal is dependent is a step in the right direction for nuclear nonproliferation.

REDUCING THE ROLE OF U.S. NUCLEAR WEAPONS IN U.S. NATIONAL SECURITY STRATEGY

Decreasing U.S. dependence on nuclear weapons is an objective in keeping with commitments in current arms reduction treaties. The Nuclear Non-Proliferation Treaty (NPT), New Strategic Arms Reduction Treaty (New START), and the Comprehensive Test Ban Treaty (CTBT) were all negotiated with the fundamental goal of nuclear disarmament.

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18. U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review Report*, 2.
19. Ibid.
20. Executive Office of the President, *The National Security Strategy of the United States*, May 2010, 4, www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf.
21. U.S. Government Accountability Office, *Nuclear Weapons,* 11.

The NPT entered into force March 5, 1970,[22] requiring all signatories, including the five recognized Nuclear Weapon States (NWSs),[23] to "pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament."[24] The treaty provides Non-nuclear Weapon States (NNWSs) inclusion on nuclear issues, a nonproliferation move to prevent NNWSs from feeling compelled to establish their own nuclear enterprise. As a NWS, the United States is the primary role model in the nuclear realm. A nation in the proverbial "fish bowl," the United States is looked upon by other states to lead the way. In this role, it is important that, when possible, the United States takes positive first steps to prevent further nuclear proliferation. The consolidation of the strategic and nonstrategic variants of the B61 into one strategic design is a substantial precedent of nonproliferation, ending the era of maintaining exclusively nonstrategic weapons in the U.S. nuclear arsenal.

Moreover, the LEP fosters U.S. arms reductions for New START. New START is the treaty between the United States and Russia that sets strategic arms limits. It entered into force February 5, 2011, and the central limits of the treaty must be met by February 5, 2018.[25] New START only addresses strategic weapons, even though Russia is known to have an expansive nonstrategic arsenal. The U.S. transition to a purely strategic arsenal through the B61 LEP would eliminate the need for a strategic/nonstrategic distinction by DOD planners. All deployed weapons in the U.S. arsenal would be subject to the terms of the treaty, speeding along reduction for the United States, and again, promoting positive nonproliferation measures in the hope that other nations, Russia included, follow the U.S. lead.

Even though establishing a quantitative goal is a cornerstone of nuclear arms reduction, the National Security Strategy stresses the importance of the United States remaining conventionally superior and "as long as nuclear weapons exist, [maintaining] our nuclear deterrent capability, while continuing to enhance its capacity to defeat asymmetric threats. . . ." [26] The B61-12 tailkit provides better targeting capability and the ability to achieve desired probability of damage at lower yields, allowing the United States to continue to reduce the quantities and role of nuclear weapons, while still maintaining an arsenal able to combat asymmetric threats that threaten U.S. vital interests.

The CTBT bans all nuclear explosive testing, stressing the need to "reduce nuclear weapons globally, with the ultimate goal of eliminating those weapons."[27] It was signed by

22. Nuclear Non-Proliferation Treaty (NPT), *Arms Control Association,* http://www.armscontrol.org/documents/npt.

23. Nuclear Weapon States are defined by NPT Article IX, 3, as countries who manufactured and detonated nuclear devices prior to January 1,1967. This includes the United States, United Kingdom, Russia, France, and China.

24. Nuclear Non-Proliferation Treaty (NPT), *Arms Control Association,* NPT Article VI, www.armscontrol.org/documents/npt.

25. U.S. Department of State, "New START," http://www.state.gov/t/avc/newstart/.

26. Executive Office of the President, *The National Security Strategy of the United States,* 14.

27. The Comprehensive Nuclear Test Ban Treaty, *U.S. Department of State*, www.state.gov/www/global/arms/treaties/ctbt/ctbt-preamble.html.

President Clinton on September 24, 1996,[28] and although the United States has not yet ratified the treaty, the administration declared its intention to "pursue ratification and entry into force"[29] of the CTBT in the 2010 NPR. Still, the United States has not conducted a nuclear explosive test since 1992, declaring a unilateral testing moratorium in the Hatfield-Exon-Mitchell Amendment to the Fiscal Year (FY) 1993 Energy and Water Appropriation Bill.[30] The most evident way to ensure that the United States abstains from nuclear testing is through support of LEPs. New designs are unnecessary if the United States practices diligent maintenance of its current nuclear deterrent and ensures that for years to come, suitable steps are taken to keep nuclear weapons safe, secure, and effective. With the addition of the B61-12 guided tailkit, the United States can better bolster its nuclear deterrent by sustaining appropriate capability to defeat hardened military targets. Without the increased precision offered by the tailkit, the B61 would be lacking in this capability, ultimately requiring either a high-yield weapon, or a new low-yield design. The former produces widespread collateral damage, while the latter requires extensive testing for design certification, which is not an option under the CTBT. Additionally, fielding a weapon design without adequate testing risks the foundation of the U.S. deterrent and confidence in the weapon.

MAINTAINING STRATEGIC DETERRENCE AND STABILITY AT LOWER NUCLEAR FORCE LEVELS

The DOD outlines various ways to achieve effective deterrence in the *Deterrence Operations Joint Operating Concept* (DO JOC). It states that through "providing the President an enhanced range of options for both limiting collateral damage and denying adversaries sanctuary from attack,"[31] we can safeguard deterrence and decrease the probability nuclear use would be necessary at all. The B61 LEP results in increased precision of the weapon, "enabling the military to achieve the same effects as the older bomb, but with lower nuclear yield."[32] The capability of the B61-12 guided tailkit allows the United States to reduce nuclear force levels by ensuring that in the event that conventional force is insufficient, military goals can be accomplished with more efficient and fewer deployed nuclear weapons (versus the superfluous nuclear weapons quantities of the Cold War era).

Some critics believe that the usability of a nuclear weapon begets nuclear proliferation,[33] but it is the usability that actually provides for more sound deterrence. A DO JOC concept asserts that: "when an adversary perceives truly severe consequences of restraint, and doubts [U.S.] willingness to use nuclear weapons, deterrence could fail

28. The Status of the Comprehensive Test Ban Treaty: Signatories and Ratifiers, *Arms Control Association,* July 2013, www.armscontrol.org/factsheets/ctbtsig.

29. U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review Report*, 38.

30. Public Law 102–377, Section 507(b), October 2, 1992, http://www.gpo.gov/fdsys/pkg/STATUTE-106/pdf/STATUTE-106-Pg1315.pdf.

31. U.S. Department of Defense, *Deterrence Operations Joint Operating Concept (Version 2.0)*, December 2006, 40, www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA490279.

32. U.S. Government Accountability Office, *Nuclear Weapons,* 30.

33. Greenpeace UK, "Developing 'usable' nuclear weapons," www.greenpeace.org.uk/peace/developing-usable-nuclear-weapons.

despite our nuclear capabilities."[34] Due to its reduction in nuclear material, nuclear fallout, and collateral damage, the B61-12 becomes a more feasible military option. The sheer presence of that option can ultimately alter an adversary's threatening course of action, achieving strategic deterrence with lower nuclear force levels.

STRENGTHENING REGIONAL DETERRENCE AND REASSURING ALLIES AND PARTNERS

Although many factors, including declaratory policy and the physical and performance metrics of internationally deployed nuclear weapons, are relevant to providing assurance to our allies, the most pertinent is the perceived strength of the alliance. The National Security Strategy states the benefits of diplomacy and supporting a common agenda: "Our diplomats are the first line of engagement, listening to our partners, learning from them, building respect for one another, and seeking common ground."[35] The United States must maintain a sense of closeness, transparency, and respect with our allies, and U.S. actions should be supportive of these underlying principles to adequately nurture assurance.

The 2010 NATO Strategic Concept describes three core tasks, "all of which contribute to safeguarding Alliance members."[36] One task, *Collective Defence*, explains that NATO will have "the full range of capabilities necessary to deter and defend against any threat."[37] The need to maintain these capabilities was reiterated in the *Deterrence and Defence Posture Review* press release in May 2012.[38] If NATO military capability requirements[39] for the B61 LEP were outlined as such to strengthen deterrence and uphold the principles of the Strategic Concept, then as a nuclear weapon state and a member of NATO, the United States has the responsibility to uphold those requirements. This move shows respect for each state's role in the alliance, promotes trust, and endorses the ideals of NATO's Strategic Concept.

According to the GAO, "U.S. European Command officials [say that] the B61 bombs couple U.S. and NATO security, and tangibly assure the members of NATO that the United States is committed to their national security."[40] As a classic depiction of the axiom *actions speak louder than words*, maintaining the tangibility of U.S. commitment throughout the B61 life extension timeline is diplomatically essential. However, continued delays to reaching a solid conclusion on requirements for the B61-12 have put the strict 2017 production deadline in jeopardy, and now, due to budgetary issues, first production has been pushed back to FY 2019, thus jeopardizing the deployment of the refurbished weapon and

34. U.S. Department of Defense, *Deterrence Operations Joint Operating Concept (Version 2.0)*, 42.
35. Executive Office of the President, *The National Security Strategy of the United States*, 14.
36. North Atlantic Treaty Organization, *Active Engagement, Modern Defence*: *Strategic Concept for the Defence and Security of the Members of the North Atlantic Treaty Organization*, November 2010, 7, www.nato.int/lisbon2010/strategic-concept-2010-eng.pdf.
37. Ibid., 5.
38. North Atlantic Treaty Organization, *Deterrence and Defence Posture Review* (Press Release), May 20, 2012, www.nato.int/cps/en/natolive/official_texts_87597.htm?mode=pressrelease.
39. Refer back to "B61 LEP: Specifics of the Mod 12," paragraph 2.
40. U.S. Government Accountability Office, *Nuclear Weapons*, 5

continued assurance to the alliance. Any additional adjustments to the LEP's requirements will further derail the schedule, potentially injuring trust within the NATO alliance.

SUSTAINING A SAFE, SECURE, AND EFFECTIVE NUCLEAR ARSENAL

No weapons in the enduring nuclear stockpile were designed to last forever. Thus, when U.S warhead production stopped in the early 1990s, creation of the Stockpile Stewardship Program (SSP) allowed the United States to maintain a safe, secure, and effective nuclear weapon stockpile without underground testing. For over 20 years, through skill in nuclear weapon "design, system integration, manufacturing, security, use control, reliability assessment, and certification,"[41] the SSP has been a primary force in helping the United States to achieve its nonproliferation objective.

The Stockpile Stewardship and Management Plan (SSMP) is the roadmap for nuclear stockpile maintenance and states that "Life Extension Programs . . . will address known aging issues in weapon systems, and each LEP will study the options for increasing the safety, security, and reliability of nuclear warheads on a case-by-case basis."[42] A current safety measure for the B61 bomb is the utilization of retarded delivery by means of a parachute. The parachute allows for additional time between bomb drop and detonation, so that the delivery aircraft is able to make a safe escape, limiting the radiation dosage to the pilot. The guided tailkit of the B61-12 (a nonnuclear modernization) will replace the parachute and "is intended to allow for increased aircraft survivability, safer delivery profiles, and more space for additional components, such as safety and security enhancements."[43] The fact that aging weapons are being stretched well beyond their original service lives only highlights the importance of LEPs embracing all potential avenues to achieve nuclear weapons surety. The tailkit, though a controversial avenue, undisputedly allows for improvement upon the overall safety of the B61.

The need for nuclear weapon surety is echoed in National Security Presidential Directive 28, which requires the DOD and Department of Energy (DOE) to "identify and employ new approaches to improving nuclear weapon security."[44] As mentioned previously, the consolidation of the four mods and the tailkit of the B61-12 allow for added security measures on the weapon itself, but the LEP also contributes to the security of the entire nuclear weapons complex. Various adjectives have been used to describe the state of the complex, ranging from *aging* and *neglected*[45] to *dismal*,[46] and the totality of resources required to

41. 50 U.S.C. § 2521, 526, www.gpo.gov/fdsys/pkg/USCODE-2011-title50/pdf/USCODE-2011-title50-chap42-subchapII-partA-sec2521.pdf.

42. U.S. Department of Energy & National Nuclear Security Administration, *FY 2012 Stockpile Stewardship and Management Plan*, April 15, 2011, 2, http://www.fas.org/programs/ssp/nukes/nuclearweapons/SSMP-FY2012.pdf.

43. U.S. Government Accountability Office, *Nuclear Weapons,* 13.

44. George W. Bush administration, *National Security Presidential Directive 28: United States Nuclear Weapons Command and Control, Safety, and Security,* June 20, 2003, 13.

45. U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review Report*, 40.

46. Kenneth Fletcher and Todd Jacobson, "Administration Requests $7.58B for NNSA's Weapons Program," *Nuclear Weapons & Materials Monitor* 16, no. 7 (February 14, 2012), 6.

update it are startling. A statement on *Budget Priorities for NNSA Weapons Activities* released in February 2013 acknowledged that in order "to support our stockpile and to continue producing the world-class capabilities, we need to modernize our Cold War-era facilities."[47] The statement continues by acknowledging that the "NNSA must balance its priorities within the current budget environment, . . . executing an interim strategy and adjusting plans for our enduring strategy to maintain capability."[48] Reducing the B61 to a single mod design reduces the number of unique weapon requirements and certifications in the stockpile, and the B61 Lifecycle Sustainment plan notes that existing storage and maintenance facilities for the B61 are sufficient to accommodate weapon maintenance for the mod-12,[49] a definite cost savings in total lifecycle costs and long-term maintenance of the new variant. The result allows for modernization and sustainment funds to be distributed to high-priority areas of the complex where they are most needed. The United States could once again embrace a safer and more secure nuclear weapons complex.

B61 LEP and International Humanitarian Law

The B61 LEP is also important to international law. The Law of War, also called the Law of Armed Conflict (LOAC) or International Humanitarian Law, is the "part of international law that regulates the conduct of armed hostilities."[50] DOD policy states, "Members of the [DOD] Components comply with the law of war during all armed conflicts, however such conflicts are characterized, and in all other military operations."[51] In military operations utilizing either conventional or nuclear weapons, the LOAC is to be observed.

Central to International Humanitarian Law is a series of treaties: the Geneva Conventions and their Additional Protocols (AP). AP I, Article 51 identifies forms of attacks identified as "indiscriminate" and therefore prohibited. Included are attacks that cause "incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof" that are not proportional to the military advantage they achieve.[52] Article 58 instructs taking precautions to protect against this type of collateral damage.[53] Although the United States has not ratified the APs, they are seen as customary international law and applicable to all states.[54]

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47. Neile Miller, *Budget Priorities for NNSA Weapons Activities*, House Committee on Appropriations, February 14, 2013, 5, http://appropriations.house.gov/uploadedfiles/hhrg-113-ap10-wstate-millern-20130214.pdf.

48. Ibid.

49. Air Force Nuclear Weapons Center, *B61 Lifecycle Sustainment Plan (Version 1.2)*, 10.

50. U.S. Department of Defense, *Directive 2311.01E: DoD Law of War Program*, May 9, 2006 (certified current February 22, 2011), Section 3.1, www.dtic.mil/whs/directives/corres/pdf/231101e.pdf.

51. Ibid., Section 4.1.

52. Geneva Conventions of August 12 1949, Additional Protocol 1, Article 51, 5(b), "Protection of the Civilian Population," www.icrc.org/applic/ihl/ihl.nsf/Article.xsp?action=openDocument&documentId=4BEBD9920AE0AEAEC12563CD0051DC9E.

53. Ibid, Article 58(c), "Precaution Against the Effects of Attacks," www.icrc.org/applic/ihl/ihl.nsf/Article.xsp?action=openDocument&documentId=C995BF5C5BCFB0E2C12563CD0051DDB2.

54. *Customary International Law* is the "general and consistent practice of states that they follow from a sense of legal obligation," Cornell University Law School, Legal Information Institute, *Customary International Law*, www.law.cornell.edu/wex/Customary_international_law.

The destruction created by nuclear weapons resulting from their blast wave, thermal radiation, electromagnetic pulse, and fallout provides enough reason to limit U.S. dependence on them. But in the event that the president deems it necessary to use nuclear weapons, the U.S. National Security Strategy indicates that the United States will use force in a way that "reflects our values and strengthens our legitimacy."[55] If the United States is to adhere to the customary values of the LOAC and limit collateral damage, the combination of increased precision and lower nuclear yield of the B61-12 can accomplish this.

LIMITING COLLATERAL DAMAGE

Overpressure, "pressure in excess of normal atmospheric pressure,"[56] is a dominant effect in the destruction of a targeted military structure.[57] Each target, depending upon its level of hardness,[58] requires so many pounds of pressure per square inch to achieve a desired probability of damage (Pd); a harder target requires higher pressure. The accuracy of a weapon sent to destroy the target can be measured using its Circular Error Probable (CEP), or "the radius of a circle within which 50 percent of the weapons aimed at a target will fall."[59] With more precision, the weapon produces a smaller CEP and a shorter range of collateral damage.

For a given yield, altitude, height of burst,[60] and desired Pd for a particular target, the precision increase of the B61-12 guided tailkit equates to a reduction in collateral damage. If the accuracy of the weapon increases while maintaining current yield, then the probability of damage will exceed the target requirement. Thus, by reducing the yield of the high-precision weapon and changing height of burst, the Pd is decremented back to the desired value, ultimately resulting in a reduction of collateral damage. Figure 1 is a summary of this concept.

The National Security Strategy stresses the importance of enforcing consequences for states that do not follow the rules, "whether they are nonproliferation obligations, trade agreements, or human rights commitments."[61] The pledge to reduce collateral damage and protect against civilian loss is the biggest human rights commitment a nation could make during time of war. As the state making that declaration, the United States should be the first to uphold it.

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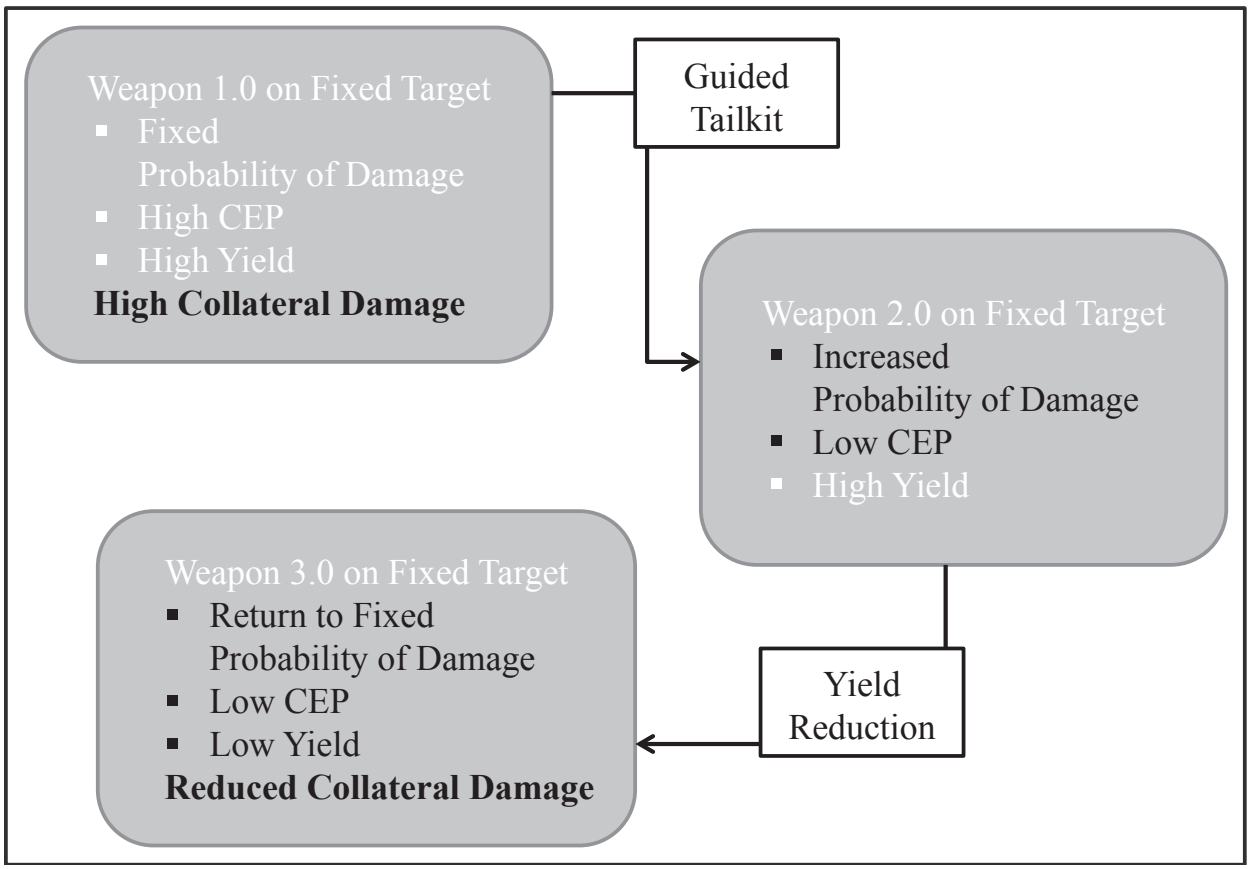
55. Executive Office of the President, *The National Security Strategy of the United States*, 22.
56. Samuel Glasstone and Philip Dolan, *The Effects of Nuclear Weapons*, 3rd ed. (DoD & DOE, 1977), 38.
57. Ibid., 80.
58. *Nuclear hardness* refers to "the extent to which [a structure] is expected to degrade in a nuclear environment." U.S. Department of Commerce, National Telecommunications & Information Administration, "Nuclear Hardness," August 23, 1996, www.its.bldrdoc.gov/fs-1037/dir-025/_3612.htm.
59. Bryan L. Fearey, Paul C. White, John St. Ledger, and John D. Immele, "An Analysis of Reduced Collateral Damage Nuclear Weapons," *Comparative Strategy,* 2 (2003): 323.
60. *Height of burst* refers to the height of weapon detonation above the ground.
61. Executive Office of the President, *The National Security Strategy of the United States*, 3.

Figure 1. High-precision, low-yield weapon on collateral damage



The Definition of New Capability

The B61-12 is not the first weapon to stir up debate with respect to LEP modifications. Following the proposal to modify the B61-7 to create an earth-penetrating weapon (B61 mod-11), controversy originated around the belief that the United States was fielding a *new weapon*. A DOE press release made the clarification that no change was being made to the nuclear package of the B61-7, and as such, the resulting B61-11 should not be considered a new weapon.[62]

The controversy born out of the current B61 LEP is concentrated on the ambiguity of the phrase "new capability." If military capability can be intuitively defined as the ability to achieve a desired probability of damage for targets in the target set, then the B61-12 has no new military capability. As the previous section explained, lowering the yield on a weapon with improved CEP achieves the same probability of damage for a given target. There is no improvement of military capability beyond that of any of the B61 variants in the stockpile, with or without a guided tailkit. Furthermore, the SSMP declares that the "future stockpile will not support new military missions or provide for new military

62. Department of Energy, *A Modification of the B61 is Expected to Replace the B53* (Press Release), September 20, 1995, www.nukestrat.com/us/afn/DOEpr092095.pdf.

capabilities, beyond what the country already possesses today."[63] The SSMP addendum to the NPR statement, "beyond what the country possesses today," holds importance for the B61-12. The guided tailkit is not a new concept, having been used on conventional weapons previously by way of the Joint Direct Attack Munition.[64] Therefore, if the tailkit is not a new capability in and of itself, and the military capability of the weapon has not increased as defined through probability of damage, can the B61-12 be labeled a "new military capability"? The answer is "no."

Conclusion

The tendency of U.S. policy to inadequately define the terms that shape its nuclear posture is a major contributor to the birth of controversies. Multiple interpretations, often contradictory, emerge from the ambiguity. However, if focus is shifted to the bigger picture, the primary objectives of policy, then the consistencies of U.S. actions with respect to those objectives become more clearly defined. The resulting capability from the B61 LEP, though controversial, is consistent with the objectives of the NPR, the nuclear disarmament goals of current international treaties, and the commitment of International Humanitarian Law to reduce collateral damage. Therefore, if advocates and opponents of the B61 LEP have each drawn their line in the sand, the United States is reasonably justified to stand with the advocates.

63. U.S. Department of Energy & National Nuclear Security Administration, *FY 2012 Stockpile Stewardship and Management Plan*, 1–2.

64. U.S. Air Force, "Joint Direct Attack Munition GBU-31/32/38," June 18, 2003, www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104572/joint-direct-attack-munition-gbu-313238.aspx.

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