Project on Nuclear Issues

A Collection of Papers from the 2015 Conference Series

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Introduction
Sarah Minot

The twenty-first century’s complex geopolitical and budgetary environment demands a solid foundation of high-quality human capital across the nuclear enterprise. For this reason, in 2003, CSIS launched the Project on Nuclear Issues (PONI) to develop the next generation of policy, technical, and operational nuclear professionals through outreach, mentorship, research, and debate. Since 2003, PONI has grown tremendously in both numbers and depth, and currently sponsors opportunities for young professionals to engage in thoughtful and informed debate over how to best address the nuclear community’s most pressing problems. In support of this work, the PONI Conference Series was created to provide a forum for facilitating new and innovative thinking and to provide a platform for emerging thought leaders across the nuclear enterprise.

The 2014–2015 Conference Series included events at Lawrence Livermore National Laboratory, the Air Force Nuclear Weapons Center, and the Center for Strategic and International Studies (CSIS). The Conference Series concluded with the Capstone Conference at United States Strategic Command. The papers included in this volume are a collection of some of the presentations delivered at the Capstone Conference. Spanning a wide range of technical and policy issues, these selected papers hope to further discussion in their respective areas.

1. Sarah Minot is the program manager and research associate with the Project on Nuclear Issues at CSIS. She holds an MA in conflict resolution from Georgetown University and a BA in political science and international relations from the College of Wooster.
21st Century Nuclear Arms Control: 
A Framework for the Next Generation of Treaty Negotiations . . . and Treaty Negotiators

Justin Anderson and Darci McDonald

The next nuclear arms control treaty between the United States and Russian Federation should shift from past approaches focused on balancing strategic (i.e., long-range) delivery systems to a new framework focused on limiting and reducing nuclear weapon stockpiles. While the former proved valuable during the Cold War and the first generation of the post–Cold War era, the upcoming 2026 expiration of the New Strategic Arms Reduction Treaty (New START) should mark the sunset for this approach. While stressing the enduring importance of the U.S. nuclear deterrent to the United States and its allies, the authors contend it is possible to simultaneously “deter and downsize”—deter through fielding a robust force of diverse nuclear-capable delivery systems while also reducing the number of weapons within the overall nuclear stockpile. The authors provide future U.S. arms control negotiators with an outline of a future agreement, to include all the salient features of a nuclear arms control treaty—central limits and timelines, a data exchange protocol, and a three-part inspection regime tailored to the full stockpile (to include deployed, nondeployed, and dismantlement queue weapons). Following a path of slow and steady reductions,

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1. At the time of writing, Dr. Justin Anderson was a senior policy analyst at Science Applications International Corporation (SAIC); at present he is a research fellow at National Defense University’s Center for the Study of WMD. Ms. Darci McDonald is a senior policy analyst at SAIC. The views expressed in this paper are their own and do not reflect those of SAIC or any of its U.S. government clients.
a data exchange and inspection regime that offers transparency across the entire stockpile, the authors argue that Washington and Moscow can gradually build confidence and enhance stability even as their numbers of nuclear weapons decrease. Moreover, the proposed weapons-focused, total stockpile framework’s clear and predictable timetable for bilateral nuclear weapon reductions provides potential entry points for other nuclear weapon states—which may also see the national security benefits to following a “deter and downsize” approach—to join the regime at some point in the future.

INTRODUCTION

Either on or before February 5, 2026, the New Strategic Arms Reduction Treaty (New START) will come to an end. The terms of the bilateral nuclear arms control treaty, which entered into force in early 2011, allow the United States and Russian Federation to consider one possible five-year extension in 2021. Given the poor state of their present relations, and of U.S.-Russian arms control in particular, an agreement to extend the treaty cannot be taken for granted. Regardless, New START has an expiration date that is, at most, just a decade away.

The years 2021 or 2026 may seem distant today, but the development of nuclear forces and nuclear arms control treaties can be years, even decades, in the making. The time to start thinking about a new framework for the next nuclear arms control agreement between the United States and Russian Federation is now. The need to begin developing this framework today is particularly important because the next treaty should depart from the delivery systems–focused approach employed by U.S.-Russian nuclear arms control negotiations and agreements since the Strategic Arms Limitation Talks (SALT) commenced in 1969.

This approach, developed against the background of superpower nuclear arms racing and brinkmanship, served Washington and Moscow well throughout the Cold War and through the first generation of the post–Cold War era. The expiration of New START, however, should mark the sunset for this approach, which primarily equated strategic stability between the two states with the establishment of a balance between their “strategic” offensive nuclear forces—that is, intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and long-range bombers capable of carrying out homeland-to-homeland strikes. This approach has reaped benefits to both sides in the past, but its continuation no longer serves their security interests.

It is time for the two states to shift to a weapons-focused, total stockpile nuclear arms control framework that better addresses the needs of strategic stability and risk reduction in the twenty-first century. It may also provide an approach allowing other nuclear states to engage in nuclear arms control in the future. This approach will require significant work by the United States and Russia to develop a verification regime that balances a high level of intrusiveness across the entirety of their nuclear stockpiles with measures to protect the most sensitive aspects of their respective nuclear enterprises. The weapons-focused, total stockpile framework proposed here, however, will preserve the long-term credibility and flexibility of the U.S. nuclear force for the purposes of deterrence and assurance. It will also gradually but steadily reduce U.S. and Russian
stockpiles of nuclear weapons—specifically, the warheads and bombs that comprise each state’s nuclear arsenal—that have remained predominately outside past arms control arrangements.

KEY ASSUMPTIONS

Critics of nuclear forces often contend that nuclear weapons are relics of the Cold War and have no purpose or utility in the present era. The authors strongly disagree with this point of view. Nuclear forces are an important part of the geopolitical landscape in the twenty-first century. In fact, the salience of nuclear forces internationally is increasing rather than decreasing. This is due to a number of factors including limited but high-profile cases of nuclear weapon development outside or in contravention of the Nuclear Nonproliferation Treaty (NPT), the decision by some states to boost the role of nuclear forces within their national security strategies and defense postures, and the continuing reality that no other type of weapon comes close to the physical destructive power of nuclear weapons.

It is highly unlikely that any of the nine current nuclear states (four of which are outside the NPT) will give up their nuclear arsenal in the near- or long-term. Despite the unlikelihood of a future proliferation cascade, it is probable that one additional state will seriously consider some nuclear option in the next decade. Nuclear competition and brinkmanship will not shape and influence international affairs to the degree they did during the Cold War, but the twenty-first century will experience multiple regional competitions and crises that will prominently feature one more nuclear-armed actor. In short, nuclear forces—and the need to deter them—will endure for decades to come. This perspective on nuclear risk as a long-term, multidimensional challenge forms a critical backdrop to the authors’ views on the roles and responsibilities of U.S. and Russian nuclear forces that will in turn influence future arms control discussions between these two states.

This paper assumes the following:

Nuclear forces will remain central to U.S. efforts to deter nuclear and other weapons of mass destruction (WMD) threats to the U.S. homeland for the foreseeable future. Several actors armed with nuclear weapons or other forms of WMD are either adversaries of the United States or do not share its interests. Indeed, the United States has received several nuclear threats—some veiled, some less so—in recent years. Moreover, these threats are not monolithic. The United States must address nuclear challenges from a range of actors, including states fielding nuclear forces capable

2. In March 2015, Ri Su Yong, the North Korean minister of foreign affairs, claimed the United States was responsible for a number of “provocative” actions against his country, including nuclear threats, and stated that North Korea was prepared to respond with a preemptive nuclear strike “if necessary”: “The DPRK [Democratic People’s Republic of Korea] cannot but bolster its nuclear deterrent capability to cope with the ever-increasing nuclear threat of the US. Now the DPRK has the power of deterring the US and conducting a pre-emptive strike as well if necessary.” Ri Su Yong (address, United Nations Conference on Disarmament, March 3, 2015), http://www.unmultimedia.org/tv/unifeed /asset/1308/1308679/. In March 2014, Dmitry Kiselyov, a Russian news anchor with close ties to the Kremlin, stated during a news broadcast that “Russia is the only country in the world realistically capable of turning the United States into radioactive ash.” Lidia Kelly, “Russia Can Turn U.S. to Radioactive Ash: Kremlin-backed Journalist,” Reuters, March 16, 2014, http://www.reuters.com/article/2014/03/16/us-ukraine-crisis-russia-kiselyov -idUSBREA2F0XF20140316.
of launching major attacks on the U.S. homeland and risk-taker regimes prepared to use their limited yet lethal arsenals to threaten U.S. allies and forces abroad.

Nuclear forces remain critical to deterring this rogue’s gallery, whose members are prone to the use of force to threaten, coerce, or attack those who oppose their goals. Like George Kennan’s toy automobile, these actors press ahead until they encounter “some unanswerable force,” such as the U.S. nuclear deterrent.\(^3\) While the Obama administration has sought to reduce the overall role of nuclear forces within the broader U.S. defense posture, it has also reaffirmed the importance of maintaining a nuclear arsenal capable of levying unacceptable costs against any adversary that contemplates a nuclear attack against the United States or its allies.\(^4\)

The United States possesses extensive conventional capabilities, but an order of magnitude continues to separate the most powerful conventional munitions in the U.S. arsenal from even its smallest nuclear weapon. Despite impressive advances in other areas of military technology since the advent of the atomic age, for the United States the most effective counter to the threat posed by nuclear weapons remains its own nuclear force. The authors are not alone in this view; it is also shared by most U.S. policymakers and by the majority of the U.S. public.\(^5\)

In addition, while the United States will likely continue to invest significant resources in homeland missile defense, missile defenses are highly unlikely to ever fully supplant nuclear forces in U.S. national security strategies. Missile defenses deter by denial; that is, when fully effective, they can deny a potential adversary the ability to threaten the United States with nuclear-armed ballistic missiles. Missile defenses, however, are costly to develop. Additionally, defensive interceptors are significantly more expensive, missile to missile, when compared to their offensive counterparts. Furthermore, missile defenses can only protect the homeland against one type of nuclear employment. They are an important but niche defensive capability that can supplement, but not replace, the deterrent value of nuclear forces.

*Nuclear forces will also remain central to U.S. efforts to extend deterrence against nuclear and WMD-armed adversaries of U.S. allies, and to assure allies they are protected from these adversaries.* A significant number of U.S. allies and partners face nuclear-armed states that do not share, or are openly hostile to, their interests. For many of these allies and partners, nuclear threats are close at hand, cannot be fully deterred by the means available to them, and pose an existential threat to their survival. Many of these states conclude that the best form of protection against nuclear

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blackmail and attack is provided by the United States extending a “nuclear umbrella” over their territory.

The depth and breadth of assurance requirements, however, is significant, requiring the United States to maintain a robust, visible, and global nuclear force. The force must be robust in terms of its top-to-bottom health, from the assembly of weapons in the laboratory to the continual planning and exercise of nuclear deterrence operations. In recent years, a number of key U.S. allies have taken a keen interest in the vitality of the force upon which they rely for protection against nuclear threats. The force must also be visible (or have the capability of being observable when necessary) to friend and foe alike, providing a tangible demonstration of the United States’ determination to extend the deterrent benefits of its nuclear force to its allies. Furthermore, given the U.S. government’s direct nuclear security guarantees to over 30 states (including members of the North Atlantic Treaty Alliance [NATO] and key allies in the Asia Pacific), and the potential need to extend nuclear deterrence to other regions in the future, the U.S. nuclear force is necessarily a global force. It must be global in terms of its reach for potential employment and in terms of the scope of its ongoing deterrent operations (including, for example, aircraft permanently stationed in Europe and continuously present in the Pacific theater).

Nuclear forces are also central to Russia’s national security strategy and defense posture. Russia has boosted the importance of nuclear forces within its military doctrine and increased the scope and tempo of its nuclear exercises. It has also devoted increased resources to both overhauling its existing forces and developing new delivery systems.

Russia views its nuclear forces as critically important to affirming its status as a global power and to deterring both nuclear and advanced conventional threats to its security. In regard to the latter, while major recent investments have allowed Russia to modernize important areas of its conventional forces, it remains concerned that it lags behind the United States and NATO in contemporary military technology. For Russia, a robust nuclear deterrent ensures it remains independent of the geopolitical influence of any other state and can halt the attack of any opposing military, regardless of its level of technological sophistication. The authors do not agree with Russia’s characterization of NATO as its “main external danger.” But it is important within negotiations to recognize the perspective of the opposite party even when you do not share it; the Kremlin clearly views the ability to exercise nuclear deterrence against the United States and its NATO allies as critical to its national security.

6. “The development of new weapons systems, such as low-yield nuclear weapons, strategic non-nuclear missiles and hypersonic high-precision non-nuclear systems for prompt, long-range strikes are also causes for concern. . . . We are developing new strategic missile systems for land, sea and air to further strengthen our nuclear forces.” Vladimir Putin (address, Federal Assembly, December 12, 2013), http://en.kremlin.ru/events/president/transcripts/messages/19825.

Russia also has extended deterrence commitments to the Collective Security Treaty Organization (CSTO), and appears to believe that visible demonstrations of its nuclear-capable forces to these key allies are important to the latter’s assurance.8

*The United States and Russian Federation have enduring nuclear force requirements that will directly shape future arms control negotiations.* The United States and Russia both view nuclear forces as remaining critically important to their national security and to their defense commitments to key allies. Furthermore, both states believe the scope of their deterrence and assurance requirements necessitate the maintenance of a diverse nuclear force, including several delivery and weapons options. The next nuclear arms control treaty between the two states will need to ensure that its limits and reductions do not impede the ability of both sides to field this type of nuclear force.

This does not obviate the possibility—or the importance—of future nuclear arms control negotiations. Both countries, and the world, are safer when the United States and Russia work together to foster a stable defense relationship (nuclear and conventional), to address issues of nuclear risk, and to verifiably reduce their respective nuclear arsenals. It is possible for both states to “deter and downsize”—to deter with a robust deployed and nondeployed nuclear force of diverse delivery systems while also dismantling significant numbers of nuclear weapons within the nuclear stockpile. As discussed below, however, this will require a paradigm shift in U.S.-Russian arms control from the delivery systems–focused approach that has characterized nuclear arms control since the late 1960s.

**FIRST-GENERATION NUCLEAR ARMS CONTROL**

From SALT to New START, the majority of U.S.-Russian nuclear arms control negotiations have focused on establishing a balance between the two sides’ deployed strategic nuclear forces. The logic behind this approach blended elements of strategy and pragmatism.

The strategic logic was that these forces represented the true center of gravity in the military competition between the two superpowers. Other forces (including other nuclear forces) were important, but not as important as the delivery systems and weapons that, in theory, could begin and end World War III within minutes. Thus, the achievement of a stable strategic balance between the two rivals depended upon establishing a relative equilibrium between their respective strategic nuclear forces. Each side would retain the ability to deter the other with its frontline deployed strategic delivery systems, but neither would engage in arms racing or brinkmanship. The relationship was a binary one, with each side facing (and balancing against) the other. Strategic stability was a two-player game within this construct; other nuclear-armed actors were not included.

A focus on strategic nuclear forces was also a pragmatic choice during the Cold War because of the challenges posed to developing an effective verification regime for each side’s total nuclear arsenals. Strategic delivery systems had the advantage of representing both the most immediately threatening forces and readily visible forces. National technical means (e.g., observation satellites) could gather a great deal of information about the numbers, posture, and basing of strategic nuclear forces, which tended to require large delivery systems. By the late 1960s, both Washington and Moscow had a good sense of the size and structure of the other side’s strategic nuclear force. As a result, there were practical reasons for focusing nuclear arms control negotiations on forces where a key element of verification—satellite imagery—already existed for both sides independent of any mutually agreed framework.9

SALT began in 1969 and New START entered into force in 2011. For over four decades, the United States and Russian Federation have negotiated and implemented agreements that were centrally concerned with establishing, maintaining, and verifying the balance between their respective deployed strategic nuclear forces. The accomplishments of this first-generation approach to nuclear arms control deserve recognition. Many Cold War strategists viewed deployed strategic nuclear delivery systems as simultaneously the most important and most threatening military capabilities fielded by the superpowers. By focusing on these systems, past nuclear arms control agreements between Washington and Moscow reduced the risk of nuclear conflict between the world’s two largest nuclear powers, slowed their nuclear arms competition, and helped stabilize their broader strategic rivalry. In addition, for a generation after the end of the Cold War, the implementation and negotiation of arms control agreements focused on each side’s strategic delivery systems, which remained an important basis for defining and managing the strategic relationship between two sometimes cooperative, sometimes competitive major nuclear powers.

This first-generation approach to controlling the risks and costs of nuclear arms, however, should also be viewed as a legacy approach that has limited applicability to the future U.S.-Russian strategic relationship. It also has limited to no applicability to other nuclear powers that to date have remained outside nuclear arms control negotiations.

NEW START: THE END OF THE BEGINNING

Most discussions about the future of nuclear arms control, and in particular discussions regarding a successor to New START, have focused on lowering the aggregate limits of deployed strategic delivery systems and their associated nuclear weapons. Some nongovernment subject matter experts have suggested that U.S. and Russian negotiators consider new limits below the 700 deployed delivery vehicles and 1,550 deployed nuclear weapons specified in New START.10


This approach has the benefit of building directly upon an existing treaty (and associated practices familiar to both the United States and Russia), but it falls short in several important ways.

First, it fails to capture nonstrategic and nondeployed nuclear weapons, which constitute a majority of each nation’s total stockpile. As New START was being negotiated, the Obama administration recognized that these two categories of nuclear weapons should be addressed in follow-on negotiations. Similarly, the Senate’s resolution of advice and consent to New START ratification required that the administration seek to address the disparity between U.S. and Russian nonstrategic nuclear weapons as soon as possible. Lowering the weapons limit in the current treaty would only account for nuclear reentry vehicles on ICBMs and reentry bodies on SLBMs, leaving out a substantial portion of each side’s stockpile.

Second, this approach retains the long-standing, but archaic, use of attribution rules that do not truly capture each side’s actual numbers of deployed weapons. Within New START, each deployed heavy bomber is counted as one warhead, regardless of how many nuclear bombs or nuclear-armed cruise missiles can be, or actually are, loaded on these systems. This method of attributing a number of weapons to a delivery system (for the purposes of counting against a treaty’s central numerical limits) that does not reflect the actual number of weapons loaded on the system is often referred to as “treaty math.” This approach was also used in earlier nuclear arms control treaties such as START, which assigned each nuclear delivery system a specified warhead number. New START began to move beyond a purely attribution-based framework by accounting for actual reentry vehicles and bodies emplaced on ballistic missiles. Both sides, however, agreed to continue using treaty math for heavy bombers, as this approach did not interfere with broader efforts to balance the two sides’ respective strategic nuclear delivery systems and permitted setting aside difficult challenges to the treaty’s verification regimes without compromising the entire regime. Treaty math, however, appears somewhat anachronistic alongside the full accounting of other deployed weapons and often baffles the uninitiated (who not unreasonably assume the central limit for deployed weapons within an arms control treaty actually counts deployed weapons).

Third, this approach does not afford either party the flexibility to deploy the capabilities needed for central deterrence, extended deterrence, or allied assurance. The United States currently deploys nearly 800 ICBMs, SLBMs, and heavy bombers, down from nearly 900 when New START entered into force. The United States will meet the treaty’s mandated limits of 700 deployed and 800

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13. According to New START data declared on March 1, 2015, the Russian Federation currently deploys 515 ICBMs, SLBMs, and heavy bombers; the United States deploys 785 ICBMs, SLBMs, and heavy bombers. U.S. State Department, “New START Treaty Aggregate Numbers of Strategic Offensive Arms,” State Department Fact Sheet, April 1, 2015, http://www.state.gov/r/avc/rls/240062.htm. According to New START data declared on February 5, 2011, the date New
deployed and nondeployed delivery systems by the 2018 implementation deadline, but as long as it maintains a nuclear triad it will struggle to meet substantially lower limits—particularly as modernized systems are deployed in the 2020s and beyond. Russia is currently below New START’s delivery system limits, but is also modernizing and expanding its strategic nuclear forces. Given that Russia is deeply invested in strategic nuclear forces as the bulwark of its national security for the foreseeable future, it is likely to balk at any negotiations proposing lower limits under the New START framework. Arbitrarily lowering these aggregate limits will be difficult for either side to negotiate and implement, and, in any case, erroneously suggests that limiting deployed assets continues to remain necessary to guarantee the stability of the U.S.-Russia relationship.

Fourth, this approach prioritizes limiting and reducing deployed delivery systems, not actual nuclear weapon stockpiles. The majority of past U.S.-Russia nuclear arms control agreements largely left nuclear arsenals alone as a challenge to be addressed by future talks and treaties, although the Moscow Treaty and New START did address a portion (deployed strategic weapons) of each side’s nuclear stockpile. However, warheads and bombs awaiting loading on nearby delivery systems, in storage, or awaiting dismantlement remain completely unlimited and unconstrained. After four decades and multiple rounds of negotiations on a range of texts (only some of which were implemented), it is time for negotiators to acknowledge the end of this first generation of arms control and focus on limiting and reducing nuclear weapons stockpiles—that is, the full inventory of nuclear weapons in each state’s possession.14

The following sections present the key elements of a weapons-focused, total stockpile framework for a potential future nuclear arms control treaty: central limits, including reductions and timelines; transparency measures, such as information exchanges and notifications; and an inspection regime to enable verification of the other side’s compliance with the treaty.

CENTRAL LIMITS: IT’S THE STOCKPILE, STUPID

In moving to a new approach, negotiators should shift the focus of nuclear arms control to total stockpile numbers and establish a single weapon limit. Under this total stockpile approach, all nuclear weapons would be accounted for across their life cycle. This would include weapons mated to delivery systems (both offensive and defensive), in storage, in transit, coming off a production line, and in the queue for surveillance or dismantlement. This approach also makes a clean break from treaty math and provides an accurate accounting, within a treaty framework, of the actual total numbers of weapons possessed by each state. Today, the total U.S. stockpile is

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14. The Moscow Treaty focused on reducing deployed strategic nuclear weapons to a numerical range, defined by the treaty as 1,700 to 2,200 weapons. Beyond this range, the treaty expressly kept the preceding START in place, to include its verification regime. As such, it did not limit or develop means of verification for most of the U.S. and Russian nuclear weapons stockpiles.
approximately 7,200 nuclear weapons and the estimated Russian stockpile is 7,700. Subject matter experts assess that France possesses the next largest arsenal in the world at approximately 300 nuclear weapons, followed by China and the United Kingdom at roughly 250 and 225, respectively. Because the United States and Russia maintain the largest stockpiles in the world, the next round of nuclear arms control negotiations should remain bilateral, but with the understanding and expectation that the treaty may include other nuclear weapons states over time.

REDUCTIONS AND TIMELINES

Negotiators should establish a process for the steady reduction of weapons over time, beginning with an initial central weapon limit below current U.S. and Russian stockpile numbers. The limit should not be too low, however, nor the process too fast. It will take time for the parties to develop and implement sound adjustments to their nuclear plans, policies, strategies, and operations at much lower stockpile numbers, and they should have an opportunity to assess the role of nuclear weapons in a future security environment in order to determine whether conditions are favorable for continued reductions. As a significant portion of both the U.S. and Russian stockpiles are maintained in storage and several thousand weapons are awaiting dismantlement in each country, a central limit of 5,000, for example, would not significantly affect either side’s operations in the near-term. It would, however, put pressure on U.S. and Russian dismantlement facilities to meet this demand and reduce the huge backlog of retired weapons that will not reenter the stockpile. The Obama administration appears poised to take on this challenge, as it recently announced it will seek to accelerate dismantlement of retired weapons by 20 percent. In addition, this paper proposes that the next treaty be of indefinite duration and the initial central weapon limit be considered the first milestone on a path toward meaningful global stockpile reductions. As numbers are reduced, the two sides can build confidence that continuing stockpile reductions will not have a negative impact on either their national security or U.S.-Russia strategic


17. At the April 2015 NPT Review Conference, Secretary Kerry stated: "Over the last 20 years alone, we have dismantled 10,251 warheads, with another approximately 2,500 warheads retired and in the queue for elimination. Now, this is complex and costly work, but we are committed to reducing this backlog. And I am pleased to announce today that President Obama has decided that the United States will seek to accelerate the dismantlement of retired nuclear warheads by 20 percent." John Kerry (address, 2015 NPT Review Conference, New York, April 27, 2015).
stability. These reductions should occur gradually, possibly over several generations, as President Barack Obama aptly articulated in his 2009 speech in Prague.\(^\text{18}\)

Negotiators can achieve a measured but steady pace of reductions by agreeing to net stockpile reductions at regular intervals as a percentage of the total stockpile, such as 20 percent reductions every 10 years. Under this approach, significant weapon reductions would occur in the early years of treaty implementation when stockpiles are largest, resulting first in the dismantlement of retired nuclear weapons, followed by nondeployed nuclear weapons. Using this example, once the parties reached the initial central limit of 5,000 nuclear weapons, they would be required to reduce their stockpiles by an additional 1,000 nuclear weapons in the following decade. In the ensuing decades, the parties would be required to reduce stockpiles by 800, followed by 640, and so on. Negotiating specified reductions in phases would not only commit the United States and Russia to deep cuts early in the life of the treaty, it would provide the international community a predictable timetable for potential third- and fourth-party entry at a later date. It will likely take decades for U.S. and Russian stockpiles to reach levels close to those of other states; this interval prior to third-party entry into the treaty, however, allows ample time for other states to familiarize themselves with the processes and practices of arms control. This approach also recognizes that the safe and secure dismantlement of nuclear weapons takes considerable time and money, a fact advocates of lower numbers sometimes fail to appreciate.

**NO SEPARATE LIMITS FOR STRATEGIC DELIVERY SYSTEMS**

Further, this paper argues against separate limits on delivery systems under this framework, which is a significant break from the START/New START model. Although New START offers the United States and Russia some flexibility to determine their own force structures, the parties must do so within the confines of the treaty’s 700 deployed delivery vehicle limit and the 800 deployed and nondeployed delivery vehicle limit. The United States has decided to retain a force of 400 deployed ICBMs, 60 deployed heavy bombers, and 240 deployed SLBMs in compliance with these limits, which allow the Department of Defense to preserve a force structure that fully supports the president’s National Security Strategy and Nuclear Weapons Employment Strategy.\(^\text{19}\) In order to meet these numbers, however, the armed services must invest resources in converting and eliminating some nuclear delivery systems in accordance with specific treaty processes that they otherwise would phase out or retire.

By employing a framework that excludes limits on delivery systems and focuses exclusively on weapons, each participating state would have total flexibility to maintain, develop, and field a force structure that meets its unique national and alliance defense requirements, as well as the flexibility

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18. “So today, I state clearly and with conviction America’s commitment to seek the peace and security of a world without nuclear weapons. I’m not naïve. This goal will not be reached quickly—perhaps not in my lifetime.” Barack Obama (address, Hradcany Square, Prague, April 5, 2009), https://www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered.  
to retire or deactivate systems as desired. Greater flexibility in fielding delivery systems will allow each side to have the nuclear force it believes is necessary for addressing its security needs, which may change as the nuclear forces of other states evolve. In fact, this approach could facilitate dropping restrictions on specific types of delivery systems in other treaty regimes (such as intermediate-range nuclear forces) as all nuclear weapons would be captured under this approach, regardless of their means of delivery. This reflects the authors’ assessment that the flexibility and visibility of U.S. nuclear forces will increase in importance in the future (placing significant demands on the future U.S. nuclear deterrent), but that the number of weapons required to deter, extend deterrence, and assure will not necessarily increase for the deployed force.

Because this framework places a hard cap on nuclear weapons, the parties will have to make tough choices about stockpile composition in order to meet the central limit. Both sides will address questions on the value of strategic versus nonstrategic weapons, possible internal trade-offs between deployed and nondeployed assets, and how to best structure and maintain their respective nuclear enterprises in response to shifting priorities. These important discussions and answers will not be reached easily, which is why slow, steady reductions are necessary. Further, this approach will not guarantee numerical parity across all types of weapons, because it does not employ sub-limits against specific types. Russia could theoretically choose to retain thousands of its tactical weapons within the total stockpile limit and maintain a quantitative advantage in this area (a disparity that, as noted above, is a direct concern of Congress), but in doing so it would have to make reductions elsewhere in its arsenal. Negotiators may face pressure to address these issues by setting sub-limits within the overall number of weapons or by setting distinct limits on delivery vehicles. However, these are lesser priorities to the goal of reducing the overall number of nuclear weapons within the U.S. and Russian stockpiles and, if necessary, should be addressed separately.20

**TRANSPARENCY: ESTABLISHING BASELINE DATA ON THE STOCKPILES**

In crafting an approach for this verification regime, this paper begins by examining and considering the verification regimes of current and past treaties and agreements, including nuclear, conventional, and WMD-focused agreements. Across many of these examples (such as START and New START, Conventional Armed Forces in Europe [CFE], and the Chemical Weapons Convention [CWC]), common elements include reporting provisions and inspection activities.

Reporting provisions can vary considerably depending on the regime. Data exchanged between parties may focus exclusively on items limited by the treaty or provide transparency on other relevant weapons or systems. Information might be provided annually, semiannually, or as necessary, and include more frequent notifications for certain changes in that data. The CFE Treaty, for

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20. If necessary for the purpose of bridging some concept of central limits for delivery vehicles between New START and a new treaty, negotiators might consider referencing its contribution to strategic stability within the preamble or retaining these limits within an agreed statement. Again, however, the authors believe the focus should remain on limits and reductions to nuclear weapons.
example, requires an annual information exchange on treaty-limited armaments and equipment, and notification if a 10 percent change in any category of that data occurs. In contrast, New START establishes a semiannual information exchange on certain categories of data, including some items not limited by the treaty (such as nondeployed ICBMs). New START also requires notification of changes to any aspect of that data, such as the movement of a heavy bomber from an operational base to a repair facility (which changes its status from deployed to nondeployed). This obligation has resulted in thousands of notifications exchanged between the United States and Russia annually, including data on systems readily monitored via national technical means.21

**INFORMATION EXCHANGE AND DATA UPDATES**

While reporting provisions may be diverse, nearly all arms control verification regimes begin with an exchange of information or a declaration of data upon entry into force, and establish a means of updating that information periodically throughout the life of the treaty. The authors’ weapons-focused framework also embraces this concept, as this initial reporting activity will be essential to providing a baseline for each party’s total stockpile and should include, at a minimum, the total number of nuclear weapons in the stockpile, their location, and whether they are deployed or nondeployed. Since a percentage of weapons will likely be deployed (i.e., mated to delivery vehicles), some of which may be mobile, the operational base where they are loaded could serve as the location used for reporting purposes. Other reportable locations could include regional storage sites, national or central storage sites, production plants, maintenance facilities, assembly and disassembly plants, and dismantlement facilities, to name a few. The United States and Russia are already aware of each side’s operational bases and nuclear weapons facilities, but one-time-only familiarization visits at declared locations would provide both sides with greater assurances at the beginning of implementation. The extent of this information exchange—the first of its kind to provide a significant degree of fidelity with regard to the numbers and locations of nondeployed (i.e., not mated to delivery vehicles) and dismantlement queue weapons—is not only necessary for transparency and verification, it also provides confidence in weapon accountability. For the United States, which still maintains forward-based nuclear weapons for extended deterrence to NATO, this will require close consultation with its European allies.

This paper also proposes that parties provide updates to this initial report regularly, such as quarterly, but no less frequently than annually. The intent should be to encourage regular accounting for all nuclear weapons and enable the parties to steadily monitor progress toward reaching the central limit, particularly since this approach does not rely on a constant stream of notifications reporting minute variations in that data. Changes in the day-to-day location of individual weapons, the majority of which are kept in storage locations, are unlikely to meaningfully alter a state’s nuclear posture and are not necessary to verify compliance with the central limit. It may be beneficial, however, to provide notification of significant changes in the number of weapons at any

21. As of April 15, 2015, the United States and Russia have exchanged 8,417 New START notifications. U.S. Department of State, “New START,” http://www.state.gov/t/avc/newstart/. Reports on the change in the status of certain systems account for a significant portion of those notifications, though not all.
single location, such as a 10 or 20 percent adjustment, as well as notification of impending dismantlement activities. This approach deviates significantly from the START/New START model of reporting daily movements of individual treaty-accountable items, but it embraces the concept of a recurring database exchange, which will provide a time-delayed yet valuable snapshot of the arsenal. Because the central purpose of the treaty is to reduce total stockpile numbers, these updates should also account for any dismantled weapons. This could include nuclear weapons that have been disassembled (into their component parts) or those that have undergone disposal (of the nuclear material). The authors recognize that negotiators face significant linguistic and technical challenges in defining what constitutes a nuclear weapon—with separate definitions required for deployed, nondeployed, and dismantled weapons. The clarity of these definitions will be critical to establishing a treaty regime that is accurate and verifiable not only for the U.S. and Russian arsenals, but one that is also applicable to other nuclear weapons states at a later date.

INSPECTIONS: ONE REGIME, THREE TYPES

Information exchanged in arms control treaties should be backed by an inspection regime that enables verification of compliance with the treaty. Here, too, the nature of activities can vary widely across treaties. Many treaties provide for specific types of on-site (i.e., on-the-ground) inspections at declared sites to verify data exchanged, as well as the use of national technical means of verification. Some treaties also allow inspections at other sites where noncompliant activities might be occurring, or where treaty-accountable assets might be located but not declared. The level of intrusiveness typically depends on the item(s) being inspected. In general, the smaller the item of inspection, the more intrusive the inspection. Intent (and how to determine it) also factors into the intrusiveness of a treaty’s verification regime. The purpose of CWC Challenge Inspections, for example, is to determine whether a participating state is engaged in noncompliant activities, such as the production, development, stockpiling, or use of chemical weapons. As the treaty bans chemical weapons, charging a CWC state party with violating any of its core provisions is a serious allegation that requires an inspection calibrated to identify what may be a very small piece of evidence of noncompliance. As such, these inspections are some of the most intrusive in arms control, potentially lasting up to 216 hours from beginning (arrival of the inspection team in country) to end (departure from country). The regularity of inspections can also be situation-dependent. Under New START, inspections of deployed assets at operational bases occur slightly more often than inspections of nondeployed assets (up to 10 inspections annually versus 8 inspections annually).

The authors’ proposed weapons-focused, total stockpile framework seeks a balanced approach to inspections. Because the unit of account is small (a single weapon), both deployed and nondeployed weapons will be subject to inspection and all inspections will be intrusive to some degree. However, the frequency of those inspections should be based, in part, on the operational readiness of the weapons—that is, the more “ready” the weapon, the more prone it is to inspection. This

22. In contrast, a New START Type One inspection at a heavy bomber base can last less than 72 hours from the arrival to return of the inspection team to the point-of-entry.
approach seeks to build increased confidence between the parties over time, while also supporting stability in several important ways. First, it would offer significant visibility into the most operationally ready portion of the stockpile, which poses the most imminent threat in deterrence calculations and necessitates rigorous transparency. Second, by also providing for inspections of nondeployed weapons, such as weapons in storage (albeit at a lesser frequency than deployed weapons), it would offer assurances that weapons removed from daily nuclear operations are accounted for and secured. Additionally, by subjecting nondeployed weapons to fewer and less frequent inspections within a given year, the parties would be incentivized to maintain more weapons in a nondeployed status as the stockpile’s overall size is reduced. Finally, it would provide increasing substantiation that progress is being made toward reductions and that the parties are dismantling weapons to reach the central limit. In support of these aims, this paper proposes a threefold, tailored inspection regime that builds on the transparency gleaned from reporting activities to instill confidence in both weapon accountability and net stockpile reductions. The regime would have one type of inspection for deployed weapons, a second type for nondeployed, and a third for weapons awaiting dismantlement.

INSPECTIONS: OPERATIONALLY READY (OR NOT)

*Deployed Weapons.* The first type of inspection would focus on deployed nuclear weapons (e.g., warheads or bombs that are mated to delivery platforms or launchers), which have the highest operational readiness in the arsenal and present the most imminent threat of attack. The authors propose both intrusive and regular inspections of deployed nuclear weapons not only for transparency and accountability, but to also foster an informed dialogue on deterrence and stability among participating parties as stockpiles are reduced.

Under this framework, the inspections would closely mirror Type One inspections under New START. They would occur regularly, on short notice, and on-site at locations where warheads and bombs can be mated to delivery platforms. This would allow the parties to confirm the number of warheads on missiles and nuclear weapons on aircraft, as well as the absence thereof. Under New START, these inspections are intended to verify the *declared number* of weapons deployed on a random sample of delivery vehicles. At ICBM and ballistic missile submarine (SSBN) bases, this entails counting the number of reentry vehicles on select missiles. For heavy bombers, it means counting any bombs and/or cruise missiles under the aircraft wings and in the bomb bays. Inspectors may use radiation detection equipment during these inspections, but only to confirm the absence of nuclear weapons on a delivery system, not the presence. This approach drastically simplifies some of the technical challenges and concerns associated with inspecting nuclear weapons, while still deterring the parties from underreporting in order to meet the aggregate warhead limit. While these inspections are very intrusive, they are also familiar to both the United States and Russia, and would remain essentially unchanged from current New START inspections counting weapons mated with strategic delivery systems. Under a weapons-focused framework, however, these inspections would now include all deployed weapons on all delivery systems (strategic and nonstrategic), regardless of range.
Nondeployed Weapons. The second type of inspection would cover the portion of the stockpile that is nondeployed. This includes warheads or bombs that are not mated to delivery platforms and retained in storage or at other facilities. In general, these weapons have a lower operational readiness compared to deployed weapons and present a less imminent threat of attack. The size, composition, and location of nondeployed warheads play less of a role in first-strike calculations, although they factor into considerations of upload potential, particularly if stored near operational bases. Therefore, these inspections can be carried out less frequently than those devoted to deployed weapons.

The authors propose that, by the terms of their inspection regime, the parties meet annually to negotiate the number of inspections they will mutually accept for nondeployed nuclear weapons (with a minimum of at least one per side per year). This number will depend on how many sites each side wants to inspect and, concurrently, is willing to accept on its territory in a given year. Once agreed, the inspection(s) would occur on short notice and be highly intrusive, given that the item of inspection—a warhead or gravity bomb—is very small. As noted above, weapons that are declared to be nuclear under New START are treated and accounted for as nuclear weapons. This has proven sufficient to date for verifying deployed numbers, because cheating—declaring a nonnuclear object to be nuclear—offers little benefit in a treaty driving reductions. This rationale can also apply to inspections of nondeployed weapons through use of a managed access approach, such as that described under the CWC. This approach will provide the inspecting party and host facility with an opportunity to negotiate the extent and nature of access within the boundaries of the declared site, enabling inspectors to confirm the number of nondeployed warheads (and the host country to take steps to protect sensitive information at the installation). Given the potential infrequency of these inspections occurring, and the ability to annually shape this part of the inspection regime, the parties have an incentive to maintain a sizeable portion of their stockpile in a nondeployed status as numbers are gradually reduced, which would greatly contribute to stability.

INSPECTIONS: DISMANTLEMENT

The final pillar of the inspection regime must address dismantled nuclear weapons. These inspections would be the first of their kind and must occur periodically throughout each phase of reductions to provide confidence that total stockpiles are diminishing, either through verification of disassembly or disposal (depending on how the treaty defines "dismantled"). These, too, should be carried out using a managed access approach, either bilaterally between participating states or with the assistance of an outside organization, such as the International Atomic Energy Agency (IAEA). This will be the toughest verification challenge to overcome, as the technical aspects of nuclear weapons design, which may be at risk of exposure during weapons dismantlement, are highly classified state secrets.

U.S. and Russian inspections of each other's dismantlement activities are feasible, however, as the two states have discussed and agreed to them in the past. In 1994, the United States and Russia agreed to bilateral on-site inspections of storage facilities for plutonium pits at Pantex (in the
United States) and Tomsk (in Russia). Although the agreement was never fully implemented, technical experts from both countries spent nearly two years debating methods to confirm the presence of weapons-grade material using nonintrusive verification procedures. Another example is the START III negotiations, which began in the late 1990s between the United States and Russia. Although talks eventually broke down, the parties spent years discussing potential transparency measures for the destruction of each other’s nuclear warheads. These prior negotiations, and lessons learned from joint deliberations and activities, may provide a useful point of departure for future U.S.-Russian arms control negotiations.

Moreover, the United States and Russia are not the only states considering the issue of disarmament verification. The United States and United Kingdom have cooperated for more than a decade on the technical challenges of verifying nuclear disarmament. Both allies have held several monitoring exercises at each other’s nuclear weapons facilities to test balanced approaches to protect sensitive information and enable effective monitoring. The U.S. Department of State also recently launched a new initiative, the International Partnership for Nuclear Disarmament Verification, to identify effective approaches to address this challenge by leveraging expertise and experience from both nuclear and nonnuclear weapon states.

As described above, there are several promising initiatives under way that may offer effective solutions to the challenge of disarmament verification. However, negotiators should not wait to begin discussions until the perfect technological solution is available to complement procedural techniques. Such a dialogue can begin in parallel to disarmament verification study efforts. Furthermore, it is not unusual for agreements to include provisions that permit the application of new technologies for the purposes of future treaty implementation activities. This approach should be applied here, especially given the encouraging research being done by nuclear and nonnuclear weapon states.

THE LONG GAME

As recognized earlier, the United States and Russia currently have the largest nuclear stockpiles in the world and are likely to retain this status for some time. The United States must be prepared to play the long game in reducing nuclear risks through the pursuit of multiple avenues, to include seeking mutual, verifiable reductions in the U.S. and Russian nuclear weapons stockpiles. A critical lesson to take from the history of U.S.-Russian arms control is that the negotiation,


24. The United Kingdom and Norway, for example, began an initiative in 2007 to examine a range of nuclear verification challenges and have tested ‘managed access’ techniques and information barrier systems.


implementation, and compliance of a treaty that realizes long-term benefits to both sides can require years of dedicated effort. The first round of nuclear arms control talks between the two began in November 1969; the two states have negotiated four major nuclear arms control treaties in 45 years. Given the stakes involved with nuclear forces, however, this investment of time and resources is worth it.

Time, however, is an ally to easing other nuclear weapons states—who have never participated in a nuclear arms control regime—into joining and implementing a weapons-focused, total stockpile treaty. The future multilateralization of nuclear arms control is supported as a matter of principle by all the NPT nuclear weapon states and as a matter of policy by both the United States and Russian Federation. If this paper’s suggested approach of 20 percent reductions per decade were applied it would take over 120 years for the United States and Russia to reach the size of the world’s next largest nuclear stockpile. Even if the other nuclear weapon states expand their arsenals while the United States and Russia reduce the size of their own, it could still take decades following entry into force before the parties’ stockpiles are close to reaching that of another nuclear weapon state. This should not discourage efforts to advance a weapons-focused, total stockpile approach committed to gradual, steady reductions. By offering a predictable timetable for U.S. and Russian reductions, the treaty would offer plenty of time for other states to prepare for, and eventually join, the treaty regime.

In addition, throughout each phase of reductions, the treaty’s implementing states could host review conferences to assess progress, build confidence, and encourage other nuclear states to consider joining the treaty. In addition to providing an opportunity for these other states to observe discussions and activities associated with treaty implementation, the conference could also provide an opportunity for current implementing states to share lessons learned, offer demonstrations of mock inspections, and take other steps to educate and familiarize governments outside the treaty regime with the language and processes of arms control.

When the U.S. and Russian stockpiles ultimately begin to approach the size of those in France, China, and/or the United Kingdom, the authors propose the treaty offer a step-by-step approach to bringing these states under the umbrella of the framework. This could include progressively greater involvement in treaty activities, from invitee status at regular review conferences, to

27. For example, Sergei Lavrov, Russia’s foreign minister, was quoted in June 2013 on Rossia-1 television as saying: “This means that further moves possibly proposed for reduction of actual strategic offensive arms will have to be reviewed in a multilateral format. . . . And I’m talking not just official nuclear powers, but all countries that possess nuclear weapons.” Global Security Newswire, “Russia: Talks on New Nuke Cuts Must Involve all Nuclear Powers,” June 24, 2103, http://www.nti.org/gsn/article/russia-non-nuclear-arms-must-play-talks-nuke-cuts/.

28. Hans Kristensen and Robert Norris estimate the third largest stockpile to be France at 300, followed by China at 250, then Britain at 225. Assuming initial U.S. and Russian stockpiles of 5,000 nuclear weapons and 20 percent net reductions every 10 years, these states would reach 344 nuclear weapons after 120 years. Kristensen and Norris, “Worldwide Deployments of Nuclear Weapons, 2014,” 97.

29. For example, based on the estimates in the above footnote, if China were to triple the size of its stockpile to 750 nuclear weapons, and the United States and Russia were reducing at a rate of 30 percent every 10 years, it would take 50 years for the parties to reach 840 nuclear weapons—at which point, it might be reasonable to expect third-party entry before further reductions are made.
observer status of some implementation activities (such as on-site inspections), to signatory status and full participant in the treaty’s implementation. Without the eventual participation of these other states, nuclear weapon reductions would likely level off at some point in the future, with the United States and Russia suspending their further implementation of weapons cuts until other states joined. Importantly, however, the authors assess that should the two major nuclear powers commit to an accord that gradually but steadily reduces their nuclear stockpiles, other states in possession of nuclear weapons are likely to feel significant pressure—applied both by the original signatories and nonnuclear weapon states—to join the regime. The benefits of transparency and the increased security realized through smaller stockpiles under the framework proposed here should incentivize other nuclear weapon states to sign on and motivate nonnuclear weapon states to support the treaty’s long-term viability.

Importantly, with regard to nuclear weapons, this paper advocates a “low but not zero” approach for the United States and other participating parties. The authors remain deeply skeptical of the concept of “nuclear zero,” because it would be difficult to verify and would create powerful incentives to cheat or break out (as even a handful of crude nuclear devices would turn an actor into a major nuclear power). Moreover, it might be impossible to define (for example, would a state without a finished weapon, but with latent capability to assemble one, be considered at zero?) or enforce. The reductions proposed here, however, would eventually bring the United States, Russia, and other participating states to low numbers of weapons, perhaps even into the dozens. This geostrategic environment would be very different from the present day (in the intervening period, for example, perhaps a revolution in verification technologies would facilitate reaching these levels), but at numbers this low perhaps a follow-on negotiation could take the additional step of de-mating all but a handful of warheads from deployed delivery systems.

CONCLUSION: RETURNING TO THE NEGOTIATING TABLE

Russia has consistently rebuffed U.S. efforts to engage in strategic or nonstrategic nuclear arms control talks in the years after New START entered into force. Russian officials have insisted that any discussions of further nuclear reductions must also address other issues, such as missile defenses, military systems in space, and conventional prompt global strike weapons, among other concerns. Furthermore, although the two sides continue to successfully implement New START, they are at an impasse regarding the future of the 1987 Intermediate-Range Nuclear Forces (INF) Treaty.30 Russia is also building up its numbers of strategic nuclear delivery systems and has stated that it is already at the “minimal” level of nuclear forces and is uninterested in discussing reductions beyond New START’s central limits.31 Given all of the above, it might appear doubtful that Russia would have any interest in engaging the United States on nuclear arms control in the future, beyond continuing to implement New START. However, similar skepticism was raised in the

mid-1980s, just two years before the United States and Soviet Union signed the INF Treaty and six years before they signed START I.\textsuperscript{32} Despite the complexities of the U.S.-Russian relationship over time, the two states have repeatedly returned to the negotiating table for the simple reason that each concludes they can reap benefits to their own security through the negotiation and implementation of nuclear arms control treaties.

When the two sides return to nuclear arms control talks, a shift to a weapons-focused, total stockpile framework will allow them to discuss weapons reductions without fear of compromising their nuclear deterrent forces. With regard to weapons on deployed delivery systems, for example, U.S. and Russian ICBMs and SLBMs represent powerful deterrent capabilities regardless of how many weapons they carry. Similarly, both states’ long-range aircraft can exercise deterrence against each other regardless of their exact numerical loadout of nuclear bombs and nuclear cruise missiles. Critically, a framework that makes a distinction between preserving a nuclear deterrent force (by not significantly limiting or reducing delivery systems) while simultaneously requiring the dismantlement of some, but not all, nuclear weapons within national stockpiles represents a “deter and downsize” approach that can prove acceptable to other states possessing nuclear arsenals. These states believe their national security demands an active nuclear deterrent but also recognize the destructive force, and potential consequences, of any potential nuclear weapon employment.\textsuperscript{33} A weapons-focused, total stockpile approach that encourages states to store (rather than deploy) their nuclear weapons, while gradually reducing their stockpiles and seeking to reduce the capacity for nuclear warfighting, acknowledges the value of nuclear deterrence.

New START and its predecessors played a vital role in stabilizing the U.S.-Russian strategic relationship. Their focus on strategic delivery systems—the highest-ranking pieces on the global chessboard of Cold War strategists—makes less sense in an era when the nuclear arsenals of multiple players pose threats to the United States. For the next generation of negotiations, and negotiators, the complex nature of nuclear risks, arms races, and coercion within contemporary geopolitics suggests an urgent need to shift the focus of future arms control agreements to the full nuclear stockpiles of nuclear-armed states.


\textsuperscript{33} “We fully comprehend the massive devastation and loss of life a major war would create, even if fought solely with modern conventional (or at any rate non-nuclear) weapons. The U.S., UK, and French deterrents help prevent this as well as nuclear war.” CSIS European Trilateral Nuclear Dialogue, “Consensus Statement Prior to the 2015 NPT Review Conference,” May 11, 2015, http://csis.org/files/publication/150510_15_European_Nuclear_Trilateral_PreRevCon_Statement_0.pdf.
Going Monadic? Debating the Future of France’s Forces Aériennes Stratégiques

Nicolas Giacometti

This article discusses the debate that has emerged in recent years regarding a potential abandonment of France’s Forces Aériennes Stratégiques (FAS), the air-leg of the country’s nuclear dyad of delivery means. It outlines and assesses the main arguments on both sides of the debate. It argues in favor of maintaining the FAS by highlighting its positive cost-benefit balance and justifies its existence in an industrial, political, operational, strategic, international, and doctrinal sense. Furthermore, it underlines the limited budgetary gains as well as the substantial strategic risks and costs that would be incurred by a decision to opt for a nuclear monad. Finally, it takes a look at the FAS’s future and demonstrates that this limited debate notwithstanding, various elements suggest that France can credibly be expected to maintain a nuclear dyad until at least the 2060 horizon.

INTRODUCTION

On October 8, 1964, a Mirage IV fighter-bomber of the Forces Aériennes Stratégiques (FAS; Strategic Air Forces) carrying the AN-11 nuclear gravity bomb took the first alert of France’s independent nuclear deterrent. Half a century later, France’s air force continues to have a strong role as the air-leg of the country’s nuclear dyad alongside the submarines of the Forces Océaniques Stratégiques (FOS; Strategic Oceanic Forces). The FAS ensures the nuclear mission equipped with

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French-made Mirage 2000N, Rafale, and Super Etendard fighter jets carrying the Air-Sol Moyenne Portée (ASMP), a nuclear cruise missile and other associated capabilities including tankers, satellites, or communication and control (C2) assets. While the main bases of the deterrent’s air-leg are based on land, France’s aircraft carrier also has all the equipment necessary to act as a forward-deployed operating base for nuclear airstrikes.2

The 50th anniversary of the FAS in 2014 and the various celebratory events have provided the air-leg’s advocates with an opportunity to highlight its various contributions to France’s national security. In this respect, the various declarations of support acted as a response to a limited debate started in 2013 when Hervé Morin, a former defense minister under President Nicolas Sarkozy, declared that in his opinion, France should abandon the air-leg in order to redirect the so-gained budgetary savings to the country’s conventional forces.3 While there are few analysts who would question the need for more investment in France’s conventional capacities at times in which they are engaged in an increasing number of the world’s hotspots, the solution put forward by Morin and advocates of a nuclear monad is a much more contentious issue. As such, it has sparked discussions that in some way disrupted the usual quietness that had characterized France’s nuclear issues.

The French case is not so different from other nuclear-armed states that currently experience discussions and debates linked to their respective nuclear force structures. In the United States, Matt Fay and Christopher Preble published a 2013 article arguing that Washington could rely on a nuclear force composed solely of nuclear submarines and their associated ballistic missiles.4 Similarly, in the United Kingdom, the perspective of the national deterrent’s renewal has led an influential think tank to suggest the abandonment of the sea-leg and a return to an air-leg equipped with the new F-35.5 Finally, Asian nuclear powers race toward fielding nuclear-capable submarines in order to ensure the survivability of their relatively small nuclear arsenals. While it is fairly easy to find articles discussing most of these developments in the English-speaking literature, the French case remains largely absent.6 Therefore, it is essential that analysts look at the French literature, which contains some recent and useful contributions on the issue of France’s nuclear force structure.

As such, this analysis aims at providing an English-speaking audience with an assessment of the utility of the air-leg for France’s national security. It argues in favor of maintaining the FAS by

2. The ASMP-A cruise-missiles are not loaded permanently on the aircraft carrier but can be embarked or transferred in a crisis situation.
6. Many reasons can be advanced for this, but the language barrier should be put first place. Indeed, debates on such issues are generally discussed in French-speaking publications that rarely have English versions.
highlighting their positive cost-benefit balance and justifying their existence in an industrial, political, operational, strategic, international, and doctrinal sense. Furthermore, it underlines the limited budgetary gains as well as the substantial strategic risks and costs that would be incurred by a decision to opt for a nuclear monad. Finally, it takes a look at the FAS’s future and demonstrates that the limited debate created by Morin’s position notwithstanding, various elements suggest that France can credibly be expected to maintain a nuclear dyad until at least the 2060 horizon.

**POSITIVE NONNUCLEAR EXTERNALITIES**

Many observers, including those who argue in favor of abandoning the air-leg of France’s nuclear forces, tend to further a view that opposes and conceptually overly disconnects the conventional and nuclear missions and forces. This, however, overlooks these forces’ inherent dependence on each other as well as the positive effects that the FAS can have for the French air force’s ability to carry out conventional missions.

The Dual Use of Nuclear Capabilities

The first positive, nonnuclear externality of the FAS for the conventional mission stems from the dual character of most of the capabilities employed by the French air force for carrying out a nuclear strike. Indeed, both the Mirage 2000N and Rafale fighter-bombers that carry the ASMP-A nuclear missile can also be used to deliver various types of conventional weapons such as conventional cruise missiles and guided bombs. Similarly, several other capabilities operated by the FAS for a primary nuclear purpose are also regularly used in conventional strike operations. For example, this is the case for military satellites used for intelligence, surveillance, and reconnaissance (ISR), targeting and electronic warfare purposes or the C-135FR tankers, which are crucial for long-range strikes and are all under the command of the FAS. The C-135FR and dual-capable fighter-bombers of the FAS have been regularly used in recent operations, such as Operation Harmattan over Libya in 2011, during which the FAS is estimated to have carried out around a third of the overall French airstrikes.7 Similarly, the FAS spend 60 percent of its time training for nuclear missions, which means that 40 percent of its activity remains in the domain of conventional warfare.8

The dual character of nuclear capabilities also permeates the realm of military technology. Indeed, some of the technologies initially developed for the nuclear mission give France the know-how to develop cutting-edge conventional weaponry. With regard to the air-leg of France’s deterrent, the work started as early as the 1970s on cruise missiles to adapt the air-leg’s capabilities to a new

threat environment characterized by increased air defenses can certainly be counted as one of the factors having contributed to maintaining France as a capable and independent missile manufacturer. Indeed, various technologies and capabilities associated with the ASMP and ASMP-A missiles were and are transferable to the manufacture of conventional missiles. As has been recognized by a senatorial report in 2012, the ASMP-A missile has been one of the main pillars of the development of the tactical missile industry in France and has led to major advances in various domains including the hardening of missile electronics, their propulsion (ramjets), navigation systems, aerodynamics, or penetration of highly defended airspaces. As such, the technological requirements of the nuclear deterrence mission give French industry a technological edge that it would not have without the FAS.

The Effet d’entraînement on Conventional Forces

A second argument in favor of maintaining the FAS stems from what French strategists label the effet d’entraînement (lead effect) of the nuclear mission for conventional forces. In a nutshell, in order to meet the nuclear deterrence mission, the conventional forces that surround the nuclear deterrent must also live up to the highly demanding standards of the nuclear domain.

These very demanding standards derive from various characteristics, including the inherent destructive capability of nuclear weapons, the limited number of assets available (France adheres to a policy of strict sufficiency in managing its nuclear arsenal), the fact that nuclear forces must strike at the heart of the enemy’s territory that tend to be the most heavily defended, their status of ultimate guarantor of the nation’s very survival, and their symbolic nature. As such, nuclear forces must remain at the highest levels of availability, safety, survivability, readiness, and efficiency at all times to guarantee the credibility of the nation’s deterrent.

These standards then permeate to conventional forces through several channels. First, it should be noted that a nuclear raid would generally mobilize not only the aircraft of the FAS carrying an ASMP-A nuclear missile but also a series of air force conventional capabilities in support of this mission. These might include suppression of enemy air defenses (both ground and air based) to protect the aircraft carrying the nuclear missile and tankers for air refueling, provide early airborne warning and control system (AWACS) notification, and coordinate battle management and command and control (BMC2). The forces fulfilling supporting roles train to meet the challenges and high-end threats that they could face during a nuclear mission. While the know-how and competencies acquired are primarily geared toward fulfilling a nuclear raid, they would also be usable in other conventional circumstances. Similarly to the training aspect, this logic also applies to the materiel used in such operations. Therefore, the requirements for carrying out a nuclear raid are

9. This has been clearly recognized by Antoine Bouvier, CEO of MBDA, France’s main missile manufacturer, in a recent article. Bouvier, “La composante nucléaire aéroportée pour MBDA,” 73.
one of the main determinants of the technologies available to the French air force in both conventional and nuclear terms. For example, the need during a penetration mission to fly at high speed, very low altitude, and high G-force to avoid detection and vulnerability to anti-air missiles puts a high stress on navigation and attack systems that have been specifically designed on the Rafale to attain maximum efficiency even in difficult and unknown environments.\footnote{André Bréand, \textit{Rafale: La suprématie aérienne} (Paris: E-T-A-I, 2005), 50–62.} While France might have developed such a system even without the nuclear mission, the need to have a credible air-based deterrent made it an absolute requirement. Again, while this capability was primarily designed for a nuclear raid, it is also very useful in conventional operations when facing an adversary with significant air defenses. Finally, the contributing role of conventional forces to the nuclear mission also means that they cannot be reduced under a certain level in terms of capabilities and numbers of assets assigned to them because this would directly impact their ability to successfully carry out a nuclear strike. This is the case with tankers, for example, which equally benefit conventional and nuclear long-range missions. Both the air-refueling capability and a sufficient number of such assets are an absolute requirement.

Therefore, French strategists often speak about the “structuring effect” of the nuclear mission on France’s overall force structure and format.\footnote{See, for example, Bruno Tertrais, “Budget Nucléaire et Retombées de la Dissuasion,” Fondation pour la Recherche Stratégique, June 1, 2015, 3, https://www.frstrategie.org/publications/notes/web/documents/2015/201513.pdf.} Such logic directly contradicts the argument against spending on nuclear forces and expenses on their conventional counterparts. Indeed, the technical and operational requirements of the nuclear mission directly necessitate sufficient spending on conventional forces that are thus protected from unconsidered budgetary cuts.\footnote{In this respect, Bruno Tertrais notes that the recent \textit{Loi de Programmation Militaire}, which defines French military expenditures, would probably not have maintained the necessary funds for the electromagnetic observation CERES (Capacité de REnseignement Electromagnétique Spatial) satellites if this had not been a requirement to fulfill the nuclear deterrence mission. Tertrais, “Budget Nucléaire et Retombées de la Dissuasion,” 3.}

The various examples outlined above directly show how the operation of an air-based deterrent positively contributes to the conventional capabilities of the French air force. Far from reducing the air force’s ability to carry out its conventional missions, the FAS actually increases it and ensures a continuous pressure on conventional forces to remain at the highest levels of competence. This serves both the interests of civilian decisionmakers aiming to have the most efficient forces at their disposal and military leaders who wish to maintain a sufficient level of defense spending.

The Complementarity between the Air-Leg and Sea-Leg in the Twenty-first-century Context

The differing characteristics of the components of the nuclear dyad complement each other in various manners that enable France to operate flexible and adaptable nuclear forces, a necessary condition for the credibility of the deterrent in today’s environment. In most instances, an adaptation of the sea-leg could not replace the advantage brought by the air-leg. This complementarity materializes in several different ways that broaden the scope of options available to the president, thus avoiding an all-or-nothing situation during a crisis.
TARGETING: THE LIMITED STRIKE OPTION

A comparison primarily of the believed accuracy of the ASMP-A cruise missile (air-leg) and M51 submarine-launched ballistic missile (SLBM) (sea-leg) associated with a quick review of some operational requirements of both legs demonstrates that the Rafale/ASMP-A combination represents the most adapted means for France to launch limited low-yield, high-precision strikes, while the SSBN (ballistic missile submarine)/SLBM combination gives the country a full second-strike capability. This capability has been confirmed several times publicly and privately by various French decisionmakers and analysts.16

Indeed, the ASMP-A missile is generally believed to have a circular error probability (CEP) situated between a few tens of meters, but not more than 30 meters. For the M51 SLBM, this number is most often believed to be situated between 100 and 300 meters. This could potentially be reinforced by a lower yield for the warhead fitted on the ASMP-A as is suggested by several declarations explaining that the ASMP-A gives France the capacity to precisely hit hardened targets with limited collateral damage.17 Indeed, this supposes a significant control over the yield of the explosion. While most open-source literature seems to point to the possibility to control the yield of the warhead fitted on the ASMP-A, authors diverge significantly over what those variable yields might be, thus prohibiting a credible comparison of the yields available to both legs. Finally, the operational parameters of the air-leg make it a more suitable limited strike force than the sea-leg, whose strike options can be modulated, but should rather be seen as a full second-strike capability. Indeed, the submarine loses its main advantage (stealth and invulnerability) at the very moment it launches one or more missiles. This might then put at risk the platform and the missiles it still carries and opens the door to a partially disarming strike that would destroy at least half of France’s immediately available intercontinental range missiles.18

The possession of a limited nuclear strike capability, certainly justified during the Cold War, has become even more important in the post–Cold War world and the second nuclear age. During the Cold War, France’s structural position in the international system was one of a medium power mainly threatened by a superpower with tremendous military superiority. This mostly required the possession of a survivable full strike nuclear force in order to deter major aggression from the Soviet Union against French territory in Europe.19 Although limited nuclear strikes were also justified by French doctrine in several ways, they could not, on their own, act as a credible deterrent.

16. See, for example, Compte-rendu n° 42 de la Commission de la Défense Nationale et des Forces Armées, “Audition du Général Denis Mercier,” 5.
18. France has a continuous at-sea deterrent; one SSBN is always at sea. French doctrine also envisages the possibility of having a second SSBN at sea in a crisis situation.
In the post–Cold War world, the situation is clearly made complicated in terms of deterrence dynamics, which requires new capabilities. Indeed, in addition to the potential resurgence of a major threat to Europe (coming, for example, from Russia), France now potentially faces other medium or smaller powers with strategic capabilities that could threaten its vital interests or those of its allies in a more limited fashion.\textsuperscript{20} Renewed French activism, especially in the Middle East, has led Paris to sign several defense agreements with different states of the region, including Qatar, Kuwait, Djibouti, and the United Arab Emirates (UAE). Although the content of these agreements is usually classified, the one with the UAE has often been described as very constraining; it is said to commit France to protect this state by all means necessary against foreign aggression.\textsuperscript{21} As a consequence, Paris permanently deploys its troops in this region. In theoretical terms, France's position has shifted from the protected during the Cold War period to the protector. This is particularly important in the context of growing concerns over Iran's behavior and its potentially threatening behavior toward French allies in the region. Indeed, Tehran might use its growing missile capability to strike French bases or allies on the Arabian Peninsula. As such, the 2013 Defense White Paper states that a conflict in the region would probably directly involve France.\textsuperscript{22} The most important fact, however, is that the threat to France's interests remains limited when compared to a full Soviet invasion before 1990.

In this context, threatening a full nuclear strike cannot be the sole instrument in the French toolbox. The more limited character of the threat against France's interests combined with increased imperatives for the proportionality of the response and respect of international humanitarian law call for a more adaptable deterrent that enables a state to better control the effects of its nuclear strike in order to maintain the credibility of the deterrent. Indeed, hugely disproportional nuclear threats are not deemed credible in Western states for several reasons. These include, among others, the public outcry they would cause, the risk for international opprobrium, and the acceptance of proportionality as a guiding principle for military operations. Furthermore, the existence of a limited strike option avoids the risk of being put in an all-or-nothing type of situation that would complicate French decisionmaking and limit the effects of France's deterrent.\textsuperscript{23}

Visibility/Demonstrability

The second advantage of the FAS over the FOS stems from its visibility, which can be used for signaling purposes during a crisis.\textsuperscript{24} The possession of a sufficient number of submarines (four in

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\textsuperscript{20} While limited threats are generally seen as coming from medium powers, they could very well stem from the actions of a stronger power such as Russia or China.


\textsuperscript{22} Ministère de la Défense, Livre Blanc: Défense et Sécurité Nationale, 2013.

\textsuperscript{23} Interview of General Patrick Charaix, commander of the FAS, by the defense commission of the national assembly on April 15, 2014, http://www.assemblee-nationale.fr/14/cr-cdef/13-14/c1314042.asp#P5_268.

\textsuperscript{24} This has been openly stated as one of the main roles of the air-leg by President Hollande during his 2015 speech at Istres Air Force Base on nuclear deterrence. President François Hollande, speech during the visit to the strategic air forces, Istres Air Force Base, February 23, 2015, www.basedoc.diplomatie.gouv.fr/vues/Kiosque/FranceDiplomatie.
the French case) enables a state to have a continuous at-sea deterrent that gives it an assured second-strike capability. SSBNs have the main advantage of being invulnerable to enemy action as they can hide underwater for extensive periods of time. On the contrary, the various components of the air-leg are generally visible by the adversary through various means, including satellite surveillance of key sites such as air bases and aircraft carriers, or radar surveillance for in-flight detection. While this visibility makes the air-leg generally more vulnerable to a disarming strike, it could also be used by France for nuclear signaling and warning a potential adversary.

Indeed, during a crisis, France could at some point want to signal to an adventurous adversary that its actions are coming close to triggering nuclear retaliation by France. France might also want to remind an adversary of its ability to use nuclear weapons to defend itself or an ally if need be. All of these elements would serve deescalation purposes as they would serve to frighten an adversary, compelling it to assume a more reasonable and less threatening posture. Additionally, they might act as reassurance measures for some allies that could grow wary of an adversary’s behavior. This would be done with the advantage of not having to actually launch a nuclear weapon. As such, it represents a less escalatory solution for France in a crisis and increases the number of options available on the escalation ladder.

Such signaling could be done by increasing the level of readiness of the FAS to a certain level. Such a maneuver could start with taking the ASMP-A missiles out of storage facilities; by loading them on aircraft; by putting the aircraft in alert mode, which can have several physical implications, such as having them ready for takeoff on the runway; by putting them in the air in a waiting position; or even by having them approach the adversary’s border. It should be noted that a nuclear raid would generally not only employ the fighter-bombers that carry the nuclear cruise missile, but also a whole series of other supporting conventional capabilities that should also be readied in parallel. This would not go unnoticed by an adversary with significant satellite surveillance capabilities who would then know that a nuclear raid is in preparation. In the case of an adversary that does not have such satellite surveillance capabilities, an ostensible fly-by of nuclear capable fighter-bombers, with or without their nuclear payload, would certainly be detected by air-defense radars and could even be publicized after completion of the mission.

Such actions are nothing exceptional and are surely not limited to the French case as was clearly demonstrated by the flight of two U.S. B-2 bombers close to North Korea during a crisis in 2013. In the French case, although they were not directly and publicly geared toward a specified adversary, recent exercises and operations involving the FAS have shown the readiness and capacity of the French air force to carry out all phases of a nuclear strike. This is the case two to three times a year with the Poker exercises conducted over French airspace. In 2014, two Rafale aircraft of the FAS conducted a 8,800-kilometer long-range flight from metropolitan France to the French Indian

25. During a recent exercise of the FAS, a foreign satellite was spotted while surveilling the French exercise. See Interview of General Charaix, commander of the FAS in front of the defense commission of the national assembly on April 15, 2014.


27. “L’armée de l’air a conduit un nouvel exercice Poker en France.”
Ocean territory of Reunion Island, thus demonstrating France’s long-range strike capability.28  
Finally, various conventional strike operations conducted by the FAS over Libya and Mali have shown its capacity to operate long-range strikes involving the launch of a cruise missile (albeit not a nuclear one) in an operational environment. While all these events were not primarily geared toward a specific adversary or linked to a particular crisis, they have shown the high level of readiness and competence of the FAS and have therefore added to the credibility of France’s deterrent. 

**A Recallable Force** 

The third advantage of the FAS over the FOS that is generally put forward is linked to the possibility to recall an aircraft up until the last moment before the launch of the cruise missile, which is not feasible with SSBNs. Indeed, although operational procedures are generally classified and thus are difficult to comment on, it seems that once the order is given to an SSBN to launch its missiles, it will cut all communications, go to its firing position, and proceed to launch. On the contrary, it seems that the aircraft composing a nuclear air raid would maintain contact with their command and control centers for a much longer period of time, which allows recalling them at the last minute. 

Such a possibility clearly has advantages as well as disadvantages. On the one hand, it might play against the credibility of France’s nuclear deterrence threats as it goes against the automaticity of the response to an attack. As such, an adversary could hope that last-minute remorse on the side of French decisionmakers could push them to recall their aircraft and thus prevent the launch of a nuclear-tipped missile. However, on the other hand, this might also be an advantage as it allows some increased level of flexibility in the management of a nuclear crisis. It is not impossible that an adversary, realizing what is to come, would decide to back down at the last minute, thus allowing for the nuclear raid to be stopped before nuclear detonation. This latter scenario can be linked to the issue of visibility, as it could be the visible character of the threat that could cause such a last-minute back down. 

**Increased Chances of Getting through Enemy Defenses** 

Finally, the last complementarity between the FOS and the FAS is based on the idea that having two delivery modes instead of one inherently complicates the possibility for the adversary to successfully mount defensive actions against a nuclear attack.29  

Indeed, an adversary facing a monad would only have to defend against one delivery means, which would automatically make it easier for it. In the case of a dyad such as France’s, potential adversaries wishing to defend themselves against a French nuclear attack would have to mount successful defenses against both the SSBN/SLBM combination and the aircraft/cruise missile combination, which is more costly and technically difficult to operationalize. This in turn increases the chances for at least a few warheads to get through the adversary’s defenses, thus leaving no

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29. See General Bentégeat’s statement during a hearing at the French National Assembly on April 9, 2014.
chance to avoid a French nuclear strike. This is particularly important today with the proliferation of both ballistic missile and air defenses increases. The additional delivery means brought by the FAS contributes to France's efforts to maintain an assured strike capability in the face of ballistic missile defenses' vertical and horizontal proliferation.

Additionally, the possession of a nuclear dyad would mitigate the effects of a sudden breakthrough in submarine detection technology, which is fairly unlikely in the short and medium term but cannot be entirely ruled out. In such a scenario, SSBNs would become targets of choice for potential adversaries wishing to launch a preemptive strike against France's nuclear forces. The concentration of most of France's intercontinental-range missiles on one or two submarines would make this endeavor even easier. The FAS, through various means including dispersal or increased levels of readiness in times of crisis, would then provide some increased survivability to France's nuclear forces, thus enhancing the credibility of the country's deterrent.

THE MONAD: LIMITED BUDGETARY GAINS AND STRATEGIC LOSSES

The analysis of the advantages gained from maintaining a dyad of nuclear forces has shown how important it is for France to retain this capability. A study of the consequences of a decision that would abandon the FAS reinforces this conclusion because of the limited budgetary gains to be made and the potential important strategic costs such a move would impose.

Limited Budgetary Gains

Most actors arguing in favor of abandoning the FAS generally do not criticize the above analysis about the advantages of a dyad. However, like Hervé Morin, they shift the debate to the budgetary arena by explaining that notwithstanding the many positive aspects of a nuclear dyad, it is no longer affordable in today's fiscal environment. As a result, they advocate that going monadic would free up a certain amount of public funds that could then be funneled into much needed investments in France's conventional forces. While this Robin Hood argument (take money from the rich to give to the poor) looks legitimate at first glance, it is much less so after a thorough analysis of the amount of potential savings that would indeed result from going monadic.

The first factor that would severely limit the potential gains of abandoning the air-leg comes from its relatively limited cost. Although some marginal variations in the calculation might appear from one analysis to another, the air-leg is generally estimated to use less than 10 percent of the public expenditure on nuclear deterrence, which itself represents around 30 percent of the investment credits of the Ministry of Defense. This number, which has remained relatively steady since the

32. See Compte-rendu n° 42 de la Commission de la Défense Nationale et des Forces Armées, "Audition du Général Denis Mercier," April 14, 2014, 8; and "LOI n° 2013-1168 du 18 décembre 2013 relative à la programmation militaire
end of the Cold War, represents a nominal sum of around €300 million per year. Furthermore, the dual-use character of many of the assets fielded by the FAS and their regular use in conventional missions must be factored in and taken out of the potential budgetary gains as a contribution in-kind of the FAS to conventional operations. Because of classification and accountability issues, it is difficult to have a precise evaluation of the part of the air-leg’s budget that is in fact allocated to conventional operations. However, this argument is useful because it highlights that only the expenses solely destined to the nuclear mission would indeed be saved if the FAS were to be abandoned. A 2012 Senate report estimated the potential savings as follows: “In the medium-term, suppressing the air-leg would save €56 million per year on operational expenses, and in the longer-term around €600 million for the mid-life upgrade of the ASMP-A missile and €500 million on various studies for its follow-on. These sums are limited when compared to the decades during which this capability will operate.” This analysis takes into account the short-term costs of a dismantlement of the air-leg, as well as the fact that most of the equipment required for the air-leg to operate until 2035 has already been entirely paid for and would thus not generate any budgetary savings. It does also take into account that the Multi Role Tanker Transport (MRTT) that will start replacing the C135-FR in 2019, while being primarily assigned to the air-leg of the nuclear deterrent, are also extensively used for conventional operations and would have to be bought anyway. It finally shows that, in fact, the only system generating substantial expenses while being exclusively used for nuclear operations is the ASMP-A cruise missile and its follow-on. As such, the limited cost of the FAS also means that it cannot be a significant source of savings. Moreover, it is difficult to believe that all the savings generated by the abandonment of the air-leg would be automatically reallocated to conventional forces. In France’s current fiscal climate, it is more likely that the money so gained would be allocated to other public expenses with a primary interest in financing the country’s ever-increasing debt.

As noted by Antoine Bouvier, such a conclusion is even reinforced in some scenarios in which France would decide to adapt the remaining sea-leg and conventional forces in order to mitigate the capability gaps that would appear with the abandonment of the FAS and that might endanger the credibility and efficiency of the country’s independent nuclear deterrent. Indeed, there is no other weapon in the French arsenal today that could rapidly replace the ASMP-A missile’s

33. Some might argue that this number should be increased to integrate part of the costs of the simulation program aimed at maintaining the safety and reliability of France’s nuclear warheads without real-world nuclear testing, but abandoning the FAS would not generate any savings in this domain as the program would have to be maintained for the safety and reliability of the sea-leg’s warheads.

34. For example, how should the 30 percent of French conventional airstrikes on Libya carried out by the FAS in 2013 be accounted for?


36. The French defense budget has already suffered severe cuts because of the country’s debt.

capability for low nuclear yield and high-precision strike. This is particularly important as this would certainly remain a requirement for French forces imposed by the country’s defense strategy even after the abandonment of the air-leg. The development of a very-high-yield conventional cruise missile with important earth-penetration characteristics could offer a mitigation option, but this would take time to develop and be both financially and technically challenging in the current environment. The alternative option would be to modify the sea-leg’s SLBMs in order to increase their precision and lower their potential yield. While technically feasible, this would again generate very high costs as it would require a complete modification of the missile’s navigation system and significant work on its nuclear warheads. As such, if France wished to maintain the current deterrence doctrine based on a variety of strike options without foreign help, it would have to accept important investments that would certainly absorb all the potential savings anticipated from an abandonment of the air-leg.

Strategic Losses/Cost

The extent of the cost imposed by an abandonment of the air-leg would be partly driven by the various requirements set to nuclear forces by France’s nuclear and defense strategies. At the core of this reflection lies the question of whether France would wish to maintain its current nuclear strategy and its central principle which is the absolute independence of its nuclear deterrent. Indeed, this decision would define the number of options available to mitigate the aforementioned capability gap.

The absolute independence of the nuclear deterrent has been at the core of France’s nuclear and defense strategy since the 1960s when the country first tested and fielded nuclear weapons. Indeed, the difficult experience of the Suez Crisis in 1956, President Charles de Gaulle’s specific perception of the United States, France’s particular position in the Cold War, and the reflections of most French nuclear strategists led France to believe that it should not rely on the United States’ extended deterrence but instead develop its own indigenous deterrent. Today, independence remains at the core of France’s defense strategy and of the dominant narrative regarding France’s international action. As such, it is highly unlikely that France would abandon such a cornerstone of its identity. Therefore, the option of integrating the French deterrent into that of NATO and counting on the alliance’s airborne nuclear capability would not be an option. Mitigation options would instead have to comply with the independence principle, whose abandonment represents an unlikely major strategic shift.

Within this framework, France would have to mitigate the capability gaps that would have appeared in several domains relating to the main advantages of the air-leg outlined above or accept capability losses that could not be easily remedied.

At the level of survivability, the disappearance of the air-leg would imply that the French deterrent would solely rest on the sea-leg. This would automatically ease the defense for a potential

38. It should be noted that the choice for the development of an SLBM with lower accuracy was made partly because of the knowledge that France could rely on the air-leg to provide more accurate strike options.

39. See, for example, President François Hollande, speech during the visit to the strategic air forces, Istres Air Force Base, February 23, 2015.
adversary who would have to defend only against ballistic missiles and not against cruise missiles. Furthermore, an unlikely but potential technological breakthrough in submarine detection technology would put at risk the entire French deterrent with only limited means to secure the survivability of France’s nuclear arsenal.

In terms of visibility, France would lose the possibility of conducting a nuclear show-of-force to deter an adversary or reassure an ally. Of course, this could also be done with conventional forces, but they would never be able to project the same symbolic and material power as their nuclear counterparts. Another option would be to put a second submarine at sea in a crisis situation. Such a move would certainly be seen by an adversary with significant ISR capabilities, but it would remain unseen by medium powers lacking these detection capabilities. As such, France’s capacity to signal resolve in a crisis would be much more limited, even with a conventional mitigation option.

The assessment is fairly similar with the effet d’entrainement ensuring that conventional forces are trained, equipped, and funded to the standards required in order to conduct nuclear missions. While nothing would prevent the French air force and government from maintaining these high standards even without the air-leg, the necessity to do so would be more limited.

The issue of the availability of a low nuclear yield and high-precision strike option in the absence of the air-leg could be the subject of significant analysis. Overall, in a scenario in which France would want to maintain the main principles of its nuclear strategy, there would necessarily be new inefficiencies or losses even after mitigation solutions are established. A first option would be to use the already existing limited strike capability of French SSBNs available due to the mating of a variable number of warheads on French SLBMs and their electromagnetic pulse (EMP) capability. However, the latter’s effects still could not be controlled in the same way as the ASMP-A because of accuracy and yield issues. Another option would be to increase the accuracy and control of the yield of France’s SLBMs and their warheads, but this would be costly and time consuming, thus negating the possibility for budgetary savings that would most likely be the primary aim of abandoning the air-leg. In any case, the operational parameters imposed on the sea-leg would limit its ability to be a perfect replacement for the air-leg. Indeed, a submarine launching even one SLBM would immediately reveal its position to an enemy with sufficient ISR capabilities. Although this would not be the case against medium powers, a great power could certainly locate the original location of the submarine and try to sink it. While a second submarine could still be at sea, this would nevertheless result in the loss of half of France’s immediately available nuclear warheads, a tremendous strategic loss. As a result, it would be very risky to use France’s SSBNs as the only available option for limited nuclear strikes in the absence of the air-leg. A last option could be to use conventional weapons to replace the capabilities brought by the ASMP-A. However, it is far from assured that this would be technically and financially feasible. Additionally, a conventional strike would not carry the same symbolic weight as a nuclear one. While this could be a positive

40. President Hollande confirmed the variable number of warheads on French SLBMs during his 2015 Istres speech. For the EMP capability of the M51 SLBM, see B. Tertrais, “Memorandum from Bruno Tertrais,” Select Committee on Defence Written Evidence, February 17, 2006, http://www.publications.parliament.uk.

41. A clear answer to this question would require having access to highly classified data.
aspect (it becomes more usable), it might also be a problem in other situations (the lower symbolism would not have the same shocking effect on the adversary). Finally, in a different scenario, France could also change its nuclear strategy to exclude some of the missions devoted previously to high-precision, low-yield strikes, but this would at least theoretically result in a decreased control of escalation during a crisis because of the more limited number of options available to French decisionmakers.

Looking to the Future: The Continued Existence of the Air-leg

This analysis would not be complete without a cursory examination of the future of the air-leg and the potential influence that the debate about its utility has had on the prospects for continued investment in the FAS. Overall, it seems that we can expect with significant certainty that France will retain an air-leg to its nuclear forces until at least 2060.

Indeed, the limited debate about maintaining the FAS does not seem to have had any influence on the development and acquisition processes of various weapons systems required by the FAS. In this respect, it should be noted that decisions and investments on most components of the air-leg had already been made prior to the eruption of the debate (part of Rafale delivery, ASMP-A delivery, C-135FR replacement) and guarantee the FAS’s capacity to operate freely until 2035.42 The most important decision being made during and after Morin’s declarations are linked to the half-life renovation of the ASMP-A missile and the development of its follow-on. If the debate about the FAS had any influence on French decisionmakers, some delays, programmatic modifications, or even an outright cancellation could have been expected. This, however, has not been the case. There is no indication currently that the nuclear cruise missile’s half-life renovation will not happen. Furthermore, during his speech on nuclear deterrence at Istres Air Force Base, President François Hollande confirmed that a study on the ASMP-A follow-on has been commissioned. Two main technological options supposed to adapt the future missile to its operational and threat environment have been selected: either hypervelocity (above Mach 6) or stealth. While the final decision on the concept for the ASMP-A follow-on should not be expected before 2018, it is noteworthy that the study currently being conducted does not ask the question of whether such capability should be maintained but what form it would take. This, added to various declarations already discussed in this analysis, confirm the willingness at the highest levels of the political decisionmaking process to maintain the existence and credibility of the nuclear force’s air-leg after 2035. If, as it is likely, the ASMP-A’s follow-on has the same life expectancy as its predecessor, it should be operational until the 2060s. As such, and considering the life expectancy and potential replacement of the Rafale aircraft, a programmatic approach suggests that the French air force can be expected to retain most of the capabilities linked to nuclear airstrikes until the 2060 horizon.43


43. The last Rafale aircraft will most likely be replaced around 2060. However, a follow-on capability will certainly be already fielded in the 2030s as suggested by General Mercier. See Compte-rendu n° 42 de la Commission de la Défense Nationale et des Forces Armées, “Audition du Général Denis Mercier,” April 15, 2014, 17.
These successive decisions ensuring the durability of the FAS show the very limited influence that opponents of the air-leg have today in France’s decisionmaking system. Hervé Morin himself, the instigator of the debate, cannot be counted as a major political French personality. Although he was minister of defense from 2007 to 2010, it should be remembered that most decisions related to international affairs, defense, and especially nuclear deterrence are traditionally concentrated in the hands of the president and his closest advisers. Since 2010, Morin has not been able to gain a significant influence in French national politics. In 2012, he announced his intention to run for the presidency, but was never able to poll above 2 percent of voting intentions and finally withdrew from the electoral race. Similarly, in 2014, he did not manage to win the presidency of the Union des Démocrates et Indépendants (UDI) party, a center-right party that generally remains under 15 percent of the votes at the national level. Finally, it should also be noted that his statements on the air-leg have only rarely been supported by other political actors’ declarations. He has not built any significant momentum. This is the same with other potential opponents of the FAS, who are global disarmament advocates. Indeed, because of the relative consensus over the need to retain a national independent deterrent in French politics, global zero movements have never been able to gather sufficient support in elite circles or the general population. As such, the national deterrent continues to enjoy an almost-sacred character that benefits advocates of the air-leg and limits the risk of a sudden political turnabout that would endanger the existence of one or more components of France’s nuclear deterrent.

Furthermore, it will be difficult for opponents of the FAS to argue against the air-leg if, as seems probable, the same cost-benefits balance exists in the future. Indeed, the arguments linked to the positive nonnuclear externalities of the FAS are not linked to potentially changing variables, which means that they will most likely remain unchanged until 2060. Similarly, the difference in operational requirements and conditions between the two legs of the nuclear dyad make it nearly impossible for one leg to fully replace the other with the same set of advantages outlined above. There is no reason to imagine that French strategy will not maintain the need for limited nuclear strike options. Finally, in a broader perspective, various strategic developments, such as proliferation tensions in the Middle East and Asia, Russia’s renewed aggressiveness, or the increasing unpredictability of the international system’s evolution are not conducive to major advances in nuclear disarmament. In this context, France will most likely continue to adapt and sustain its nuclear forces to maintain a credible and efficient nuclear deterrent to ensure its security. This is confirmed by an article by General Philippe Steininger, commander of the FAS, who outlined the three main characteristics of the future military and international environments that justify retaining the FAS. For General Steininger, the increasing number and broadening set of threats requires sufficient, long-range, and flexible assets such as those provided by the FAS. Second, the increasing probability of adversaries that are mostly inexperienced in dealing with nuclear crises and politics will require demonstrable forces to maintain the best capability for nuclear signaling. Finally, the ever-improving defensive capabilities of potential enemies, especially in the field of missile defenses, will augment the relevance of the cruise missile as an alternative delivery means.44

44. Philippe Steininger, “Pertinence de la composante aéroportée dans la stratégie de dissuasion nucléaire,” Revue Défense Nationale (Summer 2015), 42–47.
Overall, these elements demonstrate that if current and future trends have been correctly assessed, France should be expected to sustain its capability for nuclear airstrikes for the next 50 years if no strategic surprise happens in the interim. Such events are inherently impossible to predict and define accurately, but events that would lead to the abandonment of nuclear deterrence altogether (such as a limited nuclear use triggering a massive international shock and outcry), France’s abandonment of the independence concept, or a tremendous technological breakthrough in defenses against nuclear airstrikes could seriously call into question the relevance and continued existence of the FAS. While they cannot be ruled out, they still seem fairly unlikely today. In the absence of such events, the FAS will continue to contribute to France’s independent nuclear deterrent in the future.

CONCLUSION

Overall, France is poised to maintain the air-leg of its deterrent until 2060. While other approaches may have focused on other explanations, such as administrative inertia or parochial interests of various groups within the decisionmaking process, this analysis has highlighted the strategic logic that justifies maintaining the FAS. Through a combination of positive nonnuclear externalities benefiting conventional forces and the FAS/FOS complementarity flowing from the former’s inherent characteristics, the air-leg gives France the useful, flexible, and credible deterrent it needs to address some of the main challenges posed to nuclear deterrence by the twenty-first century environment. As such, far from weakening the FAS, a debate about its relevance eventually reinforced the need to maintain it as an important component of France’s independent deterrent.

Additionally, the analysis of the air-leg’s costs and the very limited budgetary savings (if any) that would flow from its abandonment confirm the idea that the shift from a nuclear dyad to a monad would yield only limited benefits (if any).

The fact that many of the arguments outlined here can be found in and traced back to statements of France’s current and former civil or military leaders shows that the strategic calculus favoring the FAS is clearly understood and internalized at the highest levels of the country’s decisionmaking process. This, in turn, explains the efforts already undertaken by France at the technological and materiel level in order to ensure the continued existence and credibility of the air-leg for the next five decades.

In this respect, French decisionmakers are not the only ones willing to invest in such capabilities. The United States, United Kingdom (through the F-35 and NATO’s nuclear sharing arrangements), China, and Russia are all in the process of upgrading and modernizing the air-leg of their nuclear forces. Thus, further analyses could seek to identify the various arguments put forward in these countries’ national debates about nuclear force structure in order to have a more comprehensive understanding of the strategic logics leading to the development and fielding of aerial nuclear forces throughout the world.
Reducing the U.S. Nuclear Arsenal: Current Plans and Challenges to Implementation

Greg Terryn

*It is the expressed position of the Obama Administration to sustain a “safe, secure, and effective” nuclear force and to preserve a credible nuclear deterrent “with the lowest possible number of nuclear weapons.” The United States is currently reducing its deployed nuclear forces in compliance with the New Strategic Arms Reduction Treaty (New START) negotiated with Russia, which places a limit on the number of strategic nuclear warheads and launchers deployed by each state. While the Pentagon has indicated that the United States could safely reduce its deployed strategic forces by as much as one-third below the New START levels, no policies to this effect have been implemented and no further strategic arms reductions have been negotiated with Russia.* This paper explores the possibility of further reductions to the U.S. nuclear arsenal, the challenges to negotiating and implementing these reductions at both the domestic and international policy levels, and other factors, such as budgetary constraints, that have a bearing on the overall size of the U.S. nuclear force.

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1. At time of submission, Terryn was a Herbert Scoville Jr. Peace Fellow. The views and opinions expressed in this paper are those of the author and do not necessarily reflect those of any organization.
4. Ibid., 6.
INTRODUCTION

On April 5, 2009, in Prague, President Obama outlined his vision for a world without nuclear weapons.\(^5\) To the applause of the crowd, the president committed the United States to reducing the size and role of its nuclear arsenal, while challenging the other nuclear powers to engage in a similar effort. Though generally optimistic, the president acknowledged the considerable obstacles that impede the accomplishment of such an ambitious task, indicating that “global zero” might not be reached in his lifetime. Until that day, the United States would be committed to maintaining a safe, secure, and effective nuclear arsenal and to striving to preserve a credible nuclear deterrent “with the lowest possible number of nuclear weapons.”\(^6\)

The Prague speech represented a high-water mark for the prospect of substantial reductions in the global nuclear stockpile. The subsequent arms control agreement between the United States and Russia, officially known as the Treaty between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (usually shortened to New Strategic Arms Reduction Treaty [New START]), was intended to be the beginning of a more extensive cooperative effort for bilateral nuclear reductions. But in the years since New START’s implementation in 2011, Russian hostilities in Ukraine and adversarial posturing between the West and Russia have blunted enthusiasm for further cooperation.

This tension only increases the difficulty of negotiating further nuclear reductions between Russia and the United States. Significant differences in the structure of each nuclear force and differing security interests between Russia and the United States also pose barriers to reaching a new arms control agreement. Notwithstanding the challenges to further reductions in the U.S. nuclear arsenal, efforts toward restarting arms control negotiations should not be abandoned because there are important security benefits associated with increasing nuclear transparency, further reducing nuclear weapons stockpiles, and preventing a backslide of the considerable progress made since the height of the Cold War.

This paper explores the potential for further reductions to the U.S. nuclear arsenal below New START levels and the international and domestic challenges to implementing these reductions. While this paper focuses on the relationship between the United States and Russia, it also considers the influence that China and allies reliant on extended deterrence have on U.S. plans to conduct further reductions.

Ultimately, the United States may need to exercise patience until a fundamental shift in the current dynamic with Russia allows for a decline of tensions and the reopening of an arms control dialogue. In the interim, the United States should strive to initiate greater transparency for nuclear arsenal–related information and reestablish cooperation in other nuclear-related areas to create an environment more conducive to future arms control discussions and negotiations.

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5. President Barack Obama (speech, Hradcany Square, Prague, April 5, 2009), https://www.whitehouse.gov/video/The-President-in-Prague#transcript.
BACKGROUND

U.S. Nuclear Arsenal: Size and Purpose

Size and Shape of the U.S. Nuclear Arsenal

As of September 2014, the United States maintains a nuclear stockpile of 4,717 warheads.7 In addition, the United States has about 2,500 nuclear weapons that have been retired and are awaiting dismantlement, bringing the total inventory of the U.S. nuclear stockpile to around 7,200 nuclear warheads.8

The United States maintains a nuclear triad of delivery systems: intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and strategic bombers to provide flexible strike options and improve the survivability of the U.S. nuclear deterrent. The ICBM leg creates a targeting complication for adversaries, requiring the use of two or more nuclear warheads to destroy a single U.S. warhead. This increases the cost for an adversary to launch a disarming strike; only Russia has an arsenal large enough to threaten these targets. The SLBMs on patrolling nuclear submarines are the most survivable leg of the triad and preserve the arsenal’s retaliatory strike capability in response to a disarming attack. Lastly, the nuclear-capable bombers are considered useful as a signaling force and can be mobilized to provide assurances to allies and demonstrate resolve to adversaries.

Currently the United States deploys 450 ICBMs, each loaded with one nuclear warhead; 14 nuclear submarines with an estimated total of 288 SLBMs, each carrying 4 or 5 nuclear warheads; and 94 nuclear-capable bombers that can deliver gravity bombs and nuclear-tipped cruise missiles.9 The United States also has an estimated 180 forward-deployed tactical nuclear weapons stationed in five North Atlantic Treaty Organization (NATO) countries: Belgium, Germany, Italy, Netherlands, and Turkey.10

Determining the actual number of deployed nuclear warheads is difficult, partly because deployment levels fluctuate as nuclear submarines, ICBMs, and bombers undergo maintenance and partly because the counting rules for arms control treaties do not account for each individual warhead. One estimate that includes tactical nuclear weapons and accounts for each individual nuclear weapon that a bomber could carry concludes that the United States has around 2,080 deployed nuclear warheads.11

Purpose of U.S. Nuclear Weapons

According to the 2010 Nuclear Posture Review conducted by the Departments of Defense and Energy, the “fundamental role of U.S. nuclear weapons, which will continue as long as nuclear

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8. Ibid.
10. Ibid., 115.
11. Ibid., 107.
weapons exist, is to deter nuclear attack on the United States and its allies and partners."\textsuperscript{12} To date, the United States provides an extended nuclear deterrent to the 28 member states of NATO, Japan, South Korea, and Australia\textsuperscript{13} by threatening to employ its nuclear capability in "extreme circumstances to defend the vital interests of the United States or its allies and partners."\textsuperscript{14} In maintaining such a posture, the United States has not adopted a "no first use" doctrine and does not identify deterrence as the sole purpose of its nuclear arsenal.

Though the United States included nuclear weapons in Cold War planning as a force multiplier in response to conventional attacks, U.S. military superiority has improved the president’s options for response and reduced the necessity for nuclear weapons to deter conventional aggression.\textsuperscript{15} In addition, the most acute threats to international security, such as terrorism, cyber attacks, climate change, epidemics, and hybrid warfare, are either unaffected by nuclear weapons or fall below the threshold of what nuclear weapons can credibly deter.

Past Progress

The United States has already made considerable progress in reducing its nuclear force. From its peak stockpile size of 31,255 warheads in 1967, the United States has significantly reduced its nuclear arsenal by nearly 85 percent to the current stockpile of about 4,700 warheads.\textsuperscript{16} Russia has reduced its arsenal in parallel with the United States, from an estimated peak of 45,000 nuclear weapons in 1986\textsuperscript{17} to its current size of some 4,500 warheads, through incremental cooperative steps during and after the Cold War.\textsuperscript{18} These arms control efforts, initiated to reduce the existential threat to humanity posed by nuclear weapons, also established transparency and verification mechanisms to facilitate cooperative arsenal reductions and enforced limitations on destabilizing capabilities. Since the United States and Russia still possess more than 90 percent of the estimated global stockpile of nuclear weapons, these past agreements, along with future initiatives between the two countries, will be essential to progressing toward the goals outlined by the president in Prague.\textsuperscript{19}

New START

The most recent arms control agreement between Russia and the United States, the New START Treaty, was signed in April 2010 by President Barack Obama and Prime Minister Dmitry Medvedev

\begin{thebibliography}{9}
\bibitem{15} Ibid., 5.
\bibitem{19} Ibid.
\end{thebibliography}
and entered into force on February 5, 2011, for a duration of 10 years. Under the treaty, neither state may deploy more than 1,550 strategic nuclear warheads and 700 strategic launchers, including bombers, nor possess more than 800 total strategic launchers and bombers by the February 5, 2018, deadline. To promote transparency and verify compliance, the countries have established a monitoring system that includes data exchanges on each country’s progress toward the treaty’s limits, a notification system for changes in deployment or force readiness, and as many as 18 annual on-site inspections of each country’s deployed and nondeployed nuclear weapon sites. As of March 2015, both the United States and Russia are on a trajectory to meet the treaty’s central limits, as shown in Table 1.

To comply with the limitations of New START, the United States plans to reduce its deployed ICBM force to 400 by unloading 50 silos; it will not, however, completely eliminate these 50 silos, which will still count toward the total force of 800 launchers. The United States will also eliminate 4 of the 24 SLBM launchers on each of its 14 nuclear submarines, maintaining a deployed force of 12 submarines and 240 deployed SLBMs at any given time. It will also maintain 60 strategic nuclear-capable bombers: 42 B-52s and 18 B-2s. This potential force structure of the U.S. strategic nuclear forces is outlined in Table 2.

Table 1. New START Deployed Strategic Nuclear Forces (March 1, 2015)

<table>
<thead>
<tr>
<th>Category</th>
<th>United States</th>
<th>Russia</th>
<th>New START Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deployed warheads (counting each bomber as one warhead, regardless of payload)</td>
<td>1,597</td>
<td>1,582</td>
<td>1,550</td>
</tr>
<tr>
<td>Deployed strategic launchers (ICBMs, SLBMs, and heavy bombers)</td>
<td>785</td>
<td>515</td>
<td>700</td>
</tr>
</tbody>
</table>


21. Under the treaty’s counting rules, each intercontinental ballistic missile (ICBM) and each submarine-launched ballistic missile (SLBM) within a ballistic submarine is counted. Each nuclear-capable bomber is counted as a single launcher, regardless of the number of nuclear weapons it may be carrying.
23. Ibid.
While New START represents a concrete step toward nuclear disarmament, the agreement did not address some of the most difficult obstacles to further reductions. The system of counting deployed strategic warheads does not account for tactical nuclear weapons, any warheads specific to the bomber leg of either nuclear arsenal, or nondeployed nuclear warheads. As a result, the United States and Russia were not forced to rectify some of the most divisive disparities in their nuclear arsenals, including the Russian numerical advantage in tactical nuclear weapons, the U.S. advantage in upload capabilities, and the challenge of creating an intrusive monitoring system to verify the status and number of strategic bombers and nondeployed warheads.

These issues will need to be addressed as the United States looks to move past New START and make further reductions while maintaining a safe, credible, and secure nuclear force. As the numbers of the respective nuclear arsenals decrease, the importance of each remaining weapon increases, and verification becomes even more crucial. In actuality, the 85 percent force reduction already achieved by the United States may have been the “easy part” of the disarmament process.

### REDUCTIONS BEYOND NEW START

The 2013 Report on U.S. Nuclear Employment Strategy, conducted by the Departments of Defense, Energy, and State and coordinated with the intelligence community, stated:

> The President has determined that we can ensure the security of the United States and our Allies and partners and maintain a strong and credible strategic

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**Table 2. Potential U.S. Strategic Nuclear Forces Under New START (April 2014)**

<table>
<thead>
<tr>
<th>Category of Launcher</th>
<th>Deployed Launchers</th>
<th>Total Launchers</th>
<th>Deployed Warheads</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICBMs</td>
<td>400</td>
<td>454</td>
<td>400</td>
</tr>
<tr>
<td>SLBMs</td>
<td>240</td>
<td>280</td>
<td>1,090</td>
</tr>
<tr>
<td>B-52</td>
<td>42</td>
<td>46</td>
<td>42</td>
</tr>
<tr>
<td>B-2</td>
<td>18</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>700</td>
<td>800</td>
<td>1,550</td>
</tr>
</tbody>
</table>

deterrent while safely pursuing up to a one-third reduction in deployed nuclear weapons from the level established in the New START Treaty.26

The strategy document suggests this new level of deployed forces, as low as 1,000 to 1,100 warheads, would be implemented while maintaining all three legs of the triad. Although no formal plans for implementing this reduction have been made public, the force structure would likely involve reductions of the ICBM force while the submarine force would be maintained, but with fewer launchers and warheads on each vessel.

From a security perspective, these reductions could be implemented on a unilateral basis while maintaining a credible nuclear deterrent. Current political realities, however, make that approach infeasible. Instead, the president has expressed his intent to negotiate these further cuts in tandem with Russia. President Vladimir Putin, however, has expressed no interest in negotiating further reductions at this time, and the proposal has stalled. U.S. Secretary of State John Kerry reaffirmed U.S. interest in this proposal during his remarks at the 2015 Nuclear Proliferation Treaty (NPT) Review Conference, insisting, “The offer is still on the table” and urging “Russia to take [the United States] up on it.”27

CHALLENGES TO IMPLEMENTING FURTHER REDUCTIONS

Although the further reductions outlined in the 2013 Nuclear Employment Strategy would meet the president’s expressed goal of maintaining a safe, secure, and effective nuclear deterrent with a smaller number of nuclear weapons, there are both domestic and international obstacles to further reductions in the U.S. nuclear arsenal. Many of these obstacles are not related to the one-third reduction specifically, but are factors of any attempt to reduce the U.S. nuclear arsenal below New START levels.

International Challenges

The international challenges to reducing the U.S. nuclear arsenal are two-fold. First, the United States must successfully negotiate a new arms control agreement with Russia. This process will be difficult to initiate, let alone conclude, given the current adversarial nature of U.S.-Russian relations, the differing compositions of each country’s nuclear forces, and the sheer lack of interest on the part of President Putin. If a new arms control agreement is reached, the United States will then need to convince its allies that the newest round of reductions and limitations does not affect the extended deterrence offered under the U.S. nuclear umbrella.

Negotiations with Russia

The principal challenge to implementing the next round of nuclear force reductions is the establishment of an arms control agreement that both the United States and Russia find beneficial to their security. While current relations between the United States and Russia have pushed these negotiations off the table, history indicates that hostilities do not preclude arms control

cooperation. The United States and the Soviet Union negotiated several arms control agreements in the midst of Cold War tension and animosity. Distrust over Russia’s incursion into Ukraine, NATO’s perceived expansion to encircle Russia, and violations of international agreements, such as the Budapest Memorandum and Intermediate-Range Nuclear Forces Treaty, currently obviate any interest in discussing a nuclear reduction agreement. A considerable improvement in diplomatic relations or a change in Russian leadership may be required before both countries are prepared to resume arms control negotiations.

Assuming the United States and Russia return to the negotiating table, the next challenge will be to address the disparity in the size and composition of each country’s nuclear forces. While the U.S. arsenal is predominantly composed of strategic nuclear weapons, with an estimated several hundred tactical nuclear gravity bombs, the Russian tactical nuclear weapons arsenal is estimated to consist of at least 2,000 weapons in central storage. To date, no arms control agreement between the United States and Russia has directly addressed the issues related to tactical nuclear weapons. Although future negotiations will undoubtedly need to include these weapons, the current proposal offered by President Obama addresses only reductions to deployed strategic weapons. In addition, while Russia has the numerical advantage in tactical nuclear weapons, the United States has a numerical advantage in deployed strategic launchers and reserve strategic warheads, which will also complicate the next round of nuclear negotiations.

While these differences in arsenal composition make negotiating for agreed reductions difficult, they also highlight the mutual interest that both countries have in conducting further arms control negotiations. Russia’s reliance on its large stockpile of tactical nuclear weapons to buttress its weaker conventional forces is concerning for the United States and its NATO allies; increasing transparency and reducing Russia’s stockpile of these weapons would be welcomed. For the Russians, the U.S. numerical advantage in strategic launchers is a cause for concern. To compensate for the over 200-launcher deficit, Russia loads multiple warheads on each deployed launcher, decreasing stability by increasing the reliance on prompt launch status to avoid an initial disarming strike. Moreover, the United States deploys fewer warheads on each launcher, leaving capacity for uploading more warheads during a time of crisis. Further rounds of arms control could help both the United States and Russia address these concerns, while also reducing the number of nuclear weapons in each nation’s stockpile.

In addition, Russia and the United States have divergent concepts of the role of nuclear weapons. While the United States has a strong conventional military force, Russia sees nuclear weapons as a supplement to its inferior conventional force, often conducting large-scale military exercises that incorporate both conventional and nuclear-simulated strikes. In addition, Russia’s nuclear

31. Ibid., 104.
saber-rattling throughout the Crimea crisis, including President Putin’s reminder that Russia is one of the leading nuclear powers\textsuperscript{33} and his later remark that he considered putting Russian nuclear forces on alert during the invasion of Crimea.\textsuperscript{34} demonstrates the role that nuclear weapons play in Russian security rhetoric, making reductions to these weapons even more difficult.

Also, in all likelihood, Russia will insist on including U.S. missile defense and emerging global strike capabilities in any arms control negotiations to mitigate the effects of its own conventional inferiority; the United States would likely consider these demands a nonstarter. But while the specifics of scope will be left to the negotiations at the time, budgetary constraints in the Russian economy could pose an incentive to bring Russia to the negotiating table. Russia’s aggressive plans to modernize its conventional and nuclear forces were based on a more robust economy, but the falling price of oil and the bite of sanctions from the West have made these plans unsustainable.\textsuperscript{35} If Russia’s current plans turn out to be unachievable, the country may be willing to reduce its nuclear weapons expenditures through further arms control cooperation with the United States in an attempt to reserve more funding for its conventional capabilities.

\textbf{Assuring Allies}

As the United States seeks to further reduce the role and size of its nuclear arsenal, it will be essential to reaffirm the strength and resolve of its extended deterrence commitments. Allies, especially those that feel directly threatened by nuclear-capable adversaries, could grow anxious that the reductions to the U.S. nuclear arsenal signify a fading commitment to their protection.

To assure these allies, the United States should make it clear that the quantity of deployed nuclear weapons is only one aspect of the U.S. commitment to their security. As expressed by the Admiral Cecil Haney, commander of U.S. Strategic Command, during a House Subcommittee on Strategic Forces hearing:

\begin{quote}
Strategic deterrence in the 21st century is far more than just nuclear, although our nuclear deterrent remains the ultimate guarantor of our security. It includes a robust intelligence apparatus; space, cyber, conventional, and missile defense capabilities; and comprehensive plans that link organizations and knit their capabilities together in a coherent way.\textsuperscript{36}
\end{quote}

This emphasis on the broader aspects of strategic deterrence should be conveyed to allies in need of assurances that the United States’ extended deterrent is still credible and intact. In addition, the


United States should keep its allies informed on the strength and validity of its retaliatory capability. A declassified Department of Defense study from 2012 indicated that, even if Russia were to increase its nuclear arsenal well above the New START limit, it would be unable to hold the U.S. second-strike capability at risk, therefore gaining no military advantages. This kind of information, in addition to conventional support, can be used to assure U.S. allies that a reduction to the U.S. nuclear force is not equivalent to a reduction in the U.S. ability to protect them.

**Nuclear Multipolarity**

One criticism of further nuclear reductions between the United States and Russia is that it incentivizes other nuclear-capable countries to build up their arsenals in an attempt to reach parity. The merits of that concern are debatable, as the significant costs of a massive nuclear production plan and the challenge of keeping that scheme a secret might outweigh the perceived benefits of increases in the size of a state’s nuclear stockpile. Nevertheless, China poses the most likely threat in this regard and is currently the only state that can feasibly build its arsenal to achieve quantitative parity with Russia and the United States.

While accurate and verified data is limited, China is believed to maintain an arsenal of around 250 nuclear weapons on a triad of strategic bombers, ICBMs, and nuclear submarines. Because of the considerable difference in arsenal size, China will not engage in multilateral arms control efforts until both Russia and the United States have further reduced their arsenals.

The current proposal, a one-third reduction of deployed strategic forces below New START, would not decrease the U.S. or Russian arsenals to a level that is readily vulnerable to a Chinese buildup, especially considering the large reserve stockpiles maintained by both countries. While direct inclusion of China in the next nuclear arms control process is unlikely and unnecessary, the United States and Russia should focus on increasing the transparency of the Chinese nuclear enterprise to create space for multilateral efforts in the future. This poses a challenge of its own, as China values its nuclear opacity and is unlikely to offer increased transparency as a token of good faith. Instead, multilateral efforts between Britain, France, and China could incrementally establish transparency mechanisms to build trust for future agreements. Regardless, little progress is likely to be made with other nuclear-capable states until both Russia and the United States show further commitment to reducing their arsenals.

**Domestic U.S. Challenges**

Aside from the international challenges described, arms control efforts also face fierce opposition on the domestic front. Future plans for reductions will cost considerable political capital to proceed through a congressional review and into implementation.

38. Federation of American Scientists, Status of World Nuclear Forces, 1.
Congressional Preferences

As the representative body of the people, Congress is positioned to play a critical role in any process that modifies the U.S. nuclear force. If the reductions are presented by way of a treaty, such as New START, then two-thirds of the Senate must vote to approve and ratify it. If adjustment of the nuclear arsenal is attempted through an executive action, Congress still has the power to appropriate or withhold the funding necessary to implement the reductions.

Tensions between the United States and Russia make any bilateral nuclear reduction efforts less appealing for congressional support. In fact, some members of Congress have advocated for the United States to withdraw from New START. In an electoral environment where being “firm on national security” often entices voters to pledge their support to candidates, it will be a challenge to create enough political space for legislators to support implementing further nuclear reductions. There are currently some champions of nuclear reductions in Congress, but the future composition and willingness of Congress as it debates the next arms control effort are difficult to predict.

In addition, some legislators have a vested interest in maintaining the U.S. nuclear force at its current level; any base, factory, or laboratory that plays a role in the nuclear enterprise produces jobs and revenue for its congressional district and state. Reductions could place these jobs at risk, incentivizing lawmakers to protect their constituents’ economic interests through opposition to future reductions.

Executive Caution

The Obama administration has already exhausted considerable political capital on nuclear-related issues. Negotiations between a coalition of international partners and Iran over Iran’s nuclear program have required a substantial effort by the Obama administration to simultaneously reach an agreement with Iran and preserve political space domestically for its implementation. Due to this limited bandwidth, the chances of President Obama engaging in another highly contested international negotiation over nuclear weapons by the end of his presidency are slim. With unilateral reductions off the table, as stated by Rose Gottemoeller, undersecretary of arms control and international security, during her Senate confirmation hearing, the next round of U.S. nuclear reductions will likely have to wait until a new president assumes office.

While President Obama placed emphasis on reducing the role and size of the U.S. nuclear arsenal, there is no guarantee the next president will have the same objectives. If the next president does not prioritize arms control, and Russia shows little interest in engaging in further reductions with
the United States, the arms control process could continue to stall, or atrophy, after the expiration of New START in 2021.

COST AS A DRIVING FACTOR

In addition to international relations and domestic politics, budgetary constraints have an influence on the size of the U.S. nuclear arsenal. Failing to secure and maintain funding for the current modernization plan of the entire nuclear enterprise could result in the modification of U.S. nuclear force structure.

To modernize its aging nuclear forces, the United States intends to develop and procure 12 new ballistic missile submarines to replace the 14 Ohio-class submarines currently in service, though the United States will operate with 10 deployed submarines for most of the 2030s. Also, the United States plans to procure as many as 100 new long-range bombers that can be certified to carry nuclear weapons, a new fleet of ICBMs or a further refurbishment to the current Minuteman III missiles, a new nuclear-tipped air-launched cruise missile, and life-extension programs for the warheads that are delivered by these systems. But while the United States embarks on these various modernization and life-extension programs, there is growing concern that completing them all concurrently is infeasible. According to Frank Kendall, under secretary of defense for acquisitions, technology, and logistics, these modernization plans are unsustainable unless the Pentagon can secure an additional $10–12 billion annually by 2021. The Budget Control Act of 2011 and its resulting budget caps make an increase of that quantity unlikely.

The Congressional Budget Office’s 2015 report on the projected costs of the nuclear force estimates the United States will spend $348 billion over the next decade to maintain and improve its nuclear arsenal. This estimate coincides with reports completed by the congressionally appointed National Defense Panel and the Center for Nonproliferation Studies, which estimated that the United States could spend as much as $1 trillion in maintenance and modernization over the next 30 years. To quote the National Defense Panel, which featured former secretary of defense William Perry, retired four-star general John Abizaid, and former senator Jim Talent, among others:

Recapitulation of all three legs of the nuclear Triad with associated weapons could cost between $600 billion and $1 trillion over a thirty-year period, the costs of which would likely come at the expense of needed improvements in conventional forces.48

As described by the National Defense Panel, both the Air Force and Navy are concerned they will be unable to fund scheduled improvements in both their conventional and nuclear forces. To compensate, the Navy is hoping to use a transfer account, the National Sea-Based Deterrence Fund, to shift the burden of procuring the new ballistic submarines from its budget to the Pentagon’s defense-wide budget.49 According to Under Secretary Kendall, however, this plan will do little to relieve the overall problem, as it merely adjusts the accounting without identifying additional funding to sustain the program.50

If the United States cannot afford to maintain its current nuclear force structure, it will be forced to make tough decisions about which nuclear capabilities are critical to U.S. strategic deterrence and which capabilities are nonessential, with the latter susceptible to reductions or cancellation. Affordability is a reflection of priorities, and it is possible that Congress and the Pentagon will decide that the nuclear modernization plans must be fully funded. In this scenario, conventional programs might be sacrificed, leaving both the Air Force and Navy with smaller conventional fleets and fewer capabilities.

To mitigate these concerns, arms control negotiations could be useful in lowering the overall quantities of warheads and launchers that must be produced and maintained. Continuing the current U.S. plan to modernize its nuclear forces, however, without a significant change to the budgetary conditions in which the plan is based, could lead to unintended reductions to the nuclear force and billions of dollars spent on research and procurement for programs that will never be completed. Whether as an incentive or an obstacle, the cost to modernize and maintain the U.S. nuclear force will play an influential role in the size and shape of the arsenal.

OPTIONS FOR ACTION

While awaiting a shift in relations with Russia, the United States can take action on both international and domestic policy to progress incrementally toward its goal of further reducing the size of its nuclear arsenal.

Manage International Relations

Although a major arms control agreement between the United States and Russia does not appear likely in the near term, there are incremental steps the United States can initiate to build trust and transparency between the nuclear powers as a prelude to future agreements.

Increase Nuclear Arsenal Transparency

Increasing the transparency of each country’s nuclear stockpile should be a top priority for the United States and the nonproliferation regime at large. Greater understanding of Russia’s stockpiles of tactical and nondeployed nuclear weapons and of China’s nuclear forces should be priorities in this effort, as this is critical to future arms control efforts. The United States, and the growing movement of nonnuclear states frustrated with the slowing disarmament process, can use the commitment to disarmament under the Nuclear Nonproliferation Treaty as leverage in an attempt to pressure Russia and China to conduct more data exchanges and increase transparency regarding the specifics of their nuclear arsenals. While there is no assurance that these efforts will be successful, greater transparency is a necessary first step to completing further arms control negotiations.

Provide Assurances to Allies

As mentioned previously, the United States should convey a holistic approach of security support to its allies dependent on the United States’ extended deterrence, deemphasizing the number of nuclear weapons as the principal measure of deterrence and security. In addition, the United States should look increasingly to shift focus from its nuclear force to its conventional capabilities, which are a more credible deterrent to hybrid warfare and to threats of aggression by Russia, China, and North Korea. By providing conventional support as a means of conveying assurances, the United States can assuage the concerns of allies that fear their national security will be negatively affected by reductions to the U.S. nuclear arsenal.

Reengage Russia in Nuclear Security

According to the Nuclear Posture Review, “the most immediate and extreme threat [to U.S. national security] is nuclear terrorism.”\(^51\) In December 2014, the long-standing history of nuclear security cooperation with Russia to address this threat came to an abrupt end, partly as a result of tensions over Russia’s incursions in Ukraine and partly due to Russia’s growing dissatisfaction with appearing to require U.S. assistance to secure its nuclear materials.\(^52\) Though not directly related to nuclear arms control, nuclear security cooperation between the United States and Russia can play a vital role by reestablishing trust and communication between the two countries on mutually beneficial initiatives. To reengage on nuclear security, the United States will be better served to establish a partnership, as opposed to a sponsorship, with Russia. This would include the reinstitution of nuclear science cooperation and the establishment of a bilateral approach to nuclear security in which both countries are considered equal partners, instead of the previous donor-recipient dynamic.

Managing at the Margins

In the absence of a bilateral arms control agreement, the United States can pursue efforts to reduce excesses in its stockpile of over 7,000 warheads without affecting its strategic deployment levels.


Trimming the Hedge

The U.S. nuclear enterprise maintains a large stockpile of reserve weapons to be deployed in the case of a technical failure or to respond to changing geopolitical threats. Comparing the 1,550-warhead limit under New START to the 4,717 warheads the United States possessed in September 2014, the United States maintains nearly a two-to-one ratio of reserve to deployed warheads. As warheads undergo life-extension programs currently planned by the National Nuclear Security Administration (NNSA), the necessity of a large reserve stockpile will further decrease. To reduce the overall size of the stockpile without directly affecting force projection, the United States could trim excess from this reserve.

Increase Dismantlement Rates

As announced by Secretary of State John Kerry at the 2015 NPT Review Conference, the United States has about 2,500 warheads that have been retired and are awaiting dismantlement. By increasing dismantlement rates for these retired warheads, the United States can reduce the overall size of its nuclear stockpile without affecting force structure or employment strategy. During his remarks at the conference, Kerry committed the United States to accelerating its dismantlement efforts by 20 percent.53 The United States should fulfill this commitment and reduce the considerable backlog on its nuclear dismantlement efforts.

CONCLUSION

The Obama administration has made clear its intentions to reduce the size and role of its nuclear arsenal through a bilateral agreement with Russia. The challenges to achieving this objective currently are prohibitive, and the process to initiate, negotiate, and implement this agreement will be arduous. Progress will require strong international cooperation, willingness to compromise, and the solutions to several unanswered questions regarding how to address the major differences in structure, composition, and role between the U.S. and Russian nuclear arsenals. In addition, the next round of arms control will be susceptible to changing interests in both the executive and legislative branches of the U.S. government, which could prevent further reductions.

But, for all its challenges and complications, reducing the nuclear arsenal is a worthy objective. Well-crafted arms control agreements can prevent destabilizing arms races, increase transparency while reducing the risks of miscommunication and misunderstandings, and reduce the global stockpile of weapons that pose an existential threat to the United States and its allies. Although substantial changes are currently dependent on a bilateral agreement with Russia, there are several steps the United States could take, on both the domestic and international level, to incrementally progress toward further nuclear reductions.

The United States and international community are still a long way from the vision described in President Obama’s 2009 Prague speech. To progress further toward that goal, the United States must be persistent in its commitment to reducing the size and role of its nuclear arsenal.

Reexamining Proliferation Drivers in the Middle East

Evan Thompson

Since 2010, the political and security dynamics in the Middle East have changed drastically, enough so to warrant reevaluating the conventional claims stating that most states in the Middle East will not seek nuclear weapons. Using Scott Sagan’s three models of proliferation, this paper examines three key states often cited as potential proliferators. Using these three models, this paper concludes that proliferation incentives have risen across the board, but often not by much. The greatest rise in drivers is in Saudi Arabia, which sees an increased threat from Iran and the rise of the terrorist organization the Islamic State of Iraq and Syria (ISIS). This is followed closely by all three countries that are dissatisfied with the progress of the Nuclear Proliferation Treaty (NPT) and the creation of a weapons of mass destruction (WMD)—free zone in the Middle East. Finally, changes in governments and the expansion of nuclear energy programs in all three states have led to low- to mid-level increases in proliferation drivers across the board.

INTRODUCTION

The Middle East has changed dramatically since 2010. New threats have emerged, old threats have evolved, and the preferences and objectives of governments in the region have changed along with their governments. A major contributor to these changes has been the Arab Spring protests—overthrows of governments in four states (including two in Egypt and Yemen) catalyzed major civil
wars in Libya and Syria, and created a power vacuum that allowed the emergence of the terrorist organization the Islamic State of Iraq and Syria (ISIS). This is not the only factor of change, as all of this occurred in the shadow of an advancing Iranian nuclear program that many leaders and experts believe is the beginning of Iran’s plans to acquire nuclear weapons. These developments, and more, have caused significant shifts in the way analysts perceive the region, enough so that the conventional wisdom regarding proliferation dynamics in the region should be reconsidered. Has developing a nuclear weapons program become a more attractive option for major states in the Middle East? Likely, yes. This paper will examine the rising drivers in three key states in the region.

This project addresses the research question and its implications in two steps. First, this study develops several hypotheses related to the determinants of proliferation and whether the incentives and drivers related to each have risen in the Middle East. The literature on why states proliferate is extensive, with authors organizing dozens of theories in a multitude of different categories. For the purpose of this study, it will use the theories, informally called models, laid out by Scott Sagan in “Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb.” Second, the study applies these models to each of the country cases. While there are over a dozen countries in the Greater Middle East where these models could apply, there are far fewer that present genuine proliferation risks. The dominant literature suggests that the countries of greatest concern are Egypt, Turkey, and Saudi Arabia.

EGYPT

Security Model

The dominant narrative surrounding any Egyptian attempt to acquire nuclear weapons has centered on its relationship with a nuclear Israel. Since the conclusion of the Camp David Peace Accords and the Egyptian-Israeli Peace Treaty in 1979, many analysts have written off Egypt as a potential proliferation threat, as it is now a cornerstone of the “cold peace” with its one nuclear adversary in the region. Nearly four decades of peace make a compelling case that the strategic threat posed by Israel may have dissipated, but in the current political dynamic in the region, the Egypt-Israel dynamic may play a less crucial role.

Currently, Egypt has worse relations with Iran, another major power in the Middle East that has the potential to break out with nuclear weapons. Egypt and Iran both are large states with large populations and ambitions as leaders in the region, but diverging religious and cultural backgrounds have led to widely differing visions of how this leadership would materialize. As a state with strong ties to the United States and Europe, Egypt has consistently found itself opposing Iran in many situations. Egypt supported Iraq during the Iran-Iraq War, Egypt was a staunch supporter of Shah

3. It is important to be clear that this paper is not testing Sagan’s models or theories. The study is using these models as a framework to gain insight into the world, and not vice versa.
Mohammad Reza Pahlavi and hosted him after his deposition, and Iran hailed President Anwar Sadat’s assassin as a hero.

Ironically, one of the major disagreements between Egypt and Iran stems in large part from the peace agreement between Egypt and Israel, because Iran views Israel as a major rival and threat. Mutual mistrust resides on both sides, as Egypt accused Iran of supporting Islamist extremists throughout the region and Iran accused Egypt of propping up the Zionists in Israel. As such, for nearly four decades Egypt did not have an embassy in Tehran. Even with normal diplomatic relations reestablished, the popular opinion of Iran in Egypt is incredibly low, with only 15 percent of respondents viewing Iran favorably and 48 percent holding negative views. Even with new governments, it is difficult to overcome decades of strategic differences, competing hegemonic bids, and cultural and religious rifts. These opinions seemed to bottom out when General Abdel Fatah al-Sisi overthrew the Morsi government and assumed control of the state, an act that Iran called a coup against the friendly Muslim Brotherhood government.

In other strategic areas, relations between Egypt and Iran seem to be stabilizing, though many of the underlying factors of their rivalry remain the same. The point of flux may be with ISIS. As a Sunni group opposing Syria and the Shi’a government in Iraq, Iran has a vested interest in defeating ISIS. Egypt, as a state with a long history of combating religious fundamentalist and Islamist extremists, also has an interest in combating the spread of ISIS. Some experts consider this a potential warming of relations between Iran and Egypt in the face of an even greater threat.

While ISIS confined itself to Syria and Iraq it posed relatively little threat to Egypt, but with the expansion of ISIS activities to Libya, it has become a far more acute threat. The civil war between the Libyan military in eastern Libya and the Islamist militias in the west has always been of interest to Egypt, threatening to have its violence spill over into an already unstable Egypt. As ISIS increased its influence and murdered 21 Egyptians, Egypt began to take action against the terrorist organization. In February 2015, Egypt launched airstrikes against ISIS targets in Libya, expanding the theater of operations against ISIS. As a threat, these do not represent the typical existential deterrent threat that nuclear weapons can address, but they do add to the level of insecurity in Egypt’s environment. It also raises questions about the viability of Egypt’s security guarantees from its allies and the international community, as much of the turmoil in its external environment can be traced to the fall of Muammar el-Qaddafi and the subsequent collapse of the Libyan state. This occurred in large part due to the United States-led intervention in the civil war, but after the

collapse, the international community largely abdicated responsibility for the ensuing conflict and civil war, raising questions about reliability in ensuring Egypt’s security.

A final consideration regarding security in Egypt relates to the relationship Egypt has with the United States. Egypt is one of a few countries with Major Non-NATO (North Atlantic Treaty Organization) Ally status with the United States. This typically involves increased military coordination and arms sales. The 2011 Egyptian Revolution that overthrew the Mubarak regime put considerable strain on the relationship between Egypt and the United States. When Mohamed Morsi assumed the presidency, the Obama administration described the new regime in Egypt as neither an ally nor an enemy. When Sisi subsequently overthrew the Morsi government, this brought further strain on the Egyptian-U.S. relationship and resulted in a freezing of a considerable portion of military assistance to Egypt. While the Obama administration reinstated total military assistance in late March 2015, statements by Sisi intimate that he regarded the freeze as a betrayal by the United States. During the freeze, sources indicated that Egypt was even considering turning to Russia to supplement its military aid, an option that became all the more real when Russian president Vladimir Putin visited Egypt in February 2015. While Egyptian-U.S. relations are stabilizing, events in 2014–2015 have proven that the relationship is not as sound as was once believed and that Egypt is not entirely dependent on the United States for its security.

Domestic Politics Model

Since December 2010, Egypt has undergone two government overthrows, and now faces considerable domestic instability. Conventional wisdom dictates that a major factor in Egypt’s decision to remain nonnuclear was the effect that President Hosni Mubarak had on decisionmaking. Mubarak had proved himself staunchly antinuclear, as he quashed any attempt to expand the civilian nuclear program or pursue nuclear weapons for decades. On the domestic front, the removal of Mubarak from the decisionmaking calculus fundamentally changes the Egyptian government’s calculus, and while this may not be a driver for proliferation, it removes an important proliferation disincentive.

More importantly, the government’s opinion on nuclear weapons shifted after the Mubarak regime. Since coming into office, President Sisi has expanded Egypt’s civilian nuclear program. The country has been struggling with an energy crisis for years, and the Sisi regime, as part of its plan

to revitalize the economy, has sought to diversify its energy resources through solar, wind, hydro, and nuclear. The plans to expand the nuclear energy program began in 2010 under Mubarak, a marked change in his preferences, but the project never got off the ground due to financing concerns and vandalism. In 2012, the Ministry of Electricity and Energy expanded this plan to call for four new plants by 2025.

These plans in themselves are not necessarily indicators that Egypt has an increased desire to acquire nuclear weapons, as Egypt has legitimate energy concerns that nuclear power could help alleviate. The manner in which plans are being made is of more concern. Initially, Egypt had expressed interest in nuclear energy as a partner in the Bush administration’s global nuclear energy partnership (GNEP) with a cradle-to-grave fuel service. In 2009, the Obama administration made significant cuts to the program and effectively halted cooperation with Egypt’s nuclear program. As a result, Egypt looked beyond the GNEP framework and ultimately signed an agreement with Russia during President Putin’s February 2015 visit.

The deal arranged for Russia to construct four reactors at the power plant in El-Dabaa. Each of the reactors would produce 1,200 megawatts of electricity, a major boon for energy-starved Cairo. Since this agreement was outside of the GNEP framework, it did not have any of the safeguards inherent to it. Since 2011, there have also been significant questions about the extent to which Egypt would expand its nuclear program. While Egypt has made it clear that it intends to build additional reactors, the government’s policy on indigenous enrichment or reprocessing has been ambiguous. In 2008, Nabil Fahmy, Egyptian ambassador to the United States, indicated in an interview that Egypt maintains the right to have the full nuclear fuel cycle, but had not made a decision as to whether obtaining it would be the right choice for Egypt. There has been no official change to this policy since 2010.

Since the 2011 revolution, there has been relatively little straight talk regarding any change in the Egyptian government’s stance on nuclear weapons. The return of Mohamed El-Baradei, former director general of the International Atomic Energy Agency (IAEA), to Egypt and his role as acting vice president from July to August 2013 indicated that Egypt might retain its nonnuclear course. Other government officials have made similar statements, opposing any Egyptian pursuit of nuclear weapons. Since the officials made those statements, however, all of them, including El-Baradei, have resigned from their government posts, in El-Baradei’s case, his fundamental

disagreement with the rise to power and methods of the Sisi regime caused him to leave his position.\textsuperscript{21}

It is also important to note the military origins of President Sisi. Historically, the Egyptian military and the Ministry of Defense have been, perhaps unsurprisingly, the major proponents of an Egyptian nuclear weapons program. While the military did not lead Egypt’s earliest attempts at a nuclear weapon program in 1960, a former military officer who retained strong ties to the military and headed the Atomic Energy Authority did. In one instance, the Egyptian military pursued this course without the president’s authorization. In 1984, General Abdel Halim Abu Ghazala, the Egyptian minister of defense, pursued a weapons program in secret after Mubarak’s refusal and even colluded with the Iraqis to advance it before Mubarak fired him.\textsuperscript{22} As former minister of defense and general, it is possible that he has the same attitude regarding nuclear weapons as many of his predecessors and is perhaps more likely to pursue a nuclear weapons program in tandem with the planned expansion of the civilian nuclear program.

**Normative Model**

Egypt has long been a major proponent of the Nuclear Nonproliferation Treaty (NPT). Presidents Gamal Abdel Nasser and Anwar Sadat both viewed the NPT as not only a means to enhance Egypt’s credibility and leadership in the region but also a way to highlight Israel’s intransigence in not signing on to the NPT.\textsuperscript{23} Since it signed the NPT in 1968 and ratified it in 1980, it has maintained a position that the Middle East should be made into a nuclear weapon–free zone.\textsuperscript{24} In the 1995 NPT Review Conference, as part of the conditions for the indefinite extension of the treaty, the parties to the NPT worked to establish a weapons of mass destruction–free zone (WMDFZ) in the Middle East.\textsuperscript{25} Many experts point to its espousal of the nonproliferation norm as a primary reason for abstaining from nuclear weapons: Egypt would gain more in terms of legitimacy and prestige by adhering to the nonproliferation norm, and it would be more secure if it could persuade Israel to give up its weapons.

It has now been 20 years since the states made the commitment to establish a WMDFZ in the Middle East, and Egypt’s patience and faith in the system are beginning to wear thin. The parties to the NPT made plans at the 2010 NPT Review Conference to hold a Middle East WMDFZ negotiation in 2012.\textsuperscript{26} Disagreement over the terms of the negotiations led to what Egypt referred to as the “unilateral postponement” of the 2012 conference. At the 2013 NPT Preparatory Committee (PrepCom) during a discussion of the implementation of the WMDFZ, the Egyptian delegation left, citing a lack of authority on the organizers’ part to postpone the 2012 conference and the

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\textsuperscript{22} Einhorn, “Egypt: Frustrated but Still on a Non–Nuclear Course,” 45–46, 55–56.


\textsuperscript{24} Gawdat Bahgat, Proliferation of Nuclear Weapons in the Middle East (Gainesville: University Press of Florida, 2007), 109, 153–157.


“unacceptable and continuous failure to implement the 1995 Middle East Resolution.” The head of the Egyptian delegation also remarked that Egypt “cannot continue to attend meetings and agree on outcomes that are not implemented, yet be expected to abide by the concessions we gave for this outcome.”

Egypt’s statements at the 2013 PrepCom demonstrated a deep dissatisfaction with the NPT regime and how it has been implemented. While some analysts say that this is not the “saber-rattling of a state that wants to leave the NPT and develop nuclear weapons,” it is certainly an indication that support for the NPT is not unconditional and that Egypt is beginning to lose confidence that the treaty will ever be completely implemented or its disarmament obligations fulfilled. If Egypt decides that the NPT and the promise of a Middle East WMDFZ is ineffectual or incapable of guaranteeing its security, then it may decide that the norm of nonproliferation is not worth following. Furthermore, if the major powers in the regime keep subverting the regime to protect the interests of non-NPT members, namely Israel, then it risks undermining the regime and indicating to other parties in the NPT that their interests and commitments are virtually worthless.

Beyond this, Egypt has not ascribed much importance to the ideas of prestige or modernity that weapon states often ascribe to nuclear weapons. Egypt frames any discussion it has over its nuclear energy program and expansion around the economic benefits it will bring and how it can alleviate Egypt’s energy crisis. Domestic instability has also curbed much of the discourse around Egyptian leadership in the region. Recent interviews with President Sisi focused more on the risk of a collapse of the state than any aspirations of hegemony or prestige. Overall, the normative trends tend toward reduced disincentives to acquire nuclear weapons than a rise in the incentives or drivers to acquire them.

**TURKEY**

**Security Model**

Like the rest of the Middle East, the region’s volatility and resulting threats affect Turkey as well. Since the Arab Spring, this has meant a civil war in neighboring Syria and the rise of ISIS. These two threats pose the greatest risk to Turkey’s security and the greatest point of contention between Turkey and its NATO allies. For much of their history, Turkey and Syria have been at odds with one another. Turkey’s alliance with NATO and the United States, its attempts to join the European Union (EU), and its secular government ran contrary to a Syrian government more closely aligned with Iran.


29. Weymouth, “Egyptian President Abdel Fatah al-Sissi.”
A thaw in relations during the rise of the Adalet ve Kalkınma Partisi (AKP) was short lived because in 2011 civil war broke out in Syria. As Turkey's prime minister, and later president, Recep Tayyip Erdogan's position on the civil war has always been that Bashar al Assad, Syria's president, must step down from power. Since 2012, Turkey has been holding high-level meetings with the United States regarding a potential change in government in Syria. This position was only reinforced and the perception of the threat the civil war posed when a Turkish reconnaissance jet was shot down in June 2012. Many other border clashes and disputes followed, including the downing of a Syrian helicopter that violated Turkish airspace in 2013 and the downing of a Syrian jet that violated Turkish airspace in 2014.

The rise of ISIS has further complicated the situation in Syria and Turkey. It has long been acknowledged that Turkey is a major corridor for the foreign fighters joining ISIS from around the world. It was not until March 2014 that Turkey came under direct assault from ISIS, with threats to attack a Turkish-guarded tomb of Suleyman Shah and a deadly attack in Nigde a few weeks later. With the exception of an operation that evacuated the tomb of Suleyman Shah in February 2015, Turkey’s response to ISIS has been largely muted, with President Erdogan indicating that he did not wish to provoke ISIS in a manner that may threaten Turkish lives. Erdogan indicated that he believed ISIS was tertiary to solving the deeper political and military problems in Syria and Iraq, namely removing Assad from power and ending the Syrian civil war. Again, this is not necessarily a threat that nuclear deterrence might address, but still adds to insecurity in Turkey’s environment.

Iran adds another dimension to the conflict in Syria. Turkey has had relatively normal relations with Iran, particularly compared to the rest of the Middle East and it even played an active role in attempting to negotiate a nuclear fuel deal for Iran. That is not to say their relations have been entirely peaceful, as Turkey’s connection with the United States and NATO has led it to be the base of U.S. nuclear missiles and the missile shield, which Iran views with distrust. Iran has threatened that any attack on Iran by Israel or the United States would provoke retaliatory attacks against Turkey as well. The Arab Spring has also placed a great deal of tension on this relationship, as Iran supports the Assad regime in Syria as staunchly as Turkey opposes it. While Turkey does not

inherently view Iran’s nuclear program as a threat, an officially nuclear Iran would no doubt pose a great threat to Turkey.

Threats to Turkey, which serves as a bridge between the Middle East and much of the rest of the world, expand beyond the region. As a NATO ally, Turkey has always been under NATO’s nuclear umbrella. For much of its existence, this guarantee was informed by the Cold War and the threat that the Soviet Union posed to Turkey. When the Cold War ended, it was unclear to what extent Turkey would continue to participate in NATO activities. Ultimately, Turkey retained its membership, but proved to be a reluctant ally in many aspects of its NATO membership. In March 2014, history revived old threats when Russia annexed the Crimean peninsula of Ukraine. Historically, Crimea was a former part of the Ottoman Empire, ceded to Russia after the Russo-Turkish war, but still populated by a significant minority of Turkic Tatars. While Turkey was unwilling to escalate the conflict further without provocation in the form of persecution of Crimean Tatars or the violation of the Montreux Convention, it significantly raised the level of historic tension between the old adversaries.

Despite the growing tension and number of threats that surround Turkey, there has been less cooperation between Turkey and the United States than one might expect. When the Syrian civil war began, there was a great deal of expectation from the international community that the United States would engage in an intervention similar to that in Libya to prevent the worst excesses of violence against civilians. This intervention failed to materialize, but President Barack Obama drew a red line regarding the use of chemical weapons. Much to Turkey’s chagrin, when Syria used chemical weapons, no response materialized. To Turkey, this is a failure of leadership and commitment to security on the part of the United States. Meanwhile, the United States has loudly accused Turkey of supporting Islamic extremist groups, which led to the rise of ISIS. Turkey’s reluctance to participate in the coalition against ISIS has also invited criticism, ranging from accusations that Turkey supports ISIS to claims that Turkey is an unreliable ally that should be expelled from NATO. The early U.S. strategy for countering ISIS also highlighted rifts in the Turkey-U.S. relationship, as it primarily revolved around supporting regional allies in their struggles. For the United States, this meant arming the Iraqi Kurds only days after President Erdogan had called the Kurdish groups terrorists. Turkey only officially entered the war against ISIS at the end of July 2015, but there is speculation that it is as much a war against the Kurds as it is one against ISIS.

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particularly given the 400 Kurdistan Workers’ Party (PKK) targets hit as compared to the three ISIS targets hit.42

Domestic Politics Model

Turkey has undergone many political changes, primarily through the rise of the Justice and Development Party (AKP) and election of Recep Tayyip Erdogan to the presidency in 2014. While Turkey has a long history of secular rule, the AKP, a party grounded in traditional conservatism and Islamism, has held considerable sway in the Parliament and presidency since its formation in 2001. The election of AKP members into Parliament brought rise to what some have called a neo-Ottoman foreign policy.43 Erdogan’s presidency has been hailed as particularly authoritarian with a strong shift toward a more centralized government—akin to the days of rule by the Ottoman Sultans.44 Some experts have deemed it more likely that the start of a nuclear weapons program would begin from decisions in the civilian leadership, particularly under an Islamist government that has drifted away from a relationship with the United States.45

These fears are well founded. Currently, Turkey imports almost all of the energy it consumes, but one of President Erdogan’s primary initiatives since coming into office, both as the prime minister and now as the president, has been the construction of nuclear reactors to meet some of Turkey’s growing energy needs.46 These plans have been in place since 2006, when he was prime minister, but have been consistently pushed back due to political and economic pitfalls. In May 2010, Turkey and Russia signed an agreement to begin construction of a nuclear reactor at Akkuyu, and Turkey began construction in 2015. In 2013, Turkey made plans for the construction of two more nuclear reactors, one supplied by a Franco-Japanese contractor and one tentatively supplied by China.47

Like Egypt, the energy demands of Turkey make the pursuit of a high-energy reactor a valid economic and developmental course, but considerable questions remain about the details of these programs. For example, unlike GNEP’s cradle-to-grave fuel handling, as of May 2014 the deals with Russia and Japan have no clear specification of the handling of spent fuel, creating an acute proliferation risk. Turkey’s fuel supply and the expansion of its nuclear fuel cycle remain under question. Turkey already has limited mastery over the nuclear fuel cycle because of its lack of research centers, but it also hopes to expand its uranium-mining operations throughout the

45. Fuertth, “Turkey: Nuclear Choices amongst Dangerous Neighbors,” 166.
country. Since 2013, the Ministry of Energy and Natural Resources has been awarding production licenses to that end.\textsuperscript{48}

This expansion of the nuclear energy program in Turkey has not been without opposition, particularly from environmentalists concerned about the effects Turkey’s seismic activity may have on the nuclear reactors. The earthquake and tsunami that caused the 2011 nuclear accident at Fukushima put the spotlight on the fact that Turkey lies on two major fault lines. Protestors and environmentalists argued that the frequent earthquakes in the area could cause a similar nuclear accident in Turkey, as the fault line has the potential to generate magnitude-7 earthquakes, close to the magnitude-7 quake that caused the Fukushima disaster. Seismologists also expressed concerns regarding the second reactor site in Sinop.\textsuperscript{49}

The trend in Turkish domestic politics has been toward a much more conservative, centralized government that is distancing itself from the United States. This neo-Ottoman government also has a key interest not just in expanding its nuclear energy program but also its total mastery of the complete nuclear fuel cycle. Given the ambiguity surrounding the fuel sourcing and disposal of the project, as well as the considerable opposition and risks associated with a nuclear project in a fault area, it raises questions about the potential for the expansion of Turkey’s civilian program into a weapons program.

Normative Model

As a long-time dependent on the NATO nuclear umbrella, Turkey can hardly be accused of being antinuclear weapon, but it also has an equally robust history of supporting nonproliferation policies and norms. Turkey is a signatory to all major WMD conventions and has been a major proponent of the WMDFZ in the Middle East. Thus far, any efforts to establish such a zone have been unsuccessful, but Turkey remains hopeful that by reducing tensions in the region, the international community could establish a WMDFZ in the Middle East that could eventually lead to a global disarmament movement.\textsuperscript{50} Turkey is also a key supporter and participant in the U.S.-led Proliferation Security Initiative.\textsuperscript{51}

There is still a fundamental disconnect between Turkey’s calls for nonproliferation, including establishing the WMDFZ, and its tacit approval of U.S. tactical nuclear weapons on Turkish soil. Turkey claims that while it supports nonproliferation and the related idea of disarmament, it acknowledges that in the interim that it must have a secure deterrent capability, which the NATO weapons provide.\textsuperscript{52} While many other NATO countries express support for the removal of tactical nuclear weapons in Turkey, Turkey has been largely reticent on the matter, which many take as

\begin{itemize}
\item \textsuperscript{48} Ibid.
\item \textsuperscript{52} Ulgen, “Turkey and the Bomb,” 11–13.
\end{itemize}
tacit approval for continued basing in Turkey. For Turkey, there is the inherent assumption that by removing the nuclear weapons, they diminish the role that Turkey has in NATO, as the United States would have less invested in the country.\textsuperscript{53}

There is also an argument that Turkey has pragmatic motivations for investing its resources in the nonproliferation regime. Turkey has always had ambitions to join the European Union; despite its best efforts, its applications have always been blocked or found inadequate. Any attempt on Turkey’s part to develop WMD would “be suicidal to Turkey’s EU membership bid.”\textsuperscript{54} Given Turkey’s troubled past bids, anything less than full compliance with any of the nonproliferation bids would be a strike against Turkey’s EU membership. On the other hand, if Turkey does not ground its commitment to nonproliferation in a strong belief in the norm, then any change in Turkey’s preferences, such as a reconsideration of EU membership, could lead to a change in Turkey’s stance on WMD.

Turkey also has a renewed neo-Ottoman identity. Part of this new tradition of governance and resurgence in Ottoman culture is a reestablishment of Turkey as a leader in the Middle East. Turkey in the modern era has always strived to be secular and Western-facing, but this new era of neo-Ottomanism has seen a shift back toward the Middle East, starting with the AKP’s Zero Problems policy and continuing to its active involvement in solving regional disputes today.\textsuperscript{55} President Erdogan has also made it very clear that he fully embraces the neo-Ottoman spirit, embodied in his oft-criticized, Ottoman-styled presidential palace. Despite the critique of Erdogan’s ostentatiousness, Ottoman culture is depicted frequently in Turkey’s media, with many of the most popular television shows and movies set in Ottoman times and highlighting the greatest achievements of the Empire.\textsuperscript{56} If Turkey truly seeks to increase its prestige and leadership in the Middle East in a bid to reclaim past Ottoman glory, it may find that it is simpler to abandon its commitment to nonproliferation, which has failed it in its bids to join the West, and instead pursue hard power and nuclear weapons.

**SAUDI ARABIA**

Security Model

Saudi Arabia has long viewed itself as a bastion of stability in the Middle East, bolstered by its stalwart ally in the United States. Despite this stability, it has always felt itself surrounded by rivals


and enemies. It has frequent disputes with Iran, the Persian Shi’a state across the Gulf, which also has hegemonic leadership ambitions over the Middle East. This Shi’a-Sunni rivalry informs much of Saudi Arabia’s perception of its security environment. By virtue of its dispute with Iran, it has clashed with Syria, an ally of Iran. Iran and Saudi Arabia have also clashed through proxy in surrounding states—Iran supporting the Houthis in Yemen and the Saudi Arabia supporting Yemen’s government; Iran supporting the Shi’a majority in Bahrain and Saudi Arabia supporting the monarchy.

Since the events of the Arab Spring, Saudi Arabia’s security environment has looked increasingly unstable and its American ally increasingly unreliable. To begin, security concerns began to rise when the United States began pushing for the authoritarian leaders in Libya and Egypt to step down. While this was unsurprising in the case of Libya, which has had a troubled past with the United States, it seemed something of a betrayal in the case of Mubarak because he had been a long-standing ally of the United States. For the authoritarian monarchy in Riyadh that was having its own set of domestic disturbances, this seemed an ill omen of continued relations with the United States.57

When the United States and other members of the international community intervened in Libya on behalf of the revolution, Saudi Arabia took this as the official policy of the United States. This seemed a major boon for Saudi Arabia when Syria began to fall into its own bloody civil war, as Saudi Arabia had long been at odds with the Iranian-backed Assad regime. Saudi Arabia threw its support behind the Sunni opposition to Assad from the beginning, and it expected a similar U.S. intervention in Syria, which never materialized. Instead, the United States largely ignored the Syrian civil war beyond the drawing of President Obama’s red line regarding the use of chemical weapons. Like Turkey, Saudi Arabia was disappointed when Syria crossed the red line and not only had nothing to fear from regime change but also went unpunished altogether. Saudi Arabia claimed that the world had “betrayed the Syrian opposition” and promised that Saudi Arabia would continue aiding them. In 2014, Crown Prince Salman Bin Abdul Aziz said, “We are doing more and we will continue to do more. We are going this alone as difficult as it is for us.”58 Saudi Arabia’s faith in its ally’s commitments waned considerably in the face of a major strategic security threat.

Saudi Arabia’s security situation only worsened with the rise of ISIS in Iraq and Syria. Saudi Arabia was an early supporter of the U.S.-led coalition against ISIS. Recently, ISIS has made statements indicating that Saudi Arabia has become a main target for its terror operations. This was unsurprising to Saudi Arabia, which has long claimed that it would be the primary target for ISIS in its attempt to establish a Sunni caliphate.59 These threats have made the mission of stopping ISIS all the more pressing.

While the Syrian civil war and rise of ISIS have recently been the dominating strategic focus of Saudi Arabia, the strategic rivalry with Iran has not abated. More than ever, Saudi Arabia is in a

58. Ibid.
no-win scenario as negotiations over Iran's nuclear program continue. Since the international community implemented the comprehensive sanctions regime on Iran in 2009, Saudi Arabia benefited from a weak rival and near-dominance on the Middle East oil market. Now, with a comprehensive deal on the table and facing review in the U.S Congress, Saudi Arabia faces a potentially resurgent Iran that has regained international credibility and perhaps regular diplomatic relations with the United States.60 Saudi Arabia would not benefit from the United States growing closer to its rival, but neither does it benefit from Iran acquiring nuclear weapons, which a deal would forestall. Saudi Arabia has long claimed that whatever capabilities Iran acquires, be they simply enrichment or weapons, Saudi Arabia would match.61

This strategic dueling exists outside of the nuclear realm as well, as Saudi Arabia must contend with a growing Iranian sponsored conflict along its southern border as well. The Iran-backed Houthi rebels in Yemen advanced on the large portions of Yemen in the last year, assuming control of the capital in January 2015 and forcing President Abd Rabbuh Mansur Hadi to flee to Aden. When the Houthis moved on Aden, President Hadi fled to Riyadh and invoked protection from the Gulf Cooperation Council (GCC). On March 25, 2015, Saudi Arabia began a bombing campaign against Houthi forces and began staging a full-scale intervention just across the border. For the Saudis, defeat in Yemen is an unacceptable outcome, as at best it would provide Iran with a foothold in the Arabian peninsula, but at worst it could give al Qaeda (AQ) in the Arabian Peninsula, the most violent and active AQ franchise, free movement of the peninsula.62

Underpinning all of these conflicts is a shaky relationship with the United States. Since the Arab Spring, the relationship has continued but is far more uncertain. Uneven application of U.S. commitments and policies led to a considerable rift over the Syrian civil war. While cooperation between Saudi Arabia and the United States has continued in the fight against ISIS and the United States has even pledged support and logistical aid to the Saudi intervention in Yemen, there are still many questions left unresolved, not least of which is the question of relations with Iran in the wake of the nuclear deal.63

**Domestic Politics Model**

Stable monarchy that it is, Saudi Arabia saw only minor protests that were largely assuaged with several minor concessions during the Arab Spring. In fact, given the void of power left by the virtual collapse of Syria and Libya, the instability in Egypt, and the sanctions on Iran, Saudi Arabia may be one of the few stable governments in the Middle East and one of the only major powers left in the Middle East capable of projecting its power.64 This is not to say that Saudi Arabia has not

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undergone any political changes since the Arab Spring, as King Abdullah passed away in January 2015. King Salman Bin Abdul Aziz succeeded him. Salman was the mayor of Riyadh for 48 years before becoming defense minister and then crown prince in 2011 and 2012, respectively. While it is very early to project what kind of policies and government King Salman will enact, he does have a reputation as a mediator among his family and for growth and stability in his governance. To that end, many analysts expect him to focus on establishing stability in Saudi Arabia and the surrounding area and place less focus on reform than his predecessor. One can expect to see a policy of continued balancing against Iran in the conflicts around the Middle East and further support for embattled anti-Islamist leaders.65

Even before the passing of King Abdullah, Saudi Arabia was on track to expand its energy programs, as the rapidly growing population was rapidly increasing its energy consumption—the fastest in the Middle East. Saudi Arabia planned to expand its solar energy to 15 percent of its total production and build nuclear reactors to produce another 15 percent of its total production.66 Unlike Egypt and Turkey, Saudi Arabia signed a memorandum of understanding (MOU) with the United States very early on, committing Saudi Arabia to sourcing fuels internationally and not proliferating sensitive nuclear technologies. Despite delays in the development of the reactor, Saudi Arabia still conducted a MOU agreement with South Korea’s Korean Atomic Energy Research Institute to build two small-medium units and an agreement with GE Hitachi Nuclear Energy and Toshiba/Westinghouse for large reactor construction for a total of 17 gigawatts by 2032.67

Aside from the claims that Saudi Arabia would pursue whatever capabilities that Iran has including nuclear weapons, the development of the Saudi nuclear energy program is probably the least concerning of the three cases. Sourcing for Saudi reactors is primarily through Japanese and Korean companies, both of which have strong ties to the United States. While the United States would not have the direct capability to institute safeguards on the Saudi nuclear program, it would still have some leverage and the 2008 MOU regarding proliferation to back it up.

Normative Model

Like Turkey, there is a compelling case for labeling Saudi Arabia as a pragmatic supporter of the norm of nonproliferation. Saudi Arabia has always been a supporter of the creation of a WMDFZ in the Middle East, calling for a peaceful resolution to the nuclear negotiations with Iran and insisting that Israel sign on to the NPT and place its facilities under IAEA safeguards. At the 2013 NPT Prep-Com, Saudi Arabia highlighted its leading role as a founding member of the United Nations and

compliance with all international nonproliferation regimes. On the other hand, it has always conditioned support for the regime on a nonnuclear Iran. It has even gone so far to say that if Iran developed nuclear weapons, they would follow suit with a weapons program of their own.

Beyond this, Saudi Arabia does not necessarily seem to be a prestige-seeking entity, instead more focused on maintaining stability in its sphere of influence and checking Iran’s influence and expansion. Saudi Arabia even grounds its nuclear energy expansion in the pragmatic necessity that it is more profitable to sell its oil abroad than use it at home, and with an energy need set to double in the next ten years, Saudi Arabia needed a more diverse energy portfolio. The one exception to this would be if Iran acquired nuclear weapons. Beyond the obvious security concerns, Saudi Arabia would be in much the same position as France in the early Cold War—confronted with both nuclear rivals and allies, and itself lacking. For a great regional power, it would be somewhat embarrassing to be wholly dependent on security guarantees of others and be unable to constrain the actions of a nuclear rival. In this instance, the acquisition of nuclear weapons would have significant normative prestige drivers.

**ANALYSIS AND CONCLUSIONS**

Each of the hypotheses bears out, as proliferation drivers for each of these three countries appear to have risen across the board. The distinction lies in the degree to which each of the drivers have risen for each country. Table 1 summarizes the relative rise in proliferation drivers for each of the countries and each of the models.

**Egypt**

Egypt faces few new or qualitatively different external threats. The greatest threats to its security are regional instability and the possibility of increases to that instability from neighboring Libya and ISIS, threats that nuclear weapons would do little to ameliorate. However, ISIS and the regional instability do represent a failure of the international community to ensure stability after intervening in conflicts. Moreover, the relationship between Egypt and the United States has significantly cooled.

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raising questions about the commitment of the United States to Egypt’s security. Overall, the security
drivers to acquire nuclear weapons have definitely risen, but only in the margins and at a low rate.

Overall, the domestic drivers for Egypt are something of a mixed bag. The removal of Mubarak as a
barrier to proliferation is a major change in the domestic calculus. Additionally, a former minister
of defense and general in the military, historically the greatest advocate for nuclear weapons in
Egypt, now heads the government, and he has presented ambitious plans for expanding the
nuclear energy program. There are few indicators that this is definitively a tack toward a nuclear
weapons program, but Egypt now exists in an increasingly permissive environment to allow it,
indicating that drivers have perhaps risen to a low degree.

The normative drivers are perhaps where Egypt has seen the most change since 2010, as its frus-
tration with the lack of progress toward a WMDFZ in the Middle East has come to a head. While
traditionally a stalwart supporter of the NPT and the norm of nonproliferation, Egypt has signaled
that the international community’s, and specifically the United States’ and Israel’s, intransigence is
severely testing its commitment. While there are few positive normative drivers to acquire nuclear
weapons, the deterioration of the one major disincentive rates at least a moderate increase in the
total normative drive to acquire nuclear weapons.

Turkey

Turkey faces many of the same stability issues as Egypt because of the turbulence in Syria and the
threat of ISIS. Again, this is not a threat that nuclear weapons could address, but raises many
questions regarding the nature of the U.S. commitment to Turkey. Turkey does also face greater
external threats in a resurgent Russia and a potentially nuclear Iran. These threats remain some-
what nebulous, as only Iran, as of yet nonnuclear, has issued direct threats against Turkey, and
mostly in the context of threatening NATO. As such, security drivers to acquire nuclear weapons
appear to have risen since 2010, but only moderately.

These concerns indicate that the domestic drivers toward acquiring nuclear weapons have likely
increased to a moderate degree in Turkey. In contrast to Egypt, which simply seeks to increase its
nuclear energy program, Turkey seeks full mastery over the nuclear fuel cycle, a necessary re-
quirement for a weapons program. Sourcing from Russia with questions over fuel sourcing and
disposal also raises additional questions about the safety and security of the nuclear energy in
Turkey. Paired with a more centralized and conservative government, there seem to be fewer
domestic checks on Turkey’s ability to pursue nuclear weapons.

Ultimately, Turkey seems to have the greatest increase in positive normative drivers largely due to
its focus on its neo-Ottoman identity, an identity that has a great focus on reestablishing itself as a
major player in the Middle East and reclaiming its lost prestige. While not explicitly included in this,
acquiring nuclear weapons could play into this. On the nonproliferation front, Turkey displays a
measured ambivalence, expressing support for a Middle East WMDFZ while still quietly insisting on
maintaining a U.S. nuclear presence in the country. The norm of nonproliferation is seen as some-
thing to be pragmatically used to advance its interests in joining the European Union, and a norm
that one could imagine easily being discarded in a bid to establish itself as a major power as it pivots
back to the Middle East. In all, the normative drivers have likely increased by a moderate amount.
Saudi Arabia

Saudi Arabia faces the greatest increase in security threats since 2010. It faces all of the same challenges as Turkey and Egypt regarding instability in the region and U.S. commitment to combating that instability and ensuring security. However, where Egypt and Turkey view Iran as a distant, somewhat amorphous threat, Saudi Arabia is engaged in a protracted rivalry and conflict with it. Recently, this conflict has gained new life in the proxy war in Yemen, making the external threats to Saudi Arabia and its sphere of influence even more real. The threat of Iran weaponizing its nuclear program and making this rivalry a nuclear one is extremely threatening. Given the rapid increase in instability, questionable security guarantees, and external threats, the security drivers for Saudi Arabia have risen greatly.

The trend in the Saudi government has been one of maintaining the status quo. The recent instability of the Arab Spring has left the region shaken, but the Saudis came out on top. Now Saudi Arabia has to stabilize the region if it wishes to continue to prosper. Nonetheless, the drivers to acquire nuclear weapons have still risen marginally, as the creation of an advanced nuclear program creates a permissive condition that could allow Saudi Arabia to pursue a weapons program later.

Overall, the normative drivers toward nuclear weapons have increased by a moderate amount. Saudi Arabia follows the same pragmatic approach to nonproliferation as Turkey—expressing support for the regime so long as it falls within its own interests. Saudi Arabia is not in general a prestige-seeking entity, with the exception of areas concerning Iran. It has openly stated it will pursue whatever capabilities Iran has, weapons or otherwise, always making sure to keep pace with Iran. Given Iran’s advanced nuclear program and its potential to weaponize, prestige drivers to that end have certainly risen.

The Regional Trend

It is clear that drivers for acquiring nuclear weapons are rising across the board in the Middle East, though it varies considerably by state and model. Saudi Arabia is the most likely instance of potential weapon development, but Turkey and then Egypt cannot be discounted. This is by no means a guarantee that Saudi Arabia or any of the states will develop nuclear weapons, and it may be more likely that the countries will pursue a nuclear hedge instead, but the trend indicates an increasing likelihood. Fortunately, the United States and the international community have every opportunity to take steps to reverse these trends, beginning with the implementation of the Iran deal that would head off its nuclear development.
From Terrorism to Nuclear War: The Escalation Ladder in South Asia

Elizabeth Whitfield

India and Pakistan have each possessed an overt nuclear weapons capability for close to two decades now. Deterrence has held between the nuclear-armed neighbors thus far, but the India-Pakistan rivalry is historically extremely crisis prone. The risk remains that a future conflict between the two countries could escalate past the nuclear threshold, most likely following the blueprint of a specific escalation pathway that represents the highest-risk scenario for the breakout of nuclear war. Developments in the past several years have made this escalation ladder even more threatening, such as Pakistan’s recent acquisition of tactical nuclear weapons and India’s eroding culture of strategic restraint. In addition, the prevailing atmosphere of uncertainty combines with a lack of direct policymaker control over many of the rungs on the ladder to render escalation control in the fog of war extremely difficult. This paper describes the escalation ladder as it exists today in South Asia and analyzes the growing challenge that this escalation ladder poses for deterrence stability. Because it is not so much a matter of if there will be another India-Pakistan crisis but when, the paper concludes with policy recommendations for future U.S. administrations.

INTRODUCTION

Ever since India and Pakistan conducted reciprocal nuclear tests in May 1998, the possibility of a nuclear exchange between the two countries has existed. However, in a world in which a nuclear

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war has fortunately never occurred, it can be difficult to envision precisely how or why such an escalation could take place. When examined in isolation, it is hard to imagine an Indian or Pakistani leader making the monumental decision to use nuclear weapons. But such decisions are not made in isolation. In reality, South Asian policymakers are much more likely to make a series of relatively smaller choices that would lead, step by step, to precisely that outcome.

This paper seeks to elucidate the escalation ladder along which this series of decisions would proceed. In doing so, it demonstrates how an act of terrorism could potentially trigger a conventional conflict between India and Pakistan, which could in turn escalate to the level of nuclear war. It is important to understand that many of the rungs on this escalation ladder are new and the potential for escalation continues to become increasingly more dangerous, and is largely unnoticed by U.S. decisionmakers.

BACKGROUND: THE INDIA-PAKISTAN RIVALRY

India and Pakistan have been locked in an ongoing rivalry since both states came into existence in 1947. This enmity began with the bloodshed of partition, when communal violence claimed the lives of approximately half a million people as refugees flooded across the quickly closing national borders.² The conflict between the two countries remains a potent mixture of identity politics and ongoing disputes. Pakistan, in particular, defines itself in opposition to India. The founding rationale for its existence as a state was to provide a Muslim alternative to secular India, and Pakistan’s leaders continue to feel the need to defend this concept in order to prove the country’s viability.³ Pakistan and India also have an ongoing border dispute over the territory of Kashmir, which similarly originated during the partition. The accession of the princely state of Kashmir was in question during this time, and the nascent states went to war over the territory almost as soon as they gained their independence. When the dust settled, India possessed two-thirds of Kashmir and Pakistan the remainder, divided by a border known as the Line of Control that remains contentious and heavily militarized to this day.⁴

Since 1947, India and Pakistan have fought two additional wars against each other (in 1965 and 1971) as well as a more limited conventional conflict in 1999 known as the Kargil War.⁵ The Kargil War is particularly noteworthy because it was fought after India and Pakistan became nuclear weapons states in 1998—one of the few times in history that two nuclear weapons powers have engaged in a direct, conventional conflict.⁶ This conflict began after Pakistani troops, disguised as militants, occupied several remote mountain peaks across the Line of Control in the

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6. There has only been one other example of a direct conflict between nuclear weapons states: the 1969 Sino-Soviet conflict over the Damaanski Island. See Timothy D. Hoyt, “Kargil: The Nuclear Dimension,” in Asymmetric Warfare in
Indian portion of Kashmir. Two months of intense, high-altitude fighting ensued before Pakistan eventually decided to withdraw its forces under pressure from the international community.7

Tensions between India and Pakistan peaked again in 2001, when the Pakistan-based terrorist group Lashkar-e-Taiba launched an attack against India’s parliament, killing about a dozen people.8 Lashkar-e-Taiba maintains ties to Pakistan’s intelligence service and is commonly believed to be a covert instrument of Pakistani national security policy.9 India consequently held Pakistan responsible for the parliament attack and mobilized its troops en masse along the border. Pakistan mobilized its own troops in response, and both countries engaged in a tense 10-month standoff.10 This standoff was punctuated by another militant attack against an Indian army camp that claimed the lives of many families of deployed Indian soldiers—the second rise in tensions in what is commonly referred to as the Twin Peaks crisis.11 Both militaries eventually stood down after U.S. diplomacy secured a pledge from Pakistan’s President Pervez Musharraf to permanently end terrorism emanating from Pakistan across the Line of Control.12

In spite of this pledge, in November 2008 Lashkar-e-Taiba mounted another spectacular terrorist attack, this time a series of coordinated shootings and bombings across Mumbai over four days that left 164 people dead.13 This terror attack—referred to as 26/11 after the date on which the assault began—is sometimes called India’s 9/11. One of the militants involved in perpetrating the attack later testified that he was recruited by Pakistan’s Inter-Services Intelligence (ISI) directorate and that the agency played a major role in planning the attack.14 Although both India and Pakistan engaged in heated rhetoric and appeared on the verge of mobilizing their troops again following the attack, India showed considerable restraint and the crisis was defused without major incident.15

South Asia: The Causes and Consequences of the Kargil Conflict, ed. Peter R. Lavoy (New York: Cambridge University Press, 2009), 144.

11. Ibid., 18.
12. Ibid.
THE ESCALATION LADDER

Although past crises on the subcontinent have not escalated to the level of a nuclear exchange, a host of troubling dynamics and recent developments in the region have increased the risk of escalation in future crises. To understand how escalation could play out, it is necessary to examine each of the rungs on the escalation ladder in turn (see Figure 1). It is the very existence of so many rungs on the ladder that makes escalation such a threatening prospect: the danger is that a series of relatively small decisions could lead step by step to nuclear war, without necessitating that either side make a great leap at any point in the process. In addition, there are forces outside of India and Pakistan’s direct control that at certain points along the ladder would create great pressure toward escalation—turning it from a ladder, which one can voluntary climb or descend at will, into an escalator, pushing both countries toward nuclear war in a process that is largely out of their own control. This is not to say that escalation is inevitable; it certainly is not. However, India and Pakistan face a uniquely paved path toward nuclear war—one that most nuclear-armed adversaries in our history have not been confronted with.

The Trigger: Subconventional War

To understand this escalation ladder, imagine that a Pakistan-based militant group—one that is either directly supported by elements of the Pakistani government or at least given safe haven within the country—launches another major terrorist attack upon an Indian target. Whether or not this particular terrorist attack was planned with the knowledge or help from elements of the Pakistani government, India will hold Pakistan responsible based on its role in past attacks and history of supporting militant groups that target India. Tensions will rise, and domestic pressure on the Indian government to respond will mount quickly in the wake of the tragedy.

Historically, India has responded to such attacks with considerable strategic restraint. In the Kargil War, India was very careful not to escalate the war into Pakistani territory.16 After the 2001 Parliament attack, India massed its troops but never actually attacked. After the 2008 Mumbai attacks,

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India countered with no military response whatsoever. However, this strategy of restraint has not been successful in convincing Pakistan to crack down on terrorism emanating from within its borders, and there are signs that India may abandon the strategy going forward. In this escalation ladder scenario, the Indian government consequently begins to explore military options for responding to the attack, believing that another weak response will only further embolden these terrorist groups and persuade Pakistan of the utility of supporting them.

The Response: Conventional War

India would have a range of options when deciding on a military response. One option would be for India to respond with subconventional proxy attacks of its own. This option is beginning to garner discussion in India, but is not part of the escalation ladder scenario and therefore outside the scope of this paper. India’s other options for responding all involve the use of conventional force. For instance, India could increase artillery fire across the Line of Control, capture Pakistani border posts, or send troops just across the border to seize very small amounts of Pakistani territory. The Indian navy could also institute a maritime exclusion of Pakistan’s port at Karachi, or India could use ballistic or cruise missiles to strike targets in Pakistan. The most likely option, however, would be the use of airpower. India could authorize strikes against militant camps in Pakistan-controlled Kashmir (on the lower end of the escalatory scale) or against high-value terrorist camps in Pakistan proper. Such strikes could also extend to Pakistani military and intelligence infrastructure in Kashmir, if India believed them to be associated with supporting the attack.

The reality is that all of these options carry significant escalatory potential, particularly those that would exact a higher punitive value against Pakistan. For instance, India could chose to strike Lashkar-e-Taiba’s sprawling headquarters at Muridke, but this installation is located only 30 kilometers from Lahore and is believed to contain a hospital, farms, and residences. The proximity to Pakistan’s second-largest city and high likelihood of noncombatant casualties means that such an attack would be considered extremely threatening by Pakistan. The country’s military leaders would find it almost impossible not to respond, for a multitude of reasons. For instance, Pakistan has consistently denied responsibility for terrorist attacks emanating from its territory in the past, and would thus consider India to be the aggressor and an airstrike to be the opening salvo in an Indian war against Pakistan. The need to defend the homeland would be further compounded by the fact that Pakistan’s national security apparatus has for decades won disproportionate influence in Pakistan by hyping the threat from India and claiming that only the army can protect the

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21. Ibid., 29.
country; consequently, its continued domestic power rests on its ability to back up that claim.\(^{22}\) As one former top-level officer from Pakistan’s Inter-Services Intelligence put it:

They talk of hitting Muridke. It’s in the middle of a town! We know their capabilities. If a strike hits the outskirts of Lahore, in central Punjab, it would be a severe escalatory step. We’ll strike back. We could hit camps where they work with the Baloch. Our argument would be the same as Indians argue. We don’t want it to be escalatory, but it must be commensurate to what they did. If they kill 20, we can’t just drop bombs in a field. We would claim we imposed more [emphasis in original] casualties than they did. It may be true or not, but the media will report it. An attack on Muridke will also lead to a mobilization on both sides. We would move troops to the border, as they will. We will move from the Eastern border—forget the war on terror. Fighting India would become the priority.\(^{23}\)

With both India’s and Pakistan’s credibility on the line, the result would likely be an escalating cycle of tit-for-tat retaliation.\(^{24}\) As both countries struggled to gain the upper hand in the conflict and casualties mounted, it would be tempting for India to make use of its primary strategic advantage over Pakistan: its enormous army.\(^{25}\) Strategists in India have advocated for sending ground troops across the international border into Pakistan in such a situation, with the aim of destroying Pakistan’s war-fighting capabilities and seizing territory as both a punitive measure and to use as a bargaining chip in postwar negotiations.\(^{26}\)

The Final Rung: Nuclear War

If the Indian army crossed the international border in force and Pakistan perceived that its territorial integrity was in danger, Pakistan has repeatedly signaled that it would use its tactical nuclear weapons (TNWs) against invading Indian forces.\(^{27}\) For instance, Maleeha Lodhi, Pakistan’s ambassador to the United Nations, has said that Pakistan’s tactical nuclear weapons are specifically intended “to counterbalance India’s move to bring conventional military offensives to a tactical level.”\(^{28}\) On another occasion, Lieutenant General Khalid Kidwai, the former and longtime director


\(^{23}\) Perkovich and Dalton, *Modi’s Strategic Choice,* 29.


of the body that controls Pakistan’s nuclear weapons, laid out this set of unofficial Pakistan red lines for the first use of nuclear weapons:

a. India attacks Pakistan and conquers a large part of its territory.
b. India destroys a large section of its land and air forces.
c. India proceeds to the economic strangulation of Pakistan.
d. India pushes Pakistan into political destabilization or creates large-scale internal subversion.29

It is unclear exactly what would constitute “a large part” of Pakistan’s territory. However, given that Rawalpindi has consistently considered India to be engaged in a relentless effort to jeopardize Pakistan’s continued existence as a state,30 it is likely that the country’s leaders would view any seizure of territory in the Pakistani heartland as an existential threat. In addition, even if India’s goals in seizing territory were relatively limited, it would be extremely difficult to convey this to Pakistan in a credible manner. Regardless of Indian signaling along those lines, Pakistan would not be able to discount the possibility that India might continue to sweep into the country and seize more and more territory, in pursuit of regime change in Islamabad or worse. In that situation, Pakistan’s national security apparatus might well see the detonation of a tactical nuclear weapon against an India battle formation as the only available option to convince India to back down and de-escalate the conflict.

India’s own nuclear doctrine states that “nuclear weapons will . . . be used in retaliation against a nuclear attack on Indian territory or on Indian forces anywhere” (emphasis added) and that “nuclear retaliation to a first strike will be massive and designed to inflict unacceptable damage.”31 Thus, if India follows its declared doctrine, any Pakistani use of tactical nuclear weapons would be met with massive nuclear retaliation. It is possible that India might decide to ignore its massive retaliation doctrine in such a situation and respond with a much more limited nuclear strike of its own. Regardless, this would still constitute the first-ever nuclear exchange in history and result in massive damage. In addition, once the nuclear threshold had been crossed, it is difficult to imagine that the resulting nuclear war would somehow be kept limited. Retired Indian ambassador Jayant Prasad has said that “controlled’ nuclear war between the U.S. and Russia is hard to imagine. Between India and China, or between India and Pakistan, it is impossible.”32 In this way, a conflict sparked by a terrorist attack could escalate first to the level of conventional conflict, and then to limited nuclear use, and finally to a full-scale nuclear war between the two countries.

30. Fair, Fighting to the End, 155.
HOW HAS THE RISK OF ESCALATION INCREASED?

It is important to understand that many of the rungs on the escalation ladder are either new or newly more dangerous, and thus that the risk posed by the above scenario has increased significantly in recent years. In addition, many other risk factors that increase the chance of escalation up the ladder are new in the sense that they are unique to the India-Pakistan nuclear rivalry and thus novel in the history of nuclear weapons and deterrence stability. Many of these risk factors are still relatively poorly understood.

Pakistan’s Development of TNWs

Pakistan only developed tactical nuclear weapons (TNWs), which represent one of the key rungs on the escalation ladder, relatively recently. Pakistan first tested its 60-kilometer, nuclear-capable Nasr missile in April 2011, and only declared it technologically ready for induction into the country’s arsenal in 2013.\(^{33}\) It is still unclear to what extent these weapons have actually been operationalized. By developing TNWs, Pakistan seeks to lower the nuclear threshold and thereby deter conventional military action by India. These weapons make a Pakistani threat of nuclear first use more credible, but by the same token this lowering of the nuclear threshold makes it much easier to cross the line into nuclear use. The general agreement among experts is that Pakistan’s TNW capability is severely destabilizing, particularly given the challenges of operationalizing such weapons in a wartime environment.\(^{34}\) TNWs create strong pressures for preemption by the other side; pose serious difficulties for command, control, and communications; require giving commanders on the ground predelegated launch authority; and generate severe use-it-or-lose-it pressures if opposing forces appear likely to capture or destroy the weapon.\(^{35}\) All of these pressures significantly increase the risk of an unauthorized, accidental, or ill-considered nuclear detonation during a conflict.

India’s Eroding Culture of Strategic Restraint

Another of the rungs on the escalation ladder that has newly become more dangerous is the possibility of Indian use of conventional force in retaliation to a terrorist attack. There are reasons to believe that the current Indian government, under Prime Minister Narendra Modi and the Bharatiya Janata Party (BJP), would be much more likely to use conventional force against Pakistan than previous Indian administrations. The BJP evinces a more hard-line stance toward Pakistan than India’s traditionally dominant Congress Party has in the past. Importantly, the BJP’s victory in the 2014 elections marks a true break with the past: it was the first time in the country’s history that a party besides Congress had won an outright majority and could govern directly

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Rather than through a coalition government. For that reason, it seems more likely that this new administration could deviate sharply from the past and have the ability to do so.

Already, the BJP government has shown signs of a more bellicose reaction to Pakistani actions in comparison with previous Indian governments. For instance, artillery exchanges across the Line of Control occur habitually, but since Prime Minister Modi took office they have increased significantly, and India’s Border Security Forces have retaliated with considerably more force than in the recent past. This increase in shelling has been accompanied by warnings from Indian leaders that “times have changed,” and India is determined to “make the cost of [Pakistani] adventurism unaffordable.” India’s defense minister, Manohar Parrikar, said that the Indian army has now been instructed to “react with double the force” in response to any attack. According to South Asia expert Frederic Grare, “The message sent to Pakistan over the past 12 months has been consistent and simple: India is ready for dialogue, but will respond to any Pakistan recourse to violence with disproportionate force.” This change in rhetoric indicates that India’s government may have decided that because strategic restraint has not been successful in the past—that is, it has not deterred Pakistan from continuing to support or shelter terrorist organizations that attack India—a new policy is needed. Such a decision would have grave implications during the next major India-Pakistan crisis, if the Modi government decides to retaliate with conventional force as described in the escalation ladder above.

Direct Attacks and the Nonunitary Actor Problem

To some extent, the entire dynamic of the India-Pakistan conflict is relatively new in the history of nuclear weapons. That is to say, the dynamic is new not in the sense that the risk of escalation has increased in comparison to past India-Pakistan crises, but rather that the risk of escalation is much higher in this rivalry than it has been in other historic nuclear flashpoints. For instance, India and Pakistan are contiguous states, which adds to the sense of insecurity that permeates the rivalry and dramatically shortens the time decisionmakers would have in a crisis to decide where to use nuclear weapons or launch a retaliatory second strike. Unlike other nuclear dyads, India and Pakistan have already fought three direct wars against each other and one limited conventional

conflict (the Kargil War). The most important way in which the India-Pakistan rivalry represents a nuclear novelty is in the involvement of proxy actors that perpetrate direct attacks upon the homelands of the nuclear-armed adversaries. These direct attacks by proxy actors are unprecedented in a rivalry between nuclear-armed powers. The United States and the Soviet Union certainly engaged in a multitude of proxy conflicts during the Cold War, but neither was ever bold enough to extend those attacks directly into each other’s territory, for fear of the escalatory potential of such an action. However, this is exactly the strategy that certain elements of the Pakistani government pursue, or at least permit terrorist groups residing within their country to pursue.

This dynamic is particularly troublesome in South Asia given what George Perkovich has defined as the nonunitary actor problem. Essentially, all traditional models of deterrence are predicated on the idea that the actors involved are rational unitary actors, meaning that the state is rational and also exercises control over the use of force within and emanating from its territory. However, Pakistan does not necessarily fit the model of a unitary actor in the context of this conflict. The terrorist groups that operate within its territory are only tenuously under the control of the Pakistani state, which has significant implications for deterrence stability. Traditional deterrence models are based on the idea that a rational state would not voluntarily take a step down a path it knows leads toward mutually assured destruction. Classic deterrence theorist Michael Quinlan once wrote that “only a state ruler possessed by a reckless lunacy scarcely paralleled even in pre-nuclear history would contemplate with equanimity initiating a conflict that seemed likely to bring nuclear weapons down upon his country.”

This classic deterrence model breaks down when unpredictable, non-state groups can hijack crisis decisionmaking. A state leader would be highly unlikely to initiate a conflict that could lead to nuclear war, but a terrorist group may have no such compunctions. In this situation, the entire edifice of deterrence rests on a shaky foundation. A terrorist organization could launch an attack on India during a moment of heightened tension or crisis, either not recognizing—or not caring—about the escalatory potential such an attack would represent. Although the hypothetical attack may not have been authorized by the Pakistani government, the Indian government would undoubtedly treat it as such, and could retaliate accordingly. Pakistan would then be locked into a crisis not of its own making, hurtling toward an unwanted decision to either use nuclear weapons or risk backing down from its stated red lines. The nonunitary actor problem thus adds a more unpredictable and dangerous aspect to the India-Pakistan rivalry and is one of the rungs at which

41. Ibid.
42. Ibid., 1113.
44. Ibid.
the escalation ladder is more reminiscent of a conveyer belt or an escalator, pushing India and Pakistan into a conflict in a process largely out of their control.

**THE IMPACT OF UNCERTAINTY**

One of the most important variables in any future India-Pakistan conflict will be uncertainty. Many of the aspects of this nuclear-armed rivalry are uncertain, and it is precisely this uncertainty that makes conflict more risky and escalation more likely. For instance, because Pakistan’s possession of tactical nuclear weapons is so new, it is difficult to predict how Pakistan would choose to employ them in a crisis, what Pakistan’s red lines are, or if the weapons themselves would even work. It is likely that even Pakistani decisionmakers do not know the answers to these questions, so it is difficult to see how Indian leaders could make informed policy decisions in a conflict.

This unpredictability and uncertainty is dangerous because in any future conflict between India and Pakistan, both sides will seek to succeed at the game of brinkmanship. That is to say, both India and Pakistan would aim to escalate the conflict just enough so as to be intolerable to their adversary and force it to back down, but not so much as to cross any of the other side’s nuclear red lines. India would hope to wage a sufficiently damaging conventional conflict to punish Pakistan for its support of militant groups, while keeping the conflict just limited enough to avoid triggering a Pakistani decision to use tactical nuclear weapons. Pakistan, on the other hand, would hope to lower the nuclear threshold enough with its threats to use TNWs that India would be scared into backing down, without lowering the threshold quite so much as to make nuclear war inevitable. Essentially, both countries’ strategies would depend upon their ability to successfully balance on the very brink of nuclear war without toppling over. However, as famed deterrence theorist Thomas Schelling once wrote:

> The brink is not . . . the sharp edge of a cliff where one can stand firmly, look down, and decide whether or not to plunge. The brink is a curved slope that one can stand on with some risk of slipping, the slope gets steeper and the risk of slipping greater as one moves toward the chasm. But the slope and the risk of slipping are rather irregular; neither the person standing there nor onlookers can be quite sure just how great the risk is, or how much it increases when one takes a few steps downward.46

Balancing on the brink of nuclear war is an excessively risky proposition. If brinkmanship of this nature is to be successful, it would require not only a great deal of luck but also exceedingly precise control of the situation and detailed, accurate knowledge about the adversary’s nuclear red lines. It is highly unlikely that either side possesses this type of precise and detailed information. This is partly due to the fact that many of the rungs on the escalation ladder are so new and untested, as explained previously, but also partly because decisionmakers in India and Pakistan

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have almost no contact with their counterparts and exchange very little information.\textsuperscript{47} Pakistan, in particular, pursues a policy of ambiguity with regard to its nuclear doctrine, and thus purposefully works to keep its red lines unclear.\textsuperscript{48} In spite of all this, both sides seem confident that they have the necessary knowledge to successfully pursue a strategy of brinkmanship, which is all the more troubling. For example, Varun Vira writes that “during the 2002 mobilization, several Indian generals were questioned on whether they knew exactly what would trigger a Pakistani nuclear response; all but one expressed confidence that they did. But they all laid out different red lines.”\textsuperscript{49} In this situation of limited information combined with misplaced confidence, either India or Pakistan could easily make a strategic miscalculation and accidentally cross one of the other’s red lines. This risk of miscalculation is further heightened by the fact that Pakistan’s development of tactical nuclear weapons is a classic example of what Schelling famously termed “the threat that leaves something to chance.”\textsuperscript{50} This is because the real deterrent value of Pakistan’s threat to use tactical nuclear weapons lies not so much in the damage that would be done to India’s troops and personnel by a single TNW, but in the fact that such an attack would dramatically increase the possibility of uncontrolled escalation. Nuclear weapons have never been used in a conflict against another nuclear-armed adversary, and so no one quite knows what would happen next. Even more importantly, neither of the states in question may be able to control what happens next. Once the nuclear threshold has been crossed, it is difficult to imagine that the resulting nuclear war could somehow be constrained. This threat to wrest control from the hands of both countries’ decisionmakers is designed to bolster the credibility of Pakistan’s promise to use nuclear weapons to defend against conventional attack. However, it also makes the escalation ladder exponentially more dangerous, because Pakistan is essentially threatening to turn it from a ladder into a conveyor belt, pushing both countries toward nuclear war.\textsuperscript{51}

One of the reasons Pakistan has felt the need to adopt such a strategy is that deterrence stability in South Asia is complicated by the existence of credibility problems. Both sides have reasons to doubt the credibility of the other’s threats, which could have severe consequences for crisis stability. Indian strategists, in particular, worry that their doctrine of massive retaliation is not believable. According to prominent Indian analyst P. R. Chari, “the determinism inherent in India’s nuclear doctrine that any level of nuclear attack will invite massive retaliation is too extreme to gain much credibility. It defies logic to threaten an adversary with nuclear annihilation to deter or defend

\textsuperscript{47} Christopher Snedden, Kashmir: The Unwritten History (Noida, India: HarperCollins India, 2013), https://books.google.com/books?id=0cPjAAAQAQBAJ8pg=PT1878lpg=PT1878dq=india+pakistan+lack+of+contact&source=bilots=MYZqZx8mCXbSig=93SeTfr=HXPmr3Ozd6LUnZbrkJ4bh=enbsa=Xbevi=kQpBVeaHKMGlgwT04IDADwved=0CFMQ6AEwCA#v=onepage&q=india%20pakistan%20lack%20of%20contact&f=false; For an example of how little Indian and Pakistani decisionmakers seems to understand each other, see Chaulia, “Ceasefire Violation: How India Is Misreading the ‘Suicidal Logic’ of Pakistani Army.”

\textsuperscript{48} Vira, “Escalating from Terrorism to Nuclear War.”

\textsuperscript{49} Ibid.

\textsuperscript{50} Schelling, Strategy of Conflict, 187.

against a tactical nuclear strike on an advancing military formation.\textsuperscript{52} If either India or Pakistan doubts that the other side will carry out its nuclear threats, they could attempt to call the other’s bluff, with potentially dire results. Thus, the atmosphere of uncertainty that prevails in the India-Pakistan rivalry creates the dangerous possibility that one or the other’s nuclear red lines could be crossed in a conflict, either by accident in the fog of war or deliberately as a result of a misreading of the other side’s resolve.

**PREPARING FOR THE NEXT INDIA-PAKISTAN CRISIS**

The India-Pakistan rivalry is highly conflict prone, and it is thus not so much a matter of if there will be another India-Pakistan crisis, but when. When this next India-Pakistan crisis occurs, the United States must be prepared to step in and take on the role of crisis management, as it has done so effectively in the past. During the 1999 Kargil War, the 2001 Twin Peaks crisis, and the 2008 Mumbai attacks, the United States was pivotal in persuading India and Pakistan to de-escalate, particularly after securing promises from Pakistan to crack down on terrorist groups operating within its borders.\textsuperscript{53} This dynamic will be similarly essential in any future crisis between the two countries.

In order for U.S. crisis management to be effective, it is important that the United States continue to be viewed as credibly able to play that role. In particular, the United States’ well-worn crisis management playbook may cease to be effective in the future if Indian policymakers do not believe that the United States has the power or the will to pressure Pakistan to crack down on terrorism emanating from within its borders. For instance, following the Twin Peaks crisis, U.S. diplomats secured a pledge from Pakistan’s President Musharraf to stop terrorist infiltration across the Line of Control, which allowed India to de-escalate the standoff.\textsuperscript{54} However, the 2008 Mumbai attacks clearly demonstrated that Pakistan had not made good on Musharraf’s promise. This remains true today. For example, on April 10, 2015, a Pakistani court even went so far as to release the suspected mastermind of the Mumbai attacks, Zaki-ur-Rehman Lakhvi.\textsuperscript{55}

In the future, mere pledges may not be enough to defuse the next crisis. The United States must be prepared to use all the tools at its disposal to pressure Pakistan to put an end to terrorism emanating from within its borders, lest India believe that Pakistan’s—and Washington’s—promises are not credible. For instance, the United States could condition its continued economic aid to Pakistan—such as the lucrative Coalition Support Fund program that has provided the country with $13 billion since 2002\textsuperscript{56}—on Pakistan bringing perpetrators of terror attacks to justice, closing

\textsuperscript{53} Nayak and Krepon, “US Crisis Management,” 18; Nayak and Krepon, Unfinished Crisis, 1.
terrorist training camps within its borders, and aggressively dismantling new terrorist networks as they attempt to surface. Economic aid would need to be predicated on long-term, continuing efforts by Pakistan in this regard, rather than symbolic and reversible actions in the short term, as has been the rule in the past.

The United States would most effectively preserve its credibility if it begins to seriously put pressure on Pakistan now, before the next crisis occurs. This could also be combined with a simultaneous diplomatic effort in India to highlight the significant risks of responding to a future terror attack with conventional force. In that way, the United States could work to help prevent the next India-Pakistan crisis before it takes place, as well as improve its ability to successfully manage any future crisis after it has begun. Such efforts are of critical importance because the escalation ladder outlined in this paper presents serious and ongoing risks to deterrence stability in South Asia. The specter of nuclear war on the subcontinent will continue to loom unless serious efforts are made to dismantle this escalation ladder once and for all.
An Overview of Hydrodynamic Testing, Challenges, and Advancements in Underwriting a State’s Nuclear Stockpile

Paul Willis-Patel

In the era of the Comprehensive Test Ban Treaty (CTBT), nuclear weapon states are still dependent on the archive of underground test data to underwrite their existing and future stockpile systems. There is, however, an inevitability to change. Existing warheads and the materials that constitute them age and become obsolete, and replacement components will not always be manufacturable in the same materials as the old (due to unavoidable changes in plant, facilities, and legislation, for example). To mitigate against such situations, hydrocode modeling and hydrodynamic experiments are required to provide much needed information on the aging mechanisms of the components and the consequences on performance and safety.

STOCKPILE STEWARDSHIP

In an era without recourse to undertake underground nuclear testing (UGT), nuclear weapon states (NWSs) have an obligation to use other means to continually maintain and certify their existing nuclear stockpiles. Any potential successor system would utilize existing UGT data as a baseline, because it provides high confidence of being safe, secure, and effective while also allowing deployment of modern safety and surety enhancements.

1. Paul Willis-Patel is a hydrodynamic scientist working within the Hydrodynamics Technology Centre at the Atomic Weapons Establishment, Aldermaston, UK. His work is primarily on the undertaking of hydrodynamic experiments both in the United Kingdom and collaboratively in the United States.
The aspiration for all NWSs is to be able to underwrite current and future nuclear stockpiles with a high degree of confidence in the hydrocode modeling tools without the need for nuclear and hydrodynamic testing. While an aspiration, stipulating a time frame to achieve this is difficult, with some potentially not having full confidence in the hydrocodes. There will always be the what-if factor: what if this component degrades unexpectedly? In all likelihood, a 100 percent confidence level cannot be attained but rather an acceptable margin of error applied.

For an existing NWS, that margin of error will be tighter than for a nonnuclear weapon state (NNWS) that is pursuing nuclear weapons for either aggressive (power seeking) or defensive (security dilemma) measures. A state that feels it requires a nuclear weapon to protect itself quickly may prioritize performance ahead of reliability, thus potentially relaxing some safety aspects. Any state that has a relatively simple design is less likely to suffer unexpected problems, although delivery options and range could be limited.

Will a state ever be in a situation where it can design a new nuclear warhead without referring to UGT data? To answer this requires knowledge of existing UGT and hydrodynamic data, along with hydrocode modeling capability. As previously mentioned, NWSs are still heavily dependent on their database of UGTs and use hydrodynamic experiments to underwrite their models, which in turn certifies the current stockpiles. It is also unlikely that any NWS would venture into a new warhead design without straying too far from existing UGT data. For NWSs like the United States or Russia, which have tested many different systems, this gives them options, but for a single-system state with limited testing, this could become a constraint.

Since ratifying the Comprehensive Test Ban Treaty (CTBT), the United Kingdom’s stance has been to maintain the current Trident D5 system with refurbishments to extend life as long as possible as part of the U.S. life-extension program. In parallel with extracting information from the legacy UGT database, supporting nonnuclear experiments termed above ground experiments (AGEX) are used to continually certify the current system.

AGEX are divided into two distinct areas: AGEX I covering hydrodynamic testing, and AGEX II covering plasma physics. AGEX I provides data from nonnuclear (noncritical) experiments that examine the implosion of the warhead using surrogate materials. AGEX II provides the capability to make quantitative material-property measurements at extreme temperatures and pressures as seen in a nuclear warhead. This is typically carried out using laser systems such as the Orion laser located at the Atomic Weapons Establishment (AWE) and the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory (LLNL).

Predictive capability for both UGT and hydrodynamic experiments, and therefore in-service systems, is in the form of high-powered computation modeling (Figure 1). The results of hydrodynamic testing are extremely important to certification. They are the cornerstones of warhead design as they provide empirical evidence that the supercritical configuration will implode as

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3. Above ground experiment (AGEX) should not to be confused with above ground test (AGT).
predicted, albeit using surrogate materials. UGT data, hydrodynamic data, and hydrocode modeling provide a holistic approach to ensuring a safe, secure, and reliable system.

With the introduction of the CTBT, both the capability of hydrocode modeling and hydrodynamic testing has increased to provide greater understanding of the science that underpins the warhead and removes reliance on new nuclear test data.5

HYDROCODE MODELING

A hydrocode is a computer program that solves equations governing the dynamic behavior of materials. It is the conservative equations for mass, momentum, and energy together with the constitutive relations that describe the material response. This is at the high pressures and strain rates associated with high-explosive (HE) detonation and high-velocity impact.

Nuclear programs make extensive use of supercomputers because the hydrocodes for modeling nuclear explosions are intricate and complicated. Currently, each of the main nuclear states has supercomputing power to underwrite its stockpiles and this capability is continually evolving.

From November 2012 to June 2013, the fastest supercomputer in the world was the Department of Energy (DOE) machine titled Titan Cray XK7, located at the U.S. Oak Ridge National Laboratory (ORNL) in Tennessee, with a top speed of 17.6 PetaFlops (PFlops). Since then, the Tianhe-2 (Milkyway-2) developed by China’s National Super Computer Center in Guangzhou surpassed the U.S. computer, with a top speed of 33.9 PFlops.6 This increase in computing power does not substitute for any UGT data from China’s 45 nuclear tests, but rather forms part of the methodology that states use to be able to conduct more detailed and complex calculations on the problems that may arise within stockpiles, aging components being one of them.

5. It should also be noted that although hydrodynamic testing has increased since the CTBT, another reason for this increase is a result of improved technologies enabling nuclear states to delve into designed-in features in more detail, thus allowing the states to further underwrite the surety of the system.

The United Kingdom updated its supercomputing capabilities to address hydrocode modeling when it installed AWE’s SPRUCE 1 facility in 2014 with a top speed of 1.8 PFlops. In comparison, the supercomputer at LLNL is the SEQUOIA, which has a top speed of 18.3 PFlops. The current known nuclear states and their nuclear program supercomputing power is shown in Table 1.

The U.S. National Nuclear Security Administration (NNSA) awarded the Cray supercomputer company a $174-million contract in 2014 for it to provide LANL and Sandia National Laboratory (SNL) with the next generation Cray XC computer, named Trinity. This computer will be used to ensure the safety, security, and effectiveness of the U.S. nuclear stockpile.7

### WHAT IS HYDRODYNAMICS?

Hydrodynamics is the study of materials that move like fluids. This is especially applicable within a nuclear warhead in its implosion phase. The pressures, temperatures, and densities reached by the materials causes them to behave like a fluid. This simulation (Figure 2) of two fluids interacting is like pouring milk into coffee, and it is how dense, heavy metals behave when driven by an explosion.

There are two categories of hydrodynamic experiments of note: integrated warhead experiments (IWEs) and focused experiments (FE).

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Integrated Warhead Experiments

IWEs are typically representative of in-service warhead systems containing surrogate materials in place of fissile materials to provide a near-neighbor match on material properties. These experiments provide vital information to aid in underwriting performance. The experiments can use toxic materials and as such will require specialized containment systems (see Figure 3).

IWEs include subcategories, with each category investigating different types of information.

Core Punch

A core punch (CP) is a full-scale representation of the warhead primary and can include ancillary components for testing. The name core punch comes from the main type of diagnostic to be used: strong X-rays to punch through the core of the experiment. A short pulse of X-rays in the order of 10 nanoseconds is used to provide an image (or images depending on number of axes) of the fluid dynamics.

A typical experimental setup (Figure 4) depicts X-rays being collimated (focused) through lead apertures onto the target object. Situated behind the object is an imaging detector that captures the X-rays after they have passed through the object. This provides the necessary images as the loss in energy of the X-rays passing through different densities of materials can be recorded.
A smaller version of a CP (SCP) can also be fielded, and it is a more cost-efficient way of gaining data at a higher resolution, because it reduces the amount of explosives and materials required. A campaign of SCPs would typically have a CP included to verify any scaling issues in the materials and hydrocode.

**Tamper Movement**

A tamper movement (TM) or pin shot experiment measures the implosion velocity of surfaces. The data from these experiments are used to determine if the hydrocode models are progressing too fast or too slow in relation to the actual experiment.

Traditionally, a probe head containing approximately 600 pin probes is positioned inside the experiment (Figure 5), with each of the pins shorting when the imploding surface of the tamper makes contact. The contact marks the arrival of the material and produces a measurement-versus-time plot for each probe.

The United States had recent success with a fully optical probe head providing increasingly more accurate data to the physics community, and the United Kingdom is preparing to follow suit.
These improved optical probe heads provide time-resolved data on the movement of the inner surface of the pit. As with the CP experiments, other ancillary components can be fielded as well as a suite of different diagnostics.

**Focused Experiments**

Focused experiments (FEs), although generally smaller and therefore typically cheaper than an IWE, are by no means less complicated. On the contrary, these experiments can be more challenging because they are aimed at investigating explicit components and associated phenomenon. As a result, they tend to include substantially more complicated diagnostic setups.

Focused experiments have been carried out using the Joint Actinide Shock Physics Experimental Research (JASPER) gas gun. A projectile is fired at a plutonium target in an attempt to understand the shock properties of the material. The plutonium equation of state (EOS) obtained from the equation of state of plutonium provides input back into the modeling codes for certification and surety of the nuclear stockpile. To date, over 100 experiments have been carried out at this facility.\(^8\)

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Subcritical Experiments

Work has been done at the Nevada National Security Site (formerly Nevada Test site) where subcritical experiments, such as Pollux in 2012, have taken place in drifts located underground and use small amounts of special nuclear material (SNM) and high explosives, but “the experiment never achieves criticality or a self-sustaining chain reaction.” The data is compared to the models as part of continual validation. These types of experiments use specially designed containment systems to encapsulate the experiment and prevent any radioactive release.

CURRENT FACILITY CAPABILITIES AND LIMITATIONS

When it comes to obtaining data from a CP, the limiting factor of the X-ray diagnostics is its ability to penetrate the materials within the experiment. This is alleviated somewhat by making the experiments smaller, but this instills additional complications. Within the United Kingdom and the

United States, there are currently a few facilities that can accommodate gathering this type of data, the AWE Mogul facility and the Duel Axis Research Hydro Test (DARHT) facility at the Los Alamos National Laboratory (LANL). Each of these facilities has diagnostics that are only capable of capturing data at two differing times of interest via two axes. The before and after conditions can be seen in Figure 6.

With the need to resolve the smallest of features in hydrodynamic tests, this provides a challenge with current radiographic capabilities. Depending on the type of experiment, there is the need to reduce the size of the object to enable the diagnostics to punch the core of the experiment. As current facilities have one or two machines, sometime numerous experiments are required to achieve a complete picture of what is happening throughout the experiment.

LANL does, however, have the Los Alamos Neutron Science Center (LANSCe) 800 MeV proton radiographic facility, which is able to take 21 time-resolved images of a dynamic event. However, this is at a severely reduced object scale compared to what can be fielded with Mogul and DARHT. In fact, it is currently not possible to make an object small enough to gather this data with this diagnostic.

FUTURE CAPABILITIES

The Institute of High Energy Physics (IHEP) located at Provino in Russia has developed a 70 GeV proton diagnostics, which has the ability to produce in the region of 29 time-resolved images and also has the potential to penetrate full-scale hydrodynamic experiments. There are, however, no published articles on whether this has been done, although the cost savings would be significant and data that can be acquired from one experiment rather than a suite would be valuable. Some work has been published demonstrating the diagnostics ability to record images of a cylindrical geometry with eight detonation points.10

The United Kingdom and France signed a joint defense program treaty in 2010, named TEUTATES, to “build and operate jointly a radiographic and diagnostics facility in France.”

The EPURE facility will enable three radiographic axes to be used on a hydrodynamics experiment, increasing the data acquisition from each experiment. This, in addition to higher performance radiographic machines, will enable the United Kingdom to obtain higher-resolution data and minimize the number of experiments undertaken. The TEUTATES treaty is a result of both the United Kingdom and France “reiterating their mutual interest in keeping their independent nuclear forces at the highest level of safety and reliability, at least cost, and determined to cooperate to this end in the industrial, technological and scientific fields.”11

CONCLUSION

It is critical for the success of any NWS to be able to underwrite their nuclear stockpiles, both now and in the future. Can a state ever be in a situation where it can design a new nuclear warhead without referring to UGT data? Currently, each of the five NWSs, to varying degrees, has the ability to underwrite the safety and surety of their systems through the use of hydrocode modeling and hydrodynamic testing based upon a comprehensive UGT database. However, a NNWS may also prove a latent capability by demonstrating hydrocode and experimental capabilities without actually building a nuclear weapon.

This capability can and will progress over time and ultimately underpins the credibility of any stockpile management. In this era, UGT data is still both a valuable and required commodity in underwriting existing and future nuclear warhead systems.
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