Qualitative Considerations of Nuclear Forces at Lower Numbers and Implications for Future Arms Control Negotiations

An Air Force Emerging Issues Report

Jeffrey A. Larsen
Justin V. Anderson
Darci Bloyer
Thomas Devine IV
Rebecca Davis Gibbons
Christina Vaughan

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ABOUT THE AUTHORS

Jeffrey A. Larsen (Project Lead) is a Senior Scientist with Science Applications International Corporation (SAIC) in Colorado Springs, CO. Dr. Larsen was the first Director of AF/INSS and continues to provide contract support to the Institute. He also works with Headquarters US Air Force, the Defense Threat Reduction Agency (DTRA), and US Strategic Command. He is widely published in the fields of national security, nuclear policy, arms control, NATO policy, and the role of airpower in recent conflicts. A retired Air Force Lt Colonel, Dr. Larsen earned his PhD in politics from Princeton University.

Justin V. Anderson (Analysis Lead) is a National Security Policy Analyst with SAIC in Arlington, VA, providing contract support to government clients on nuclear arms control, deterrence, and WMD proliferation issues. He is editor of the Headquarters Air Force, Strategic Plans and Policy (AF/A5XP) "emerging issues" report series and lead analyst for the portfolio's nuclear arms control analyses. His past experience includes serving as Senior Editor of the DoD Law of War Manual and providing analysis to the DTRA, OSD AT&L Office of Treaty Compliance, and Missile Defense Agency. Dr. Anderson received his PhD in war studies from King's College London.

Darci Bloyer is a Senior Policy Analyst with SAIC in Arlington, VA. She provides contract support to AF/A5XP on New START Treaty implementation, emerging issues, and nuclear policy issues. Previously Ms. Bloyer supported the Office of Nuclear and Missile Defense Policy in OSD Policy on matters relating to New START Treaty negotiations and ratification and the 2010 Nuclear Posture Review. From 2002 to 2009, Ms. Bloyer supported of the Office of Nuclear Matters in OSD AT&L on international programs and nuclear weapons issues. Ms. Bloyer received her M.S. in defense and strategic studies from Missouri State University.

Thomas Devine is a Policy Analyst with SAIC in Arlington, VA. He provides contract support to AF/A5XP's International Treaties and Agreements Branch. He was heavily involved with AF/A5XP's support to the 2009-2010 New START negotiations and was a member of the Center for Strategic and International Studies Project on Nuclear Issues' 2011 Nuclear Scholars Initiative. Mr. Devine holds an M.A. in international security studies from the Josef Korbel School of International Studies at the University of Denver.

Rebecca Davis Gibbons is a National Security Policy Analyst with SAIC in Arlington, VA. Ms. Gibbons provides support for A5XP's International Treaties and Agreements Branch, where she focuses on nuclear-related treaties. As an International Relations Ph.D. candidate at Georgetown University, her dissertation research focuses on understanding variation in adherence to the nuclear non-proliferation regime. Ms. Gibbons received her MA in security studies from Georgetown University.

Christina Vaughan is a Policy Analyst with SAIC in Arlington, VA. Ms. Vaughan currently provides support to AF/A5XP on issues pertaining to the Air Force's implementation of and compliance with arms control treaties and agreements. She previously supported the OSD Policy (Russia, Ukraine & Eurasia) and OSD AT&L Office of Treaty Compliance). Ms. Vaughan earned her Master of Public Policy degree from George Mason University.

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FOREWORD

We are pleased to publish this sixty-eighth volume in the Occasional Paper series of the United States Air Force Institute for National Security Studies (INSS). This study was sponsored and released by the Arms Control Branch of the USAF Strategic Plans and Policy Division (HQ USAF/A5XPI) and conducted by a team from the Science Applications International Corporation (SAIC). While this research was not sponsored by INSS, it is both compatible with our efforts and objectives, and it was selected by INSS as recipient of the 2011 Major General Robert E. Linhard Award for its outstanding contribution to informing strategic policy thinking for the United States Air Force. It is published here to support the education of national security professionals in the Air Force and across the government.

INSS Occasional Papers are currently published electronically and in limited numbers of hard copies specifically to support classroom use for strategic education. Other INSS research is published exclusively electronically as "Research Papers" for general national security education and to inform the security policy debate.

INSS found this study to be particularly significant because of its rigorous methodology in synthesizing the opinions of the experienced strategic policy community, its focus on qualitative characteristics of nuclear forces at a time when the overwhelming emphasis has been almost solely on quantitative factors, and the recognition that as numbers decline, the missions and deterrence requirements remain vital to the national security. We hope that it generates discussion and caution as we contemplate further reductions and policy revision.

About the Institute

INSS is primarily sponsored by the Strategic Plans and Policy Division, Headquarters US Air Force (HQ USAF/A5XP), and the Dean of the Faculty, USAF Academy. Other sponsors and partners include the National Defense University Center for the Study of Weapons of Mass Destruction (CSWMD); the Defense Threat Reduction Agency Advanced Systems and Concepts program (DTRA/ASCO); the Army Foreign Military Studies Office (FMSO); and the Army Environmental Policy Institute (AEPI). The mission of the Institute is "to promote national security research for the Department of Defense within the military academic community, to foster the development of strategic perspective within the United States Armed Forces, and to support national security discourse through outreach and education." Its research focuses on the areas of greatest interest to our

sponsors: enduring and emerging strategic security, and controlling and combating weapons of mass destruction.

INSS coordinates and focuses outside thinking in various disciplines and across the military services to develop new ideas for defense policy making. To that end, the Institute develops topics, selects researchers from within the military academic community, and administers sponsored research. It reaches out to and partners with education and research organizations across and beyond the military academic community to bring broad focus to issues of national security interest. And it hosts workshops and facilitates the dissemination of information to a wide range of private and government organizations. In these ways, INSS facilitates valuable, cost-effective research to meet the needs of our sponsors. We appreciate your continued interest in INSS and our research products.

JAMES M SMITH
Director

EXECUTIVE SUMMARY

Speaking before a crowd of 20,000 people packed into Prague's historic Hradcany Square on April 5, 2009, President Barack Obama issued an appeal to the international community to work in concert toward realizing a nuclear weapon free world. The president stated that the achievement of this goal, however, will require the United States to strike a delicate balance between pursuing nuclear disarmament and meeting its enduring defense requirements. He recognized that his administration, and likely future administrations ("this goal will not be reached quickly—perhaps not in my lifetime"), would face the challenge of negotiating verifiable reductions with other nuclear weapons states while simultaneously maintaining a nuclear arsenal that, even at lower numbers, remained capable of defending the United States and its allies against a broad range of threats.[1] The president pledged to work with other governments to reduce global nuclear stockpiles while also affirming that the United States will continue to field nuclear forces capable of meeting national security requirements, fulfilling alliance commitments, and maintaining international stability. "Make no mistake," stated President Obama, "as long as these weapons exist, we will maintain a safe, secure and effective arsenal to deter any adversary, and guarantee that defense to our allies."[2]

This research project addresses the challenge of attempting to reduce the *quantity* of U.S. nuclear weapons without compromising the *qualities* underpinning the U.S. arsenal's ability to meet policy and strategy requirements that currently rely upon nuclear options. This challenge will be central to future arms control negotiations and other U.S. military and diplomatic efforts to reduce global nuclear stockpiles. Informed by the national strategic objectives for nuclear forces identified in the 2010 *Nuclear Posture Review Report*, this project studied the impact of quantitative reductions of U.S. nuclear forces on the qualitative requirements associated with deterring adversaries, prevailing over opponents (should deterrence fail), and assuring allies. The research team identified the key qualitative characteristics of U.S. nuclear forces and conducted a detailed analysis to determine which characteristics will increase or decrease in relative importance for deter, prevail, and assure objectives as the United States reduces its numbers. The team also analyzed the possible impact of missile defenses and conventional prompt global strike (CPGS) systems on the qualitative characteristics of nuclear forces, and assessed whether these additional capabilities complement or supplement these characteristics.

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[1] "Remarks by President Barack Obama," White House Press Office, 5 April 2009. (Full citations for all footnote sources can be found in Appendix A.)
[2] Ibid.

The findings of this project can contribute to Air Force, Joint Staff, or interagency evaluations of future arms control negotiation positions or other initiatives considering future nuclear force requirements and possible reductions to the U.S. nuclear arsenal.

Key Findings

This analysis identified twelve key qualitative characteristics of nuclear forces, split into two categories: eight characteristics that may vary in relative importance depending on the number of weapons fielded by the United States (*ability to defeat defenses*, *ability to retarget*, *ability to reconstitute*, *ability to signal*, *accuracy*, *promptness*, *survivability*, and *variety of yield options*) and four "foundational" characteristics that are essential to the viability of any nuclear force regardless of size (*command and control*, *reliability*, *safety/security/surety*, and *sustainability*). The report's analysis primarily focused on the eight variable characteristics, assessing the relative importance of each of these characteristics at two levels (at New START Treaty limits, and at lower numbers) for deterring and prevailing over four types of potential adversaries (peer, near-peer, regional power, and armed non-state actor (ANSA) adversaries), and for assuring allies. The analysis yielded the following findings:

Today's key qualitative characteristics remain critical to tomorrow's smaller nuclear force. Reducing forces in tandem with a peer competitor following negotiation of a future arms control treaty will not significantly change the diverse range of qualitative characteristics required to ensure the United States achieves its deter, prevail, and assure objectives. At lower levels the relative importance of certain key individual qualitative characteristics does change for certain objectives and adversaries, but the overall depth and breadth of qualitative requirements associated with countering a range of nuclear-armed adversaries, and protecting allies across the globe, will remain the same for U.S. nuclear forces.

A reduced nuclear arsenal must meet three differing sets of force requirements. At lower levels U.S. forces must simultaneously meet three differing sets of qualitative requirements to deter, prevail, and assure. Deterring and prevailing over major nuclear powers (peer and near-peer adversaries) requires a force with qualitative characteristics such as *survivability* and *ability to defeat defenses* that ensure the United States can survive a major first strike and mount a devastating response against an opponent with a significant nuclear arsenal. Deterring and prevailing over geopolitical actors with small numbers of nuclear weapons (regional powers and ANSAs), on the other hand, requires a force with qualitative characteristics such as *accuracy*, *promptness*, and *variety of yield options*, allowing the United States to minimize collateral damage while destroying the adversary's limited arsenals. Assuring allies requires a nuclear force

with the *ability to signal*, allowing the United States to visibly demonstrate that allies are under the U.S. nuclear umbrella.

As numbers are reduced, survivability becomes increasingly important, particularly with respect to deterring and prevailing over major nuclear powers. This analysis determined that the relative importance of certain qualitative characteristics of nuclear forces that are critical to key national objectives at New START levels—such as *promptness*, *ability to defeat defenses*, and *variety of yield options*—will remain largely unchanged as a result of reductions. These characteristics will be essential to ensuring that a reduced nuclear force can continue to meet the requirements of future missions to deter, prevail, and assure.

In regard to deterring and prevailing over major nuclear powers, *survivability* was the one characteristic whose relative importance significantly increased as numbers decline. Nuclear forces that can survive an adversary's nuclear strike and mount a decisive response—whether due to their physical properties, their deployment, posture, or a combination of factors—are vital to the maintenance of deterrence. As numbers of nuclear forces are reduced, the importance of *survivability* grows, particularly in regard to ensuring stable relationships between major nuclear powers. As arsenals decline, a major power might conclude that the cumulative costs of a nuclear exchange also decline. Maintaining highly survivable forces even as overall numbers are reduced enhances stability by preserving the ability of the United States and its remaining forces to threaten all powers, including those retaining significant numbers of forces. An adversary must know it faces unacceptable costs if it launches a nuclear attack on the United States or its allies.

If the United States continues to reduce its nuclear forces, more nuclear-armed states will become "peer adversaries." The relative capabilities of near-peers will increase if the United States and a peer agree to field smaller arsenals. Pursuing further reductions may lead to the United States facing additional "peer adversaries," as the distinction between current peer and near-peer adversaries will eventually collapse at lower numbers—particularly if states in the latter category build up their forces. If this occurs, the qualitative characteristics for deterring and prevailing over former near-peer adversaries will shift to those required to deter and prevail over a peer.

Reductions may strain those qualitative characteristics viewed as foundational to fielding a viable nuclear force. Concerns exist across the military, scientific, and policy communities engaged with nuclear weapons issues that future reductions may place stress upon the U.S. arsenal's foundational characteristics (*command and control*, *reliability*, *safety/security/surety*, and *sustainability*). Many of the subject matter experts interviewed for this report stated that the exact costs and

consequences of reductions below New START limits are not fully understood. Reducing nuclear forces and maintaining a smaller force capable of meeting the standards currently associated with foundational characteristics will likely present a number of future challenges to the military services and national nuclear laboratories.

Missile defenses and CPGS can complement but not replace nuclear forces. For dealing with an adversary with a small nuclear arsenal, missile defenses and CPGS systems provide non-nuclear means to counter deployed and launched nuclear weapons. However, these additional capabilities cannot substitute for the breadth of qualitative characteristics contributed by U.S. nuclear forces.

Sustaining strategic stability with reduced nuclear forces requires an arsenal whose qualitative characteristics hold the other party's nuclear weapons at risk, while also signaling a steady state of mutual deterrence. Strategic stability between major nuclear powers requires both parties to acknowledge each has the ability to cause unacceptable damage to the other and will forego actions threatening this status quo of mutual vulnerability. The establishment (and maintenance) of the status quo requires the qualitative characteristics *ability to defeat defenses*, *survivability*, and the *ability to signal*—qualities ensuring a nuclear force can weather an attack, mount a decisive response, and retain the ability to clearly communicate intent in times of peace or war. Although maintaining strategic stability between major nuclear powers is a complex process not solely dependent upon their respective nuclear forces, these forces remain the linchpin of a relationship founded upon mutual recognition of one another's deterrent capabilities. To prevent force reductions from threatening strategic stability, a smaller arsenal should retain these three qualitative characteristics, ensuring that remaining forces are capable of communicating a posture of peacetime deterrence and mounting an assured, decisive response in the event of a nuclear conflict.

Implications for Arms Control

These findings have several important implications for future arms control negotiations:

1. Numbers alone should not determine arms control negotiating positions. Future negotiations must consider the quantitative and qualitative requirements to deter, prevail, and assure within a geopolitical environment that includes multiple nuclear powers.

2. Negotiators must preserve the qualitative diversity of U.S. nuclear forces by protecting the ability of the United States to field a range of delivery systems, means of delivery, and warheads. No monad or dyad based on current weapons delivery platforms can cover the full range of qualitative requirements of U.S. nuclear forces.

3. In the past, some arms control negotiations have considered, and some treaties implemented, concepts that traded aspects of nuclear force *survivability* for greater transparency and increased stability (for example, by taking steps to ensure each side felt confident it could hold the other party's arsenal at risk). As numbers are reduced further, however, the United States must ensure its negotiators understand and protect the *survivability* of its nuclear forces.

4. During negotiations, the United States must also ensure that any future agreement does not have a negative impact on the foundational qualitative characteristics of its nuclear forces (*command and control*, *reliability*, *safety/security/surety*, and *sustainability*).

5. If U.S.-peer nuclear reductions reach a level where a current near-peer can pose a threat to the *survivability* of the negotiating parties' nuclear forces, the near-peer should then be treated as a "new peer," and the United States should take steps to include it in future rounds of nuclear arms control talks.

6. The United States should not limit missile defenses or CPGS in a future nuclear arms control treaty. The capabilities of these systems can complement, but not substitute for, the key qualitative characteristics of nuclear forces that are vital to accomplishing deter, prevail, and assure objectives. Any discussions regarding limits or reductions to missile defenses or CPGS should remain separate from talks on nuclear reductions. If discussions regarding missile defenses or CPGS are essential to maintaining strategic stability, the United States should focus negotiations on confidence-building measures rather than numerical ceilings or other limits.

QUALITATIVE CONSIDERATIONS OF NUCLEAR FORCES AT LOWER NUMBERS AND IMPLICATIONS FOR FUTURE ARMS CONTROL NEGOTIATIONS

I. INTRODUCTION

The *Treaty Between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms* ("New START," sometimes abbreviated as NST) entered into force on February 5, 2011. The treaty places numerical limits on U.S. and Russian deployed and non-deployed nuclear delivery systems and nuclear warheads, and requires both parties to meet these limits by 2018. After the United States and Russian Federation meet the central limits of New START, both parties will still possess formidable nuclear forces. The treaty permits each side to retain up to 700 deployed delivery systems and 1550 deployed warheads, as well as fielding considerable numbers of delivery systems and warheads that remain outside the treaty.[1]

As the latest in a series of negotiated reductions of their respective nuclear arsenals, the treaty represents an additional step back from the nuclear forces fielded during the Cold War. New START limits are a 30 percent reduction from the levels of deployed strategic warheads permitted by the 2002 Strategic Offensive Reductions Treaty (SORT) and a 74 percent cut from the deployed warhead limits of the 1992 START Treaty.[2]

The New START Treaty was a key foreign policy priority of President Obama, who delivered a major address in Prague on April 5, 2009, committing the United States to "seek the peace and security of a world without nuclear weapons."[3] The Obama administration has proposed a three-pronged, long-term strategy for reaching this goal:

1) Freezing and rolling back current global nuclear arsenals through the negotiation of treaties and agreements such as New START, with future rounds of diplomacy engaging both Russia and other current nuclear states.
2) Preventing the emergence of new nuclear states by taking steps to strengthen and advance the global nuclear nonproliferation regime, to include negotiating a multilateral treaty for securing all global fissile material stockpiles and securing U.S. ratification of the Comprehensive Test Ban Treaty.
3) Balancing prospective nuclear force reductions with U.S. national security objectives—to include both homeland defense and extended deterrence commitments—that, at present, rely upon or are strengthened by nuclear forces. As President Obama stated in his April 2009 Prague speech: "Make no mistake: as long as these weapons exist, we will maintain a

> safe, secure and effective arsenal to deter any adversary, and guarantee that defense to our allies."[4]

This research project addresses the first and third part of President Obama's strategy for realizing a nuclear-weapon free world. The success of U.S.-Russian arms control initiatives has dramatically reduced global nuclear weapons stockpiles in the years since the end of the Cold War. The Obama administration remains committed to pursuing further reductions through future arms control negotiations beyond New START. Nuclear forces, however, continue to play a vital role in the defense of the United States and its allies. In addition, a number of potential U.S. adversaries continue to either pursue nuclear capabilities or improve existing nuclear forces. This project's analysis addresses the challenge of attempting to reduce the overall *quantities* of U.S. nuclear forces without weakening the *qualities* of these forces that remain vital to the defense of the United States, its allies, and U.S. forces and interests abroad.

II. PURPOSE AND BACKGROUND

2.1 Purpose and A5XP Interest

This research project investigates the relationship between qualitative and quantitative characteristics of nuclear forces. It conducts a detailed analysis of qualitative characteristics of U.S. nuclear forces in order to determine which characteristics increase or decrease in importance as nuclear forces are reduced. With U.S. nuclear forces facing possible future reductions as a result of arms control agreements or other factors, it is critically important for the Air Force and other armed services to provide military advice to U.S. decision-makers regarding how to retain a qualitatively superior force capable of performing multiple missions even as its numbers decline. The findings of this analysis may assist A5XP in its role of representing Air Force equities and interests during U.S. government discussions and deliberations regarding future nuclear arms control negotiations. In addition, the findings are relevant to other situations where nuclear weapons, and/or the platforms and programs associated with those weapons, are under review.

2.2 National Strategic Objectives

Two key concepts bound this project's analysis and inform its research questions: current national strategic objectives for nuclear forces, and the scope and framework of future nuclear arms control negotiations and reductions.

The Obama Administration's 2010 Nuclear Posture Review Report (NPR) states that the purpose of U.S. nuclear forces is to "maintain stability with major nuclear powers, deter potential adversaries, and reassure our partners and allies."[5] Noting that nuclear weapons remain vital to "security architectures in key regions," the NPR also states that the United States will continue to station some nuclear weapons overseas and maintain the capability to rapidly deploy nuclear weapons abroad in times of crisis.[6] While emphasizing that the United States will only consider the use of nuclear weapons in "extreme circumstances,"[7] the NPR also underlines the critical importance of maintaining an "assured second strike capability."[8] It also includes a specific warning to "proliferating states," stating that "any use of nuclear weapons [against the United States or its allies] will be met with a response that would be effective and overwhelming."[9] Should deterrence fail, the United States will maintain nuclear forces that can survive a nuclear attack, mount a decisive response against an adversary, and prevail within a nuclear conflict.[10]

The NPR identifies four national strategic objectives for nuclear weapons: maintain strategic stability, deter adversaries, prevail over adversaries should deterrence fail, and assure allies. This report addresses

the concept of strategic stability—established and maintained by diplomatic negotiations, arms control agreements, and a host of other factors—separately from the other roles identified by the NPR for nuclear weapons.[11] The analysis that follows focuses on the relative importance of qualitative characteristics of nuclear forces for achieving **deter**, **prevail**, and **assure** objectives.

2.3 Future Nuclear Arms Control Negotiations and Reductions

The analysis that follows does not use a specific number for its assessment of key qualitative characteristics at lower levels of nuclear forces. Several subject matter experts interviewed by the research team expressed the view that any discussion of "lower numbers" within a future nuclear arms control treaty must necessarily rely upon relative concepts of "low" or "very low." These concepts, they explained, might vary as a result of the give-and-take of negotiations, the growth or reduction of other states' nuclear arsenals (to include states outside of future talks regarding arms reductions), the state of health of the U.S. nuclear complex, and a host of other factors.

Rather than use a specific number, a key assumption of this analysis is that the force reductions required by New START provide a general template for the level of cuts a future nuclear arms control treaty is likely to propose. New START requires the United States to reduce its nuclear forces (deployed and non-deployed) over the next seven years, but its implementation will not significantly reduce the overall U.S. nuclear arsenal.

This analysis assumes that the United States will seek slow but steady reductions of nuclear forces below the limits of New START via equitable, verifiable arms control treaties. It further assumes the United States will not go lower—in relative terms—than a peer competitor, will not make significant unilateral reductions, and will not drop its numbers abruptly. In conducting this analysis, the research team did not assume a specific posture or force structure for a future reduced nuclear force, nor did it consider questions of basing. All of these factors are likely to present significant, complex challenges at lower numbers that future arms control negotiators should consider prior to beginning formal talks.

III. RESEARCH QUESTIONS AND ANALYTIC FRAMEWORK

3.1 Research Questions

This report focuses on the following research questions:

1) What qualitative characteristics of current U.S. nuclear forces are most critical to deterring potential adversaries, prevailing in future conflicts involving nuclear forces, and assuring allies?
2) Do these characteristics change in relative importance at lower numbers?

In addition, new military capabilities such as missile defenses, and capability concepts such as conventional prompt global strike (CPGS) systems, may alter a range of strategies involving nuclear weapons. This leads to a third research question:

3) At lower numbers of nuclear forces, how does the introduction of advanced capabilities such as missile defenses or CPGS affect the relative importance of these forces' qualitative characteristics?

The report concludes with recommendations, informed by analysis of these questions, regarding future nuclear arms control negotiations. Analyses, reviews, and summaries of arms control agreements, whether under negotiation or currently in force, often focus on numerical limits. In determining negotiating positions, however, numerical limits should never represent end goals separate from national security requirements.[12] A key guiding principle of this research project is the assertion by former commander of U.S. Strategic Command, General Kevin P. Chilton, that strategy must guide numbers of forces; numbers should never dictate strategy.

General Kevin P. Chilton on Nuclear Force Strategies and Numbers
"When contemplating the appropriate size and posture of the nuclear deterrent force … one should never begin with numbers. Rather, we should always begin with a clear-eyed examination of the geopolitical reality of the day and even more importantly, the geopolitical uncertainty of the future. From this should flow a strategy to address our deterrent needs, and this strategy … should drive the size and the posture of our forces and the size of our nuclear stockpile"[13]

3.2 Methodology

The research team addressed the research questions in the following steps (as shown in Fig. 3.1):

Qualitative Considerations of Nuclear Forces at Lower Numbers

For Question 1: What qualitative characteristics of current U.S. nuclear forces are most critical to deterring potential adversaries, prevailing in future conflicts involving nuclear forces, and assuring allies?

1A. Identify and define the key qualitative characteristics of nuclear forces

1B. Design an analytic framework for assessing the relative importance of qualitative characteristics across objective/actor scenarios

1C. Assess the relative importance of these characteristics for deterring and prevailing over potential adversaries and assuring allies at New START levels (9 scenarios)[14]

For Question 2: Do these characteristics change in relative importance at lower numbers?

2A. Assess the relative importance of these characteristics for deterring and prevailing over potential adversaries and assuring allies at lower levels (9 scenarios)

2B. Compare the above findings to determine which characteristics change in importance as numbers decrease

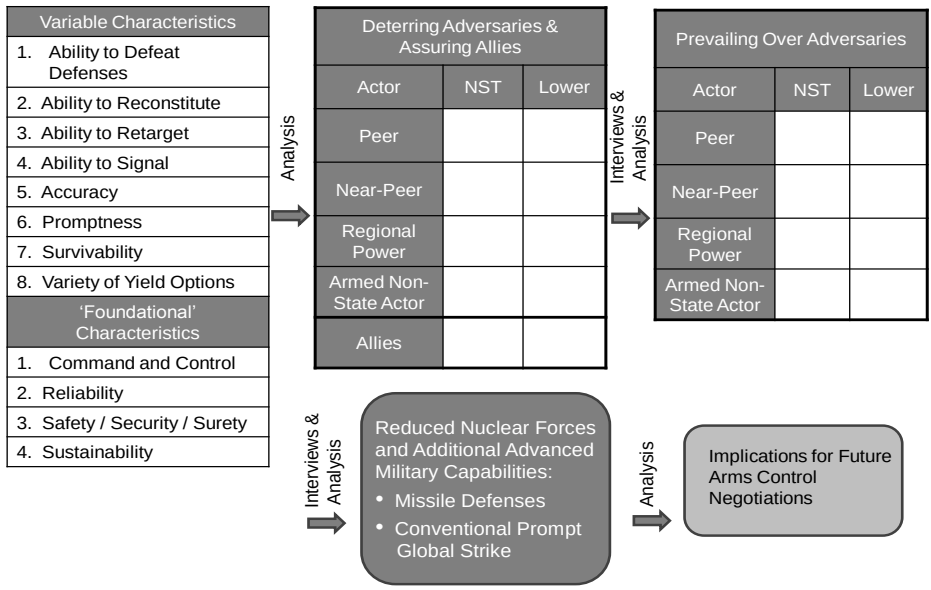
For Question 3: At lower numbers of nuclear forces, how does the introduction of advanced capabilities such as missile defenses or CPGS affect the relative importance of these forces' qualitative characteristics?

3A. Assess whether the addition of missile defenses or CPGS generally impacts any of the key qualitative characteristics identified in 1A and/or affects the results of 2B[15]

The research team concluded its research with an assessment of the findings from Questions 1-3, identifying possible implications for future arms control negotiations.

Both primary and secondary sources informed the team's analysis. Team members conducted more than 60 interviews with subject matter experts from the Armed Services, the Office of the Secretary of Defense, the national laboratories, research institutions, and universities.[16] The team also gathered data from key government publications such as *Nuclear Matters*.[17] In addition, two expert workshops were held in January and April 2011, with each event bringing together approximately 30 experts to review the research project, critique preliminary results, and discuss and debate issues related to the work of the project.[18]

Figure 3.1: Project Methodology



3.3 Identifying and Defining Qualitative Characteristics

Within this research project the term *nuclear forces* encompasses both the means of delivering nuclear warheads[19] and the warheads themselves, as it is the combination of both that provides the military capability to carry out day-to-day nuclear deterrence operations and, if necessary, mount nuclear attacks.

The key qualitative characteristics that allow nuclear forces to deter, prevail, and assure represent the base elements of this project's analytic framework. In order to identify these key qualitative characteristics, the research team gathered information from open-source government documents, academic publications, and DoD studies on nuclear weapons; surveyed military and scientific subject matter experts; hosted two workshops with select subject matter experts from government, industry, and academia; and subjected draft lists and definitions of characteristics to expert review. Wherever possible, the team sought to combine or integrate similar or complementary concepts in an attempt to find a balance between the many qualitative characteristics associated with nuclear forces and the need to restrict the list of terms to a manageable number for subsequent analytic tasks. The team deliberately avoided associating any one characteristic with any one delivery system or warhead, seeking to identify general

characteristics that apply to all types of nuclear force and to both present-day and future arsenals. This process yielded a list of twelve qualitative characteristics (Fig. 3.2).

Based on our analysis, these twelve characteristics fall into two categories: "Foundational" and "Variable." All twelve characteristics within these two categories represent critical qualities of U.S. nuclear forces, but some are more likely to be fungible at lower numbers. We treat those as variables.

Figure 3.2: Grouping Key Qualitative Characteristics
Variable Characteristics
1. Ability to Defeat Defenses
2. Ability to Reconstitute
3. Ability to Retarget
4. Ability to Signal
5. Accuracy
6. Promptness
7. Survivability
8. Variety of Yield Options
Foundational Characteristics
1. Command and Control
2. Reliability
3. Safety / Security / Surety
4. Sustainability

3.4 Foundational Characteristics

Foundational qualitative characteristics are those characteristics the United States considers essential to fielding a viable nuclear force. Any uncertainty regarding the four qualitative characteristics in this category—*command and control*, *reliability*, *safety/security/surety*, and *sustainability*—may result in U.S. decision-makers concluding that deployments or operations involving nuclear forces are unacceptably risky. In addition, any doubts in the minds of adversaries *or allies* regarding foundational characteristics will lead to decisions in foreign capitals that may harm U.S. foreign interests, possibly including brinkmanship, nuclear intimidation, and non-nuclear allies pursuing nuclear weapons programs.

This project does not treat foundational characteristics as variables within its analysis of nuclear force reductions. Foundational characteristics must be present across the arsenal *at any level* of nuclear forces; all four are a baseline requirement of each and every nuclear delivery system and warhead. The United States should never compromise on any of the four foundational characteristics. Military, policy, and scientific subject matter experts interviewed for this research project cautioned, however, that major cuts to U.S. nuclear forces may place these foundational characteristics at serious risk in the future, shrinking the fiscal, industrial, and intellectual capital required to maintain the U.S. nuclear complex. Thus, significant reductions may cause cracks to appear within the foundation of the nuclear enterprise.

3.5 Definitions of Foundational Characteristics

***Command and Control* –** The exercise of authority and direction by a properly designated commander over assigned and attached nuclear forces in the accomplishment of missions assigned to these forces. This requires reliable and secure communications between command authorities and nuclear forces at all times.

***Reliability* –** The physical properties of the warheads and the mechanical properties of the delivery platforms are such that they will perform as expected.

***Safety/Security/Surety* –** Materiel, personnel, and procedures that contribute to the safe and effective control of nuclear warheads, preventing inadvertent use, ensuring successful employment, and reducing the risk of accidents, incidents, loss, or degradation in performance.

***Sustainability* –** The ability of a nuclear weapons complex to supply new warheads and delivery systems in response to force requirements and successfully maintain and/or overhaul existing warheads and delivery systems. Relevant factors include supply of fissile materials, mechanisms to test reliability of warheads, and infrastructure to design and build nuclear warheads and delivery systems to meet evolving mission requirements.

3.6 Variable Characteristics

Whereas foundational characteristics remain uniformly important at all levels of nuclear forces, the relative importance of qualitative characteristics within the "variable" group may change as a result of geopolitical circumstances, selected strategies, and numbers and types of fielded nuclear forces. *Ability to defeat defenses, ability to reconstitute, ability to retarget, ability to signal, accuracy, promptness, survivability,* and *variety of yield options* fall into this category and are the principle focus of this analysis. The relative importance of qualitative characteristics within this category can change as a result of geopolitical circumstances, selected strategies, and numbers and types of fielded nuclear forces.

> By way of comparison to foundational characteristics, at current numbers of forces the United States might prove willing to accept limitations to variable characteristics, or favor one variable characteristic over another, within certain scenarios. As the United States reduces its nuclear forces, it may need to make difficult choices in terms of reducing or trading some or all of one qualitative characteristic within this category in order to retain or strengthen another. The analysis below focuses on the eight variable qualitative characteristics, assessing their relative values at New START levels and at lower numbers of U.S. nuclear forces.

3.7 Definitions of Variable Characteristics

Accuracy – The ability to deliver a strike with sufficient precision for the assigned mission; precision is often measured as circular error probability (CEP).

Ability to Defeat Defenses – The ability to overcome active and passive defenses and destroy a target.

Promptness – The ability to rapidly deliver destructive effects upon a target following the decision to engage or attack.

Ability to Reconstitute – The ability to expand numbers and/or diversity of the deployed nuclear force via upload or regeneration of forces in reaction to operational or geopolitical change.

Ability to Retarget – The ability to change the desired point of warhead impact after the delivery vehicle is in flight.

Ability to Signal – The ability of nuclear forces to visibly communicate intent through the enhancement of alert levels, re-positioning of forces, or other mechanism for transparency.

Survivability – The ability of nuclear forces to absorb a strike from an adversary and deliver a desired response.

Variety of Yield Options – The ability to produce varied nuclear effects on targets by adjusting yield of individual warheads or fielding delivery systems capable of carrying and delivering a range of warheads of different yields.[20]

3.8 Analytic Framework

The matrix below represents the base model for the analytic framework developed by the research team to assess the relative importance of qualitative characteristics when considering the requirements for deter, prevail, or assure objectives for different types of geopolitical actors.

The matrix represents a framework for answering the following set of questions: In regard to geopolitical actor *X* (peer, near-peer, regional power, ANSA, ally), what are the most important qualitative characteristics for achieving objective *Y* (deter, prevail, assure) at New START levels and at lower numbers? The framework is divided into three Tiers, representing a spectrum ranging from most valuable characteristics (Tier 1) to characteristics of lesser relative importance (Tiers 2 and 3). The eight qualitative characteristics are then placed into one of the three Tiers, with each Tier limited to no more than three characteristics.[21] This framework provides a simple but durable means to:

Figure 3.3: Matrix for analyzing qualitative characteristics

	Sample Matrix for Geopolitical Actor Y		
	Tier 1 (most important)	Tier 2	Tier 3 (least important)
Objective X, NST numbers	(no more than 3 qualitative characteristics per box)		
Objective X, lower numbers			

"Variable" Qualitative Characteristics
Ability to Defeat Defenses
Ability to Reconstitute
Ability to Retarget
Ability to Signal
Accuracy
Promptness
Survivability
Variety of Yield Options

This three tier matrix provided a heuristic framework for assessing the relative importance of each of the eight "variable" qualitative characteristics for deter, prevail, and assure objectives, evaluating the needs/requirements of each objective associated with the geopolitical actors (peer, near-peer, regional power, ANSA, or ally) included in this report's analysis.

The research team conducted two assessments for each objective/actor combination, one for nuclear forces at New START levels and one for nuclear forces at lower levels.

a) Assess the relative importance of the qualitative characteristics for each individual scenario considered by this analysis. The framework presents hard choices. All eight of the variable qualitative characteristics included within this report's analysis represent critically important qualities of nuclear forces. The framework's arbitrary limit of three qualitative characteristics per Tier forces the analyst to weigh the relative importance of these characteristics against each other in order to determine the handful of characteristics that are most valuable for achieving a particular mission. Qualitative characteristics grouped within any particular Tier, however, are not further ranked. There is no hierarchy within an individual Tier—for the three characteristics within each matrix's Tier 1, for example, no one "super-characteristic" is placed above the other two. The decision to select a heuristic of grouping characteristics rather than ranking characteristics one through eight reflected the research team's assessment that a rigid ranking hierarchy would prove unmanageable, requiring evaluations such as which characteristic is "seventh-most" important within a given scenario.

The research team developed this framework and tested it with a sample set of subject matter experts prior to the analytic phase of the project. These experts validated this approach for assessing the qualitative characteristics of nuclear forces across various geopolitical scenarios.

b) Determine which qualitative characteristics increase or decrease in importance as forces are reduced. The approach of using a three-

tiered model provided sufficient differentiation between levels of importance to readily monitor "movement" up or down Tiers as the research team compared the placement of characteristics at New START levels and at lower numbers for each scenario.

Movement across Tiers indicates that a characteristic rises or falls in relative importance as numbers decline. Identifying a characteristic that does not shift in importance, however, also represents an important data point. For example, a characteristic that remains within Tier 1 as numbers decline likely represents a quality of nuclear forces vital to every arsenal, regardless of size, and thus something that is particularly important to preserve at lower numbers. Both types of findings may be relevant to future arms control negotiations.

IV. GEOPOLITICAL ACTORS

U.S. nuclear forces play key roles in regard to both potential adversaries and established allies. This analysis considers five categories of geopolitical actors: peer, near-peer, regional power, and armed non-state actor adversaries, and U.S. allies. For classification reasons and to avoid analytical bias we chose to use generic categories of adversaries rather than focus on specific geopolitical actors.

4.1 Adversaries

Peer Adversary. This analysis defines peer adversary as a state whose nuclear forces can pose an existential threat to the U.S. homeland. A peer can launch hundreds of nuclear weapons at a broad range of U.S. targets on short notice using a variety of platforms.

Peer Nuclear Forces. A peer adversary's overall numbers of nuclear forces are roughly equivalent to those of the United States.

- *Delivery Systems*: A peer adversary fields several hundred long-range delivery systems, to include air, sea, and land-based (both mobile and fixed) means of delivery. It also possesses hundreds of shorter-range systems. A peer adversary possesses MIRV and missile defense countermeasure technologies. It designs and builds all its delivery systems.
- *Warheads:* Similarly, a peer adversary's overall numbers of deployed nuclear warheads are roughly equivalent to those of the United States.[22] It fields 1000+ warheads from very high to low yields, and retains hundreds to thousands more as a hedge. A peer adversary designs and builds all of its warheads. It maintains an extensive nuclear complex.
- *Active Defenses:* A peer possesses limited missile defenses and extensive air defenses.
- *Command and Control:* A peer adversary possesses a robust command and control system designed to maintain operations during a major nuclear conflict.

Near-Peer Adversary. A near-peer adversary is a state whose nuclear forces are numerically smaller than those of the United States, but are capable of causing unacceptable damage to the United States homeland. A near-peer can hold multiple U.S. locations at risk through the deployment of long-range land-based delivery systems.

Near-Peer Nuclear Forces. A near-peer fields adequate nuclear forces to inflict severe damage on U.S. civil society but does not pose an existential threat. It is not capable of a disarming first strike.

- *Delivery Systems:* A near-peer deploys air, sea, and land-based nuclear-capable delivery systems of varying ranges. Its long-range systems number in the dozens, and include both fixed and

mobile land-based systems.[23] A near-peer designs and builds all of its delivery systems.

- *Warheads:* A near-peer's deployed nuclear warheads number in the dozens or hundreds. Its overall number of nuclear warheads, to include hedge warheads, is in the hundreds but less than 1,000. A near-peer designs and builds all of its warheads.
- *Active Defenses*: A near-peer possesses extensive air defenses, but does not possess missile defenses.
- *Command and Control:* A near-peer's command and control system is not as sophisticated as that of a peer adversary, but it is capable and survivable, thereby ensuring controlled operations during a major nuclear conflict.

Regional Power Adversary. Regional power adversaries are states that possess a limited number of nuclear forces and are not capable of achieving nuclear parity—measured in terms of long-range systems and overall design and manufacturing capabilities—with a near-peer or peer in the near term. The most capable regional power adversaries may possess a very limited capability to reach a small handful of targets in the United States with long-range delivery systems. All regional power adversaries, however, possess capabilities allowing them to threaten nuclear attacks against U.S. regional interests, deployed forces, or allies. The 2010 NPR states "future nuclear reductions must continue to strengthen deterrence of potential regional adversaries" which "will require an updated assessment of deterrence requirements."[24]

Regional Power Nuclear Forces. A regional power may be capable of fielding nuclear forces in the dozens. The majority of these forces are short-range or medium-range delivery systems.

- *Delivery Systems:* A regional power possesses a variety of delivery options, but most are short-range systems, and only a limited number are of intermediate or longer ranges. No potential regional power adversary currently deploys sea-based systems. A regional power's long-range systems are fixed, land-based, relatively inaccurate, and small in number (likely less than ten). A regional power cannot place multiple independently targetable reentry vehicles (MIRVs) on its ballistic missiles, nor can its ballistic systems employ countermeasures. Some regional powers can build delivery systems, but in general they require scientific and technological assistance to do so.
- *Warheads:* Warheads deployed by regional powers may number from a handful to the low dozens. Together with hedge warheads, a regional power may possess more than one

hundred warheads, but the range varies broadly across states in this category. To keep its warheads secure, a regional power may store them some distance from delivery systems, and its nuclear forces are likely kept at a low state of readiness. A regional power has the capability to build warheads, but these warheads do not approach the miniaturization capabilities or specifications of U.S. systems, may or may not be capable of being loaded onto more than one delivery system, and in some cases might represent a "nuclear device" rather than a warhead.

- *Active Defenses:* A regional power possesses air defenses—in many cases purchased or acquired from third parties—but does not possess missile defenses.
- *Command and Control:* Regional power command and control mechanisms are unsophisticated and a crisis may place them under significant strain.

Armed Non-State Actor (ANSA). An ANSA is an armed group or organization that is separate and autonomous from any state government.[25] ANSAs may physically control territory and even establish governance structures that mirror the bureaucracy of state governments, but they are not internationally recognized as the sovereign authority over any territory.

ANSA Nuclear Forces. This research project defines an ANSA as a non-state adversary in possession of a very small number of nuclear weapons (such as one or two).[26]

- *Delivery Systems:* ANSAs do not have the capability to produce air, sea, or land-based delivery systems. To field a delivery system, an ANSA must acquire it through transfer, purchase, or theft. An ANSA nuclear attack will not necessarily rely upon the use of a delivery system; this type of actor is more likely to use non-traditional means of delivery, such as detonation following covert transit via a non-military ship or airplane.
- *Warheads:* ANSAs cannot produce their own fissionable material. In addition, the industrial and manufacturing base required to construct significant numbers of nuclear weapons—particularly modern, miniaturized warheads that make for easier delivery—is far beyond the reach of any contemporary ANSA.[27] Nevertheless, the proliferation of nuclear weapons and associated materials and technologies raises the possibility that an ANSA could acquire nuclear materials—or even a very small number of nuclear weapons—through theft or purchase on the black market.[28]
- *Active Defenses:* None.

- *Command and Control:* An ANSA's command and control mechanisms for nuclear weapons are likely to be primitive but nonetheless may be highly effective, with control and authority to use either directly maintained by leadership or delegated entirely to an operational cell.

4.2 Allies

This research project defines allies as those states with whom the United States has a formal defense treaty, less formal defense relationship underpinned by explicit or implicit security guarantees, or in which the United States has a fundamental national security interest.[29]

V. DETERRING ADVERSARIES

What qualitative characteristics of nuclear forces deter potential adversaries whose armaments include nuclear weapons, and do these characteristics change as the United States reduces its nuclear forces? The analysis that follows addresses these questions, focusing on the characteristics identified as most important (Tier 1) to deterring nuclear-armed adversaries at New START levels and at lower numbers. The complete analysis, to include Tier 2 and Tier 3 characteristics, can be found in Appendix A.

5.1 Deterring a Peer Adversary

The number and diversity of nuclear forces fielded by a peer adversary permit it to employ a range of nuclear strategies. A peer can use its nuclear forces to deter or combat U.S. forces (both conventional and nuclear) in the field, beyond its borders, and in circumstances where nuclear weapons are not necessarily a "last resort." A peer adversary could fight and possibly survive a major nuclear conflict with the United States.

At New START levels of nuclear forces, the most important qualitative characteristics for deterring a peer adversary are the *ability to defeat defenses*, *survivability*, and *ability to reconstitute* (Fig. 5.1).

The *ability to defeat defenses* supports the basic tenets of deterrence theory—being able to credibly threaten adversary targets. The ability to defeat defenses is vital in deterring peers, because a peer adversary has the national industrial and technical base to develop and deploy robust active defenses, such as anti-aircraft and (limited) missile defense systems. A peer also has the resources and know-how to harden a broad range of targets, to include key military, civilian, and communication facilities. In order to deter such an adversary, the United States must be able to guarantee the destruction of key targets despite the adversary's efforts to defend them.

Survivability is another critical factor for maintaining stable deterrence against a nuclear peer. Failing to safeguard and maintain the survivability of nuclear forces in the face of an opponent whose own forces are capable, both in quantity and quality, of simultaneously attacking nuclear forces, command and control nodes, and key supporting infrastructure, permits an adversary to contemplate launching a disarming first strike.

The *ability to reconstitute* forces is also critically important for deterring a peer adversary. In the near term, a peer adversary is the only type of adversary capable of significantly escalating the risk posed to U.S. nuclear forces through measures such as uploading ballistic missiles or mobilizing large numbers of de-alerted or inactive nuclear forces. A peer adversary undertaking these actions could upend the nuclear balance with the United States, throwing the ability of U.S. nuclear forces to deter it into doubt. By retaining the capability to match these moves, the United States

ensures that a peer adversary will be unable to use a sudden change in its nuclear posture or numbers of fielded forces to gain the upper hand. At the same time, the United States must retain sufficient nuclear capabilities to ensure it can deter a range of additional actors that may not be involved in the current crisis.

5.2 Deterring a Peer Adversary at Lower Numbers

As the number of nuclear weapons in the U.S. nuclear arsenal decline, the most important qualitative characteristics for deterring peer adversaries remain unchanged. At lower numbers, the qualitative characteristics *ability to defeat defenses*, *ability to reconstitute*, and *survivability* remain critically important to deterring peer adversaries (Fig. 5.1).[30]

As stated above, this analysis assumes that any U.S. reductions will occur in tandem with a peer. Even if the United States and a peer adversary undergo significant reductions, however, a peer will keep a large number of deployed nuclear forces. The *ability to defeat defenses* remains key to peer deterrence. Reductions, even if implemented equally, will reduce the ability of the United States to destroy peer targets. In addition, as nuclear arsenals are reduced, the incentives to build up both active and passive defenses to compensate for lower numbers are high for both sides. Deterrence is weakened if a peer adversary concludes that arms reductions lower the potential costs of nuclear conflict. Maintaining the *ability to defeat defenses* at lower numbers stabilizes the U.S.-peer deterrence relationship, ensuring that the peer remains at risk of sustaining significant-to-devastating losses if it initiates a nuclear conflict.

The general scope of reductions under a future arms control treaty considered by this analysis still permits a peer to maintain a large hedge force and robust nuclear complex. A peer will retain the capability to rapidly change its number of deployed forces, force posture, and introduce force modifications or even new platforms. As nuclear force levels decline, any change involving even a small number of forces may become strategically significant. Within this environment, maintaining an *ability to reconstitute* forces is a significant bulwark against deterrence failure.

In addition, with parity in numbers maintained, but the overall numbers and types of platforms and warheads reduced, a peer adversary attempting to seek an advantage is likely to carefully weigh whether any part of the United States' remaining nuclear forces is a "weak link" that could be significantly degraded by strikes using only a small number of nuclear weapons. Taking steps to protect or enhance the *survivability* of a reduced nuclear force is vital to deterring a peer adversary at lower numbers.

Figure 5.1: Deterring a Peer Adversary as Numbers Decrease		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Deter Peer Adversary at NST Numbers		
Ability to Defeat Defenses	Ability to Signal	Ability to Retarget
Ability to Reconstitute	Accuracy	Variety of Yield Options
Survivability	Promptness	
Movement from NST Numbers to Lower Numbers		
Ability to Defeat Defenses		Ability to Retarget
Ability to Reconstitute	Ability to Signal ←	Variety of Yield Options
Survivability	Accuracy	
	Promptness →	
Deter Peer Adversary at Lower Numbers		
Ability to Defeat Defenses	Ability to Signal	Ability to Retarget
Ability to Reconstitute	Promptness	Accuracy
Survivability	Variety of Yield Options	

5.3 Deterring a Near-Peer

The nuclear capabilities of a near-peer permit it to threaten a number of targets on the U.S. homeland, but it lacks the numbers to pose a significant threat to U.S. nuclear forces. Within a potential nuclear conflict, United States nuclear forces significantly outnumber those of a near-peer. A near-peer, however, is the only adversary besides a peer that is largely self-sufficient in designing and manufacturing delivery systems and warheads. It may have the potential to build up its limited arsenal relatively quickly.

The most critical qualitative characteristics for deterring a near-peer adversary are the *ability to reconstitute, ability to defeat defenses*, and the *ability to signal* (Fig. 5.2).

A near-peer's capability to expand its nuclear forces elevates the importance of the *ability to reconstitute* nuclear forces for the purpose of deterrence. If a near-peer is capable of rapidly accelerating efforts to build up its nuclear arsenal, it may conclude that in a relatively short amount of time it can reach parity with U.S. nuclear forces (also referred to as a "breakout" scenario). Maintaining the *ability to reconstitute* nuclear forces ensures that the United States can respond to any near-peer expansion of its nuclear arsenal and retain a significant edge over this type of adversary.

A near-peer's nuclear forces, which include both fixed and mobile ballistic systems, are quantitatively inferior to those of a peer adversary but qualitatively similar. It fields highly capable, possibly well-defended, and hard to locate nuclear forces. This might lead a near-peer to speculate that a part of its arsenal could survive an initial attack from a numerically superior foe. Ensuring that the United States maintains nuclear forces with a robust *ability to defeat defenses* is important to deterring a near-peer, convincing this type of adversary that the United States has the capability to launch a disarming strike that holds its entire arsenal at risk.

The *ability to signal* is also critical for deterring a near-peer. Although it cannot match U.S. nuclear forces overall and only possesses a limited number of long-range delivery systems, a near-peer might believe it could use its nuclear forces to challenge the United States in a theater conflict or crisis. In these types of scenarios, a near-peer could bring a much broader range of nuclear forces to bear against forward deployed U.S. forces. A near-peer could also attempt to use its nuclear forces to change the stakes of a regional conflict in its favor. In addition, a near-peer may calculate that the communication of a nuclear threat against the U.S. homeland will slow or halt U.S. intervention within their region, granting them a free hand. Clear signals of resolve sent in response via U.S. nuclear forces, however, could convince a near-peer to de-escalate and otherwise abandon destabilizing courses of action.

5.4 Deterring a Near-Peer Adversary at Lower Numbers

The most critical qualitative characteristics for deterring a near-peer adversary at lower numbers are the *ability to defeat defenses,* the *ability to reconstitute,* and *survivability* (Fig. 5.2).

Should the United States reduce its nuclear forces while a near-peer remains at current levels, a near-peer's numerical disadvantage vis-à-vis the United States, while still significant, would become less acute. As discussed above, with a capable indigenous nuclear complex backing its current fielded forces, a near-peer may contemplate taking steps to close the gap between itself and a reduced U.S. nuclear force. U.S.-peer reductions may be one of several factors considered by a near-peer weighing the decision to expand its nuclear arsenal, and the size, scope, and speed of this expansion. The *ability to reconstitute* will remain important to deterring a near-peer at lower numbers, granting U.S. forces the flexibility to respond to any attempt by a near-peer to "breakout" and become a nuclear superpower following a future round of U.S.-peer reductions. The *ability to defeat defenses* also maintains its position as a Tier 1 qualitative characteristic. Convincing a near-peer the United States will rapidly overwhelm its nuclear forces (including its mobile forces) within a conflict, despite its efforts to defend them, remains essential to deterring this type of adversary.

Qualitative Considerations of Nuclear Forces at Lower Numbers

At lower numbers, *survivability* becomes more of a concern due to a near-peer adversary's ability to hold at risk a larger percentage of U.S. nuclear forces. At New START levels, this percentage was low enough to place *survivability* in Tier 2. At lower numbers, however, the increase in risk from a near-peer to U.S. nuclear forces, particularly those stationed or deployed outside the United States for extended deterrence purposes, makes *survivability* of those U.S. forces more important.

Significantly, as a result of this shift, the three characteristics that are most important for deterring a near-peer adversary at lower numbers are the same as those for deterring a peer adversary. At lower numbers, the two categories of peer and near-peer begin to blend into one. Following U.S.-peer reductions, a near-peer remains significantly behind the numbers of U.S. forces, but its calculations of risk and cost-benefit analysis of scenarios involving nuclear forces begin to change in its favor. As a result, the deterrence requirements of a near-peer increasingly mirror those of a peer well before a near-peer reaches numerical parity with the United States.

Figure 5.2: Deterring a Near-Peer Adversary as Numbers Decrease

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Deter Near-Peer Adversary at NST Numbers		
Ability to Defeat Defenses	Accuracy	Ability to Retarget
Ability to Reconstitute	Promptness	Variety of Yield Options
Ability to Signal	Survivability	
Movement from NST Numbers to Lower Numbers		
Ability to Defeat Defenses		Ability to Retarget
	Accuracy →	
Ability to Reconstitute	←	Variety of Yield Options
	Promptness	
Ability to Signal →		
←	Survivability	
Deter Near-Peer Adversary at Lower Numbers		
Ability to Defeat Defenses	Ability to Signal	Ability to Retarget
Ability to Reconstitute	Promptness	Accuracy
Survivability	Variety of Yield Options	

5.5 Deterring a Regional Power Adversary

Limited in number, the nuclear forces of regional powers are closely held by state leaders, who view them as vital to regime survival but also

vulnerable to attack. The armed forces of regional powers have limited opportunities to train with nuclear weapons, command and control systems are not robust, and nuclear strategies and doctrines remain nascent or undeveloped among senior military officials and policymakers.

The nuclear strategy of a regional power focuses on using nuclear forces to shift the regional balance of power, counter U.S. conventional superiority, and protect the ruling regime. For this type of adversary, nuclear weapons may serve as anti-access weapons, providing a capability that may deter the United States from taking actions within their region. A regional power may also threaten to use nuclear weapons to intimidate or attack a U.S. regional ally in an effort to either fracture the alliance or otherwise complicate U.S. or joint operations in theater. Further, a regional power may view nuclear weapons as giving it the ability to terminate a regional conventional conflict where it faces potential defeat, particularly if the core regime is under threat.

A regional power could launch a small nuclear attack on U.S. allies or forward deployed U.S. forces, and may have the capability (albeit very limited) to strike the United States, therefore necessitating the use of deterrence strategies that include nuclear forces. A regional power adversary's small number of long-range ballistic systems grants it the capability to launch a very limited nuclear attack against the United States, but the reliability and accuracy of its missiles is not high and its forces are not particularly prompt or responsive.

At New START levels, the key qualitative characteristics of nuclear forces for deterring a regional power are the *ability to defeat defenses*, *accuracy*, and *promptness* (Fig. 5.3).

Regional powers attach great importance to their nuclear programs. For a regional power, the development of a nuclear weapons program is time-intensive, expensive, and risky. They accept these costs, however, in exchange for enhancing regime security, establishing their position as a major regional power, and gaining a coveted place in the global nuclear club.

While the nuclear weapons programs of regional powers are threats the United States must prepare to address, they also represent vulnerabilities the United States can exploit for the purposes of deterrence. A regional power that recognizes the United States can readily destroy its nuclear complex or small handful of delivery systems with a precise nuclear strike is unlikely to seek a nuclear confrontation. This highlights the importance of *accuracy*, coupled with excellent intelligence gathering and assessment capabilities, for deterring regional powers. With regional actors determined to protect their investment from both internal and external threats by building or acquiring active and passive defenses (to include hardened, deeply buried nuclear facilities) the *ability to defeat defenses* is also essential

to holding these assets at risk and represents a key characteristic underpinning regional deterrence.

For this type of adversary, the ruling regime views nuclear forces as vital to its influence and survival. If a regional power believes the United States is unable to quickly intervene in a distant conflict, it may believe it can use its nuclear forces to intimidate or attack neighboring or nearby states before the United States can respond. However, if regional powers believe the United States can use its nuclear forces to pre-empt or immediately reply to any provocation, it will hesitate—and likely decide against—putting its regime and nuclear forces at risk. Thus, the ability to swiftly strike a regime's key leadership or nuclear forces before they move from a particular location or while in transit between facilities is a critical element of deterrence in a regional scenario. A regional power is likely to view a prompt and devastating strike on its ruling regime as an unacceptable risk. The fear of a swift attack that eliminates its nuclear forces and makes the regime instantly vulnerable to coercion or subsequent attacks will likely deter a regional power from using its scarce nuclear assets. The ability to hold fleeting targets at risk, whether these targets are directly associated with the regime or its highly valued nuclear forces, underscores the importance of *promptness* to regional deterrence.[31]

5.6 Deterring a Regional Power Adversary at Lower Numbers

At numbers moderately below New START levels, the key characteristics for deterring regional actors remain the same (Fig. 5.3).[32] Even after significant reductions, the fundamental quantitative and qualitative asymmetry in favor of U.S. nuclear forces remains unchanged. The nuclear forces of regional powers will remain key symbols of state power, carefully husbanded to guarantee the integrity of the state against external invaders. U.S. nuclear forces that retain *accuracy* and the *ability to defeat defenses* can continue to hold these small arsenals at risk and deter nuclear adventurism by regional powers, even if overall U.S. numbers decline. In addition, *promptness* will guarantee that a regional power does not mistake a reduction in the size of the U.S. force for a reduction in its speed of response, preventing it from contemplating a pre-emptive or early strike against the U.S. homeland or U.S. interests abroad.

Figure 5.3: Deterring a Regional Power Adversary as Numbers Decrease		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Deter Regional Power Adversary at NST Numbers		
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Accuracy	Ability to Signal	Survivability
Promptness	Variety of Yield Options	
Deter Regional Power Adversary at Lower Numbers		
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Accuracy	Ability to Signal	Survivability
Promptness	Variety of Yield Options	

5.7 Deterring an ANSA

Although ANSAs are diverse in size, capabilities, and motivation, their common lack of international recognition as a sovereign entity has significant political, legal, and financial ramifications that condition their operations and their interactions with recognized states. Some ANSAs have proven capable of mounting sophisticated military operations, creating and maintaining transnational revenue streams, and securing a degree of social and political legitimacy in the eyes of certain groups and even some state government.

Few, however, are able to maintain a permanent headquarters, and all lack the military resources to pose a direct challenge to the United States. In a conventional or nuclear crisis or conflict with the United States, an ANSA must rely on asymmetric means of warfare. Most ANSAs, however, are not "irrational" or prone to take significant risks in their use of force, particularly in regard to scarce, valuable capabilities. An ANSA in possession of a nuclear weapon might not necessarily use it immediately.

U.S. efforts to address nuclear terrorism have primarily focused on measures to prevent and deter state governments from aiding or abetting ANSAs attempting to acquire nuclear materials or weapons. As noted in the 2010 NPR, however, the United States will "hold accountable any state, terrorist group, or other non-state actor that supports or enables terrorist efforts to obtain or use weapons of mass destruction."[33]

ANSAs have strategic assets—personnel, weapons, money, and other resources—that they require to survive and operate within the geopolitical environment. As such, the threat of force, up to and including the threat of nuclear force, can deter ANSAs. The credibility of this threat may vary broadly between different ANSAs. An ANSA operating within a city, for example, may conclude that it is safe from nuclear strikes because

the collateral damage resulting from such an attack would be unacceptable to the United States. Many ANSAs, however, have sought to establish bases and training facilities outside of populated areas in an effort to evade state authorities.

ANSAs are characterized by their fluidity, mobility, and lack of transparency. In order for U.S. nuclear forces to deter an ANSA, the group must believe these forces can launch quickly, are highly accurate, and will not cause significant damage to civilian populations. The latter is particularly important in those circumstances where ANSAs operate within a host state that is unable to eject them or is unaware of their presence. As a result, the most important qualitative characteristics for deterring an ANSA are *accuracy*, *promptness*, and *variety of yield options* (Fig. 5.4). Together, these characteristics ensure that the United States could, if necessary, threaten an ANSA nuclear target (to include a fleeting target, such as a nuclear device hidden aboard a truck or ship) with a rapidly launched strike utilizing a low-yield weapon to limit fallout and civilian casualties.

5.8 Deterring an ANSA at Lower Numbers

A nuclear-armed ANSA is unlikely to change its cost-benefit analysis of nuclear conflict, or its risk assessment of the nuclear threat posed by the United States against it if U.S. nuclear forces are reduced. The quantitative and qualitative gap between its nuclear forces and those of the United States is so wide that even significant reductions by the United States do not alter the key characteristics vital to deterring an ANSA (Fig. 5.4).[34] ANSA deterrence continues to require *accuracy*, *promptness*, and a *variety of yield options*—characteristics necessary for the United States to field a nuclear force capable of holding the limited, possibly mobile, and often or always hidden nuclear weapons of an ANSA at risk.

Figure 5.4: Deterring an ANSA as Numbers Decrease

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Deter ANSA at NST Numbers		
Accuracy	Ability to Retarget	Ability to Defeat Defenses
Promptness	Ability to Signal	Ability to Reconstitute
Variety of Yield Options		Survivability
Deter ANSA at Lower Numbers		
Accuracy	Ability to Retarget	Ability to Defeat Defenses
Promptness	Ability to Signal	Ability to Reconstitute
Variety of Yield Options		Survivability

VI. PREVAILING OVER ADVERSARIES

As stated in the NPR, the United States will only consider the use of nuclear weapons under "extreme circumstances."[35] The NPR, however, warns potential adversaries—in particular, proliferating states—that "any use of nuclear weapons [against the United States or its allies] will be met with a response that would be effective and overwhelming."[36] If deterrence fails and the United States becomes engaged in a conflict involving nuclear forces, its employment strategies are guided by a number of key priorities, to include: preventing an adversary from striking the U.S. homeland, U.S. forward deployed forces, and U.S. allies; eliminating an opponent's nuclear forces; and minimizing civilian casualties. This analysis defines "prevail" in nuclear conflict as successfully eliminating an adversary's ability to conduct nuclear attacks while minimizing casualties and damage to the U.S. homeland, forward forces, allies, and civilians.

6.1 Prevailing Over a Peer Adversary

Should deterrence fail and the United States engage in a nuclear conflict with a peer adversary, the qualitative characteristics *ability to defeat defenses, promptness,* and *survivability* are of paramount importance (Fig. 6.1).

The ability to penetrate adversary defenses and destroy intended targets is of vital importance in a nuclear conflict with a peer. Every successful strike against a peer's nuclear forces—many of which may be protected by extensive active and passive defenses—destroys highly-capable delivery systems and warheads that can cause significant damage to the United States and its allies. *Promptness* is also important in a nuclear conflict with a peer, as this type of adversary possesses the capability to strike a wide range of U.S. targets quickly and accurately. Maintaining U.S. forces that can launch upon very short notice (if given warning of an imminent strike) guards against the possibility a peer could knock out many of the United States' nuclear forces with a surprise attack. In addition, *promptness* increases the likelihood of striking an adversary's mobile systems. *Survivability* is also critical to prevailing in a nuclear conflict with a peer. A peer adversary is capable of using a range of delivery systems and launching many warheads against the United States while retaining significant nuclear forces to fire additional salvos or otherwise continue fighting beyond one or possibly even several nuclear exchanges. Forces that can both survive the vagaries of a conflict that is likely to strain critical infrastructure and command and control (even for forces not directly attacked) and also conceivably survive a targeted nuclear strike are essential to prevailing against an adversary that can qualitatively and quantitatively match U.S. nuclear forces.

6.2 Prevailing Over a Peer Adversary at Lower Numbers

At lower numbers, the *ability to defeat defenses* and *survivability* remain vital to prevailing over a peer adversary in a nuclear conflict (Fig. 6.1). Against an opponent with an equal number of weapons, U.S. nuclear forces must have the capability to attack and destroy opposing forces on a one-for-one basis (or better, if possible, such as conducting a successful attack with one warhead on a delivery vehicle carrying multiple warheads). As peer arsenals get smaller, it will be strongly incentivized to build up active and passive defenses to protect its smaller arsenal, and the *ability to defeat defenses* will remain essential to defeating a peer's nuclear forces in a nuclear conflict.

Survivability remains a Tier 1 characteristic; within a nuclear conflict, a peer adversary will similarly seek to maximize the damage each nuclear weapon causes to opposing nuclear forces. As numbers go lower, although each side maintains numerical parity, if for any reason one side's forces are more survivable (for example, one side may possess an advantage in its ability to disperse forces, or in its capabilities for equipping forces to evade detection), this qualitative edge may begin to alter the dynamics of conflict. If the United States emphasizes *survivability* at lower numbers, a peer adversary may need to devote multiple weapons to attacking a single highly survivable delivery system. As forces are reduced, this scenario can place a peer adversary at a distinct disadvantage. For example, if a peer attempted to launch a pre-emptive strike with a large number of weapons but failed to disable or destroy many of the United States' nuclear forces, including significant numbers of delivery systems carrying (or capable of carrying) multiple warheads, it will likely find itself at a significant disadvantage for the remainder of the conflict.

This analysis finds that lower numbers increase the importance of the *ability to signal* for prevailing over a peer. Any peer-U.S. nuclear conflict has the potential to end inconclusively, with each side suffering massive damage and casualties. Prevailing within a peer nuclear conflict requires the ability to communicate escalation and de-escalation; at a minimum, *ability to signal* is important to prevent nuclear exchanges from dragging out beyond the point of either side achieving any militarily significant objective or clear resolution to the conflict.

Figure 6.1: Prevail over a Peer Adversary as Numbers Decrease		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Prevail over Peer Adversary at NST Numbers		
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Promptness	Ability to Signal	Variety of Yield Options
Survivability	Accuracy	
Movement from NST Levels to Lower Numbers		
Ability to Defeat Defenses	←	Ability to Reconstitute
	Ability to Retarget →	
Promptness →		
←	Ability to Signal	
Survivability	←	Variety of Yield Options
	Accuracy	
Prevail over Peer Adversary at Lower Numbers		
Ability to Defeat Defenses	Ability to Reconstitute	Ability to Retarget
Ability to Signal	Accuracy	Promptness
Survivability	Variety of Yield Options	

6.3 Prevailing Over a Near-Peer

Should deterrence fail with a near-peer, the *ability to defeat defenses*, *accuracy*, and *promptness* are critically important to prevailing over this type of adversary (Fig. 6.2).

A near-peer faces the threat of having its nuclear forces significantly degraded, and perhaps even effectively destroyed, during an initial exchange with the United States. As such, in a nuclear conflict scenario a near-peer may conclude there are significant incentives to employing a pre-emptive strike against the United States, fearing that a failure to do so will result in the United States destroying its arsenal before it can play any meaningful role in the conflict. To prevent that from occurring, U.S. nuclear forces must possess the ability to quickly reach and precisely destroy a near-peer's strike capabilities, including its mobile systems.

A near-peer does not have the same number of nuclear forces as a peer adversary, but its depth and breadth of active and passive defenses approaches that of a peer. The United States' *ability to defeat defenses* is important, to include active defenses such as anti-air systems and passive defenses such as hardened launch facilities. *Accuracy* is vital to destroying a near-peer's nuclear forces; a near-peer's mix of fixed and mobile systems and substantial nuclear complex present a diverse and disparate target set.

Carrying out an attack aimed at disabling and dismantling a near-peer's ability to wage nuclear war will require a closely coordinated, highly precise series of nuclear attacks. *Promptness* is also a key characteristic for prevailing over a near-peer, which will recognize that it cannot hope to win a protracted nuclear conflict with the United States. Whether hoping to surprise the United States prior to the initiation of hostilities, attempting to prevent U.S. intervention in a regional conflict, or trying to reverse the tide of a conventional conflict going against it, a near-peer's attempt to launch a nuclear strike against the United States or its allies is likely to be both quick and stealthy. To prevent a possible preemptive strike, U.S. nuclear forces must retain the capability to promptly destroy a near-peer's nuclear forces.

6.4 Prevailing Over a Near-Peer at Lower Numbers

The most important characteristics for prevailing over a near-peer adversary are the *ability to defeat defenses*, the *ability to signal*, and *survivability* (Fig. 6.2). This set of Tier 1 qualitative characteristics differs from the set identified above for prevailing over a near-peer at New START force levels, with *ability to defeat defenses* and *ability to signal* taking the place of *accuracy* and *promptness*.

Following this shift, the Tier 1 qualitative characteristics for prevailing over a near-peer at lower numbers become identical to the Tier 1 qualitative characteristics for prevailing over a peer adversary. Just as the Tier 1 qualitative characteristics for deterring a peer and near-peer adversary become the same at lower levels of nuclear forces, the Tier 1 characteristics for prevailing over these adversaries also become identical as forces are reduced. The fact that the characteristics for deterring and prevailing over these adversaries become identical at lower numbers demonstrates that the categories collapse from two distinct categories into one as numbers decrease.

The rationale for categorizing *ability to defeat defenses* and *ability to signal* as Tier 1 characteristics for prevailing over a near-peer at lower numbers is the same as the rationale for identifying these characteristics as critical for prevailing over a peer (see Section 6.2). *Ability to signal*, placed in Tier 2 at New START levels, moves up to Tier 1.[37] *Survivability* also increases in importance in prevail scenarios for both a peer and near-peer. Significantly, however, this analysis finds that *survivability* makes a more dramatic leap in the latter scenario. Whereas for a peer adversary, *survivability* shifts from Tier 2 to Tier 1 as numbers decline, for a near-peer the characteristic vaults from Tier 3 to Tier 1.

An implicit finding that can be drawn from this development is that a threshold exists at some lower number of forces where *survivability*—heretofore not a serious concern for the United States when facing a near-peer adversary—begins to come into play when considering the requirements for successfully attacking and destroying a near-peer's nuclear

forces. This is important to bilateral nuclear arms control negotiations with a peer adversary. If peer-U.S. reductions reach a level where a near-peer (particularly one building up its forces) can pose a threat to the *survivability* of the negotiating parties' nuclear forces, this recognition may lead to the initiation of multilateral nuclear arms control talks that include a near-peer at the negotiating table.

At lower numbers of nuclear forces, the United States' ability to ensure the timely destruction of a near-peer arsenal while minimizing damage to itself is reduced. This diminution of capacity reduces the importance of *promptness*, so long as the *survivability* of U.S. nuclear forces remains ensured. With *survivability* elevated to Tier 1, at lower numbers the relative importance of *promptness* for prevailing over a near-peer drops to Tier 2.

Figure 6.2: Prevail over a Near-Peer Adversary as Numbers Decrease

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Prevail over Near-Peer Adversary at NST Numbers		
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Accuracy	Ability to Signal	Survivability
Promptness	Variety of Yield Options	
Movement from NST Numbers to Lower Numbers		
Ability to Defeat Defenses	Ability to Retarget →	Ability to Reconstitute →
Accuracy →	← Survivability	
←	Ability to Signal	
Promptness →	Variety of Yield Options	
Prevail over Near-Peer Adversary at Lower Numbers		
Ability to Defeat Defenses	Accuracy	Ability to Reconstitute
Ability to Signal	Promptness	Ability to Retarget
Survivability	Variety of Yield Options	

6.5 Prevailing Over a Regional Power

Should deterrence fail, the United States must prepare to respond and succeed in a regional contingency or conflict involving nuclear forces. Many of the capabilities identified as Tier 1, 2, and 3 for regional deterrence retain the same relative value for prevailing over a regional adversary in a conflict involving the use of nuclear forces. This reflects the fact that the

latter's nuclear forces are relatively small in number and have a very limited capability (or no capability) to directly threaten the United States. Those characteristics that deter regional powers by putting their limited nuclear forces at risk (viewed as their only guarantee of survival) would also lead to these forces being rapidly eliminated by the United States in any conflict with a nuclear dimension—to be followed by a swift defeat by the armed forces of the United States and its regional allies.

In the assessment of the research team, the only two qualitative characteristics that change in value between the "deter" and "prevail" matrixes at New START force levels for this scenario are *variety of yield options* and the *ability to defeat defenses*.

Maintaining a *variety of yield options* rises in importance when regional deterrence fails and the United States must engage in armed conflict. Although regional actors are unlikely to differentiate between various yields when deterring threats, the United States will seek to damage or defeat highly valued assets with minimal impact to civilians, nearby allies and partners, and U.S. assets. The importance of the *ability to defeat defenses*, however, is reduced. For nuclear operations at current force levels, even if a regional power devotes considerable resources to defending key assets the United States possesses more than enough numbers to achieve the desired effect against this adversary (for example, U.S. forces could devote, if necessary, multiple warheads to defeat a regional power's hardened targets). Although military commanders always prefer to defeat a target during the first attempt, given the size of current U.S. nuclear forces it is not essential for prevailing over a regional power.

Accuracy, *promptness*, and *variety of yield options* are Tier 1 characteristics for prevailing over a regional adversary (Fig. 6.2). *Variety of yield options* rises in importance when regional deterrence fails and the United States must engage in armed conflict. Although regional adversaries are unlikely to differentiate between various yields when deterring threats, the United States will seek to damage or defeat highly valued assets with minimal impact to civilians, nearby allies and partners, or U.S. assets.

Accuracy and *promptness* ensure that U.S. nuclear forces can quickly destroy a regional adversary's small nuclear forces without using significant numbers of weapons, and prevent it from conducting any strikes of its own against the United States or allied targets. Together with *variety of yield options*, these characteristics also ensure that a U.S. nuclear response can remain limited and will not result in large amounts of fallout.

6.6 Prevailing Over Regional Powers at Lower Numbers

As numbers of nuclear forces moderately decline, the relative value of the qualitative characteristics required for prevailing over a regional power in a nuclear conflict remain unchanged. *Accuracy*, *promptness*, and *variety of yield options* continue to remain critical (Fig. 6.3).[38] Even at

reduced numbers, U.S. nuclear forces remain qualitatively and quantitatively superior to the limited nuclear forces of a regional power. This force imbalance will continue to put pressure on a regional power to consider pre-emptive strikes to gain some value out of a force likely to be completely wiped out by the United States once major hostilities were underway (if the United States perceived a nuclear threat). To respond to a regional power preparing to cross the nuclear threshold—while also limiting collateral damage—the United States will retain a need within a reduced arsenal for prompt, accurate weapons with a range of yields, with low-yield weapons favored for a regional scenario to reduce the impact of the conflict on nearby allies.

Figure 6.3: Prevail over a Regional Power Adversary as Numbers Decrease		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Prevail over Regional Power Adversary at NST Numbers		
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Survivability
Variety of Yield Options	Ability to Signal	
Prevail over Regional Power Adversary at Lower Numbers		
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Survivability
Variety of Yield Options	Ability to Signal	

6.7 Prevailing Over an ANSA

Mobile, opaque, and committed to asymmetric forms of warfare, ANSAs pose a number of unique challenges within any conflict involving nuclear forces. Prevailing over an ANSA requires *prompt* and *accurate* nuclear forces with a *variety of yield options*. If possible, the United States would seek to use non-nuclear means to destroy a nuclear weapon in the hands of an ANSA. If non-nuclear means were not a viable option, the United States would consider excellent real-time intelligence, surveillance, and reconnaissance data fixing the location of an ANSA as an essential prerequisite to readying a nuclear strike against this type of adversary.

If such a target were identified and confirmed, however, speed and precision would be of the essence. In addition, with ANSAs often operating without the knowledge or consent of the host community or state, the United

States would likely limit any nuclear attack against an imminent ANSA nuclear threat to the use of a low-yield warhead.

6.8 Prevailing Over an ANSA at Lower Numbers

The gap between the numbers of U.S. nuclear forces and those of a nuclear-armed ANSA remain enormous even if U.S. nuclear forces experience dramatic reductions. Moreover, an ANSA's nuclear strategy—remain opaque, operate covertly, and use its limited forces on high-profile strikes—is not linked to an adversary's numbers of nuclear forces. At lower numbers, *promptness*, *accuracy*, and a *variety of yield options* remain the key qualitative characteristics for prevailing over an ANSA determined to initiate a nuclear conflict with the United States.[39] These qualities are imperative for attacking an adversary whose nuclear operations will likely only present small, fleeting targets within environments where limiting fallout is essential.

Figure 6.4: Prevail over an ANSA as Numbers Decrease		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Prevail over ANSA at NST Numbers		
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Ability to Signal
Variety of Yield Options		Survivability
Prevail over ANSA at Lower Numbers		
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Ability to Signal
Variety of Yield Options		Survivability

VII. ASSURING ALLIES

For nearly 60 years U.S. nuclear forces have assured allies and partners that the United States is committed to their defense and will employ all necessary means to deter nuclear-armed aggressors. This commitment to "extend" nuclear deterrence is an important component of the U.S. relationship with a number of key states, including several that might otherwise pursue their own nuclear weapon programs. In addition, the list of potential adversaries included in U.S. deterrence calculations—and of concerns to U.S. allies—continues to grow.

The research team recognized that the requirements of extended deterrence differ from those required to deter or prevail over potential adversaries.

U.S. allies include NATO member states in Europe as well as allies and partners across Asia and the Middle East. While each relationship with individual allies possesses its own political considerations that impact the ability to provide a credible extended nuclear deterrent, several overarching qualitative characteristics apply to any ally under the U.S. nuclear umbrella. The United States' ability to assure an ally that it can and will protect them can only succeed if both the ally and their potential adversaries perceive the potential use of these nuclear forces as credible. For many allies, the *ability to signal* is the most important qualitative characteristic of U.S. nuclear forces. They want the United States to visibly communicate to all parties that U.S nuclear forces will defend America's allies against external threats. Nuclear forces capable of clearly signaling intent to both allies and adversaries strongly reinforce U.S. declaratory policy and openly demonstrate that the United States is prepared to fulfill its extended deterrence commitments.

Allies facing nuclear-armed adversaries also desire protection from nuclear forces that can act quickly in response to any nuclear threat, placing *promptness* in Tier 1 for the purposes of assurance. In addition, U.S. nuclear forces' *ability to reconstitute* in a manner ensuring that a crisis abroad (or an issue with a delivery system or warhead type) does not result in gaps of coverage in terms of geography or adversary forces is also important to allies. This qualitative characteristic assures allies by demonstrating that the United States has the ability to mobilize additional forces and configure them to address a broad range of threats (Fig. 7.1).

7.1 Assuring Allies at Lower Numbers

At numbers moderately below New START levels, the research team determined there was no change in the relative value of qualitative characteristics associated with the objective of assuring U.S. allies. *Ability to signal*, *promptness*, and the *ability to reconstitute* remain the key qualitative characteristics for U.S. nuclear guarantees to its allies. These

characteristics are unlikely to change unless U.S. nuclear forces are reduced to very lower numbers below the levels considered by this report's analysis. Subject matter experts interviewed for this project repeatedly emphasized that the United States' ability to visibly demonstrate political will to use nuclear force to uphold extended deterrence commitments will remain of primary importance to U.S. allies and partners, even at lower numbers. The *ability to signal* continues to be the key characteristic of nuclear forces enabling the United States to convey this commitment. The *ability to reconstitute* and *promptness* also maintain their importance as Tier 1 characteristics. Together these three qualitative characteristics give U.S. allies confidence that the United States will clearly, quickly, and effectively respond in the event they face a military threat.

Figure 7.1: Assuring Allies as Numbers Decrease

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Assure Allies at NST Numbers		
Ability to Reconstitute	Ability to Defeat Defenses	Ability to Retarget
Ability to Signal	Accuracy	Survivability
Promptness	Variety of Yield Options	
Assure Allies at Lower Numbers		
Ability to Reconstitute	Ability to Defeat Defenses	Ability to Retarget
Ability to Signal	Accuracy	Survivability
Promptness	Variety of Yield Options	

VIII. THE IMPACT OF MISSILE DEFENSES AND CONVENTIONAL PROMPT GLOBAL STRIKE SYSTEMS ON QUALITATIVE CHARACTERISTEICS OF NUCLEAR WEAPONS

U.S. nuclear forces do not operate in isolation from other U.S. military assets. In the past, however, decision-makers and planners generally viewed nuclear forces as the principal forces deterring nuclear coercion or attacks, and as front line forces for any crisis, contingency, or conflict involving an opponent's nuclear forces. While deterring adversaries from contemplating or undertaking actions detrimental to the national interest requires nuclear forces to act in concert with conventional forces, the qualities and capabilities of nuclear forces granted them roles distinct from other military assets.

The research and development of new military capabilities, however, may bring forward weapons systems that can match (or perhaps even someday replace) some of the key qualities nuclear forces contribute to joint military operations. This research project analyzed two types of new systems—missile defenses (MD), currently in limited deployment, and prompt global strike (PGS), currently a research concept—to determine if, for a nuclear force reduced below New START levels, either of these additional military capabilities could complement or supplement any of the key qualitative characteristics of U.S. nuclear forces required for achieving deter, prevail, or assure objectives.

8.1 Missile Defenses

The United States fields a number of systems capable of providing defenses against attacks from cruise missiles, short-range ballistic missiles, and certain types of intercontinental ballistic missiles. Additional systems and upgrades to currently fielded platforms are also under development. For the purposes of this analysis, the term "missile defenses" refers to those systems focused on defending the territory of the United States and selected allies against a small number of nuclear-capable intermediate-range ballistic missiles (IRBMs) and intercontinental ballistic missiles.[40] This includes the Ground-Based Midcourse Defense system designed to defend the United States against a limited ICBM attack,[41] which currently deploys 30 interceptors stationed at two bases, and several regional defensive systems that are at various stages of development (to include the sea-based Aegis ballistic missile defense (BMD), land-based Terminal High Altitude Area Defense (THAAD), and the family of systems involved in the European Phased Adaptive Approach (PAA) to missile defense).[42] These defenses are designed to negate the ballistic missile threat posed by regional power adversaries, up to and including small numbers of WMD-capable IRBMs or ICBMs, through the use of ballistic interceptors capable of hitting and

destroying a missile in flight. This report does not address questions of specific basing locations for regional missile defense systems.

The development and deployment of U.S. missile defenses capable of countering certain types of ballistic missiles provides a heretofore unavailable option to U.S. commanders during a nuclear crisis or conflict: the capability to destroy a small number of an opponent's nuclear-armed ballistic missiles after their launch, ensuring that their payloads never threaten a U.S. or allied target. For the first time, the destruction of these types of ballistic missiles does not require directly attacking a launch site (either preemptively or following a first nuclear salvo) with a nuclear weapon or advanced conventional munitions. This report concludes that, across the range of scenarios considered by this analysis, missile defenses can occasionally supplement or complement the qualities that allow nuclear forces to deter, and if necessary defeat, nuclear-armed adversaries, but they cannot replace nuclear weapons. U.S. missile defenses—including the nascent capabilities currently fielded, and those systems that remain under development—can only address a limited type of nuclear threat (some, but not all, IRBMs and ICBMs) and can only counter this threat in limited numbers.[43]

Peer, Near-Peer, and ANSA Adversaries. U.S. missile defenses will have no effect upon the qualitative characteristics of nuclear forces that are important to deterring or prevailing over peer or near-peer adversaries. In regard to scenarios involving these types of geopolitical actors, fielding these defenses neither complements nor supplements the desired qualitative characteristics of U.S. nuclear forces discussed above, either at current or reduced levels. Quantitatively and qualitatively, a peer or near-peer's nuclear forces could overwhelm even the most advanced U.S. missile defenses currently under consideration, causing unacceptable damage to U.S. allies, forces abroad, and/or the U.S. homeland. In addition, these types of opponents are likely to employ countermeasures that will further stack the odds against U.S. missile defenses, preventing these systems from playing a significant role in any situation involving the nuclear forces of a peer or near-peer. In any scenario involving the nuclear forces of a peer or near-peer, U.S. nuclear forces remain the backbone of U.S. deterrent and defense capabilities and strategies, and the desired qualities of these forces remain unaffected by the addition of missile defenses.

Missile defenses would also have no impact on nuclear-armed opponents that lack any ballistic missile delivery systems. The qualitative characteristics of nuclear forces required for deterring or defeating an adversary equipped with a very small number of non-ballistic nuclear weapons (such as an ANSA in possession of a nuclear device) remain the same regardless of whether or not these forces are accompanied by missile defenses.[44]

Deterring Regional Adversaries. The conclusion that missile defenses have little impact on the qualitative characteristics of nuclear forces important for deterring or prevailing over peer, near-peer, or ANSA adversaries serves to emphasize the important, but limited, types of scenarios and adversaries where U.S. missile defenses might complement or supplement some qualitative characteristics of nuclear forces. In terms of systems architecture, military strategy, and national policy, current U.S. missile defenses focus on addressing the threat posed by a regional power equipped with a limited number of intermediate or long-range WMD-capable missiles.[45] Although current missile defenses are not perfect systems and their deployment cannot replace current nuclear capabilities, they can strengthen the effectiveness of U.S. nuclear forces for deterring regional adversaries.[46]

For the purposes of deterring regional adversaries, missile defenses can supplement or complement a reduced nuclear force's *ability to signal*. They can also complement the *survivability* of a reduced nuclear force.

If tensions rise within a geographic region, the United States could visibly demonstrate its intent to defend its allies from ballistic missile attack by deploying missile defenses to the area (for example, by sending BMD-equipped Aegis destroyers to the region). This action would send a powerful signal to a regional power that its limited nuclear arsenal cannot be used to intimidate or attack U.S. allies. On its own, this deployment might be considered as a possible substitute for the visible movement of nuclear forces to communicate a deterrence message to an adversary (such as the forward deployment of bombers). Missile defenses, however, can also complement nuclear forces' *ability to signal* if the deployment of these defenses is coupled with the deployment of delivery systems. The United States, for example, could choose to send both bombers and Aegis destroyers to defend an ally, clearly communicating to a regional adversary that a missile launch will both fail to harm any targets and be met with a devastating counterattack. The deployment of both "sword" and "shield" during a crisis visibly demonstrates and communicates that the United States is prepared to employ a combination of deterrence by denial *and* deterrence by punishment strategies. This sends a powerful signal to regional powers that there is no benefit (and significant costs) to contemplating plans regarding use of WMD-armed ballistic missiles against the United States or its allies.

For the purpose of deterring regional adversaries, highly effective missile defenses also complement the *survivability* of a reduced U.S. nuclear force. A regional power adversary with aspirations of becoming a regional hegemon may observe U.S. force reductions and conclude that the United States, whether from resource constraints or a lack of political will (or both), is increasingly unwilling or unable to put its reduced nuclear arsenal at risk by continuing to extend deterrence into its perceived area of influence. If

backed by missile defenses, however, even a relatively small number of U.S. nuclear forces stationed in or rotated through a region can deter a regional power adversary. Fielding a limited number of nuclear forces, and now facing a highly-survivable nuclear-armed adversary that can effectively counter its ballistic missile attacks, a regional power could not use nuclear-capable missiles to hold U.S. nuclear forces at risk.

Prevailing Over a Regional Adversary. Should deterrence of a regional power fail and its nuclear forces are brought to bear within a crisis or conflict scenario, the addition of missile defenses to a U.S. nuclear force reduced below New START levels would affect two of the qualitative characteristics considered by this research project: *survivability* and *promptness*.

In some circumstances, missile defenses could improve the *survivability* of U.S. nuclear forces. Should a regional power attempt to use some of its limited number of ballistic missiles to attack U.S. nuclear forces by, for example, launching a strike against an airbase serving as a staging area for U.S. bombers or DCA, missile defenses could protect both the systems and the base from the weapons and their payloads. Although even significant cuts to U.S. nuclear forces will leave the United States with sufficient numbers to completely destroy the military and security apparatus of any regional power, within a theater of operations a future reduced U.S. force may not have every nuclear option (whether in terms of platforms or yields) immediately available. In these circumstances, the ability of missile defenses to provide point defenses, thereby improving the *survivability* of U.S. nuclear forces deployed within the theater of operations, may be a factor within the early stages of an armed conflict.

For nuclear conflict scenarios, however, missile defenses would likely have a broader impact—both across U.S. nuclear forces, and in terms of strategies utilizing these forces—on requirements associated with the qualitative characteristic of *promptness*. As noted above, effective missile defenses expand the response timeline for U.S. nuclear forces in the event of an attack by a WMD-armed ballistic missile. If U.S. missile defenses negated a regional power's small number of ballistic missiles, the United States would never face the prospect of weighing a possible nuclear strike during a crisis or conflict due to the following circumstances: a) needing to deliver a proportional response to a regional power's nuclear attack on the United States or an ally, or b) being forced to regard a nuclear weapon as the only preemptive option available to assure the destruction of an adversary nuclear system about to launch (from, for example, a deeply buried or hardened location). In either scenario, the *promptness* of nuclear forces is critically important to prevailing over a regional adversary. While the ultimate outcome would never be in doubt, the ability to act rapidly is important to ensuring a nuclear conflict concludes on the most favorable possible terms to the United States and its allies.

If a regional power's only nuclear delivery systems are ballistic missiles, fully effective missile defenses could grant U.S. decision-makers additional time and greater latitude in choosing how to respond to an adversary's missile attack. This lessens the need for prompt nuclear forces. If U.S. missile defenses intercept and destroy an opponent's attempted nuclear strike, the United States could select its means of counterattacking from a full suite of conventional and nuclear options without facing the urgency of having to anticipate or respond to a possible enemy nuclear missile attack.

A regional power concerned that missile defenses will degrade or negate its WMD-capable ballistic missile force, however, may turn to other, non-ballistic means to deliver nuclear weapons. Missile defenses counter one important means by which regional power adversaries seek to threaten and attack the United States and its allies. Deterring and prevailing over these geopolitical actors, however, will continue to rely on U.S. nuclear forces, which threaten to dismantle and destroy any regional power adversary that attempts to seek leverage in a crisis, or advantage in a conflict, through the use of its small nuclear arsenal.

Missile Defenses and Assuring Allies. As reductions lower the number of U.S. nuclear forces, the addition of missile defense capabilities will enhance the ability of the United States to assure allies of its extended deterrence commitments. Missile defenses add a defensive component to the U.S. nuclear umbrella, deepening the strategic relationship between the United States and its allies. Missile defenses also increase the United States' *ability to signal*, a qualitative characteristic of nuclear forces that is of paramount important to the assurance of U.S. allies and partners. Many allies view missile defense cooperation, particularly if it includes the deployment of a capable missile defense system on their soil, as confirmation of the United States' will to defend them from blackmail or attack by nuclear-armed adversaries.

As allies and partners feel increasingly secure as a result of the deployments of missile defenses, their concern regarding the *promptness* of U.S. nuclear forces to respond to their defensive needs may decrease. An ally that feels secure beneath a U.S. missile defense shield may even view these defenses as a possible replacement for nuclear forces when addressing the threat posed by adversaries with limited nuclear arsenals, particularly given concerns that a regional nuclear conflict might lead to fallout drifting across their own borders. Furthermore, some allies may consider missile defenses as finally putting to rest the longstanding question of whether the United States would really go to nuclear war over a nuclear missile attack on an ally, concluding that highly effective missile defenses make the question irrelevant by preventing allied cities or forces from facing destruction by nuclear-armed ballistic missiles.[47]

8.2 Conventional Prompt Global Strike

Conventional Prompt Global Strike (CPGS) is a family of weapons design concepts that could provide the United States with the capability to hit any point on the globe within an hour or less. Currently, only certain types of nuclear weapons delivery systems possess the capability to threaten a large number of targets at very long ranges within this timeframe. The 2001 NPR called for the development of CPGS, and the DoD declared a mission requirement for CPGS in 2003. The 2010 NPR and Quadrennial Defense Review also called for the development of long-range, non-nuclear systems.[48] To meet this requirement, the DoD has considered a number of options, to include the development of boost-glide technologies or converting some SLBMs and/or ICBMs to carry conventional warheads. The Obama Administration announced in April 2011 that the DoD would pursue boost-glide technologies for future CPGS capabilities.[49] Boost-glide technology remains in the research and development phase, however, and its future remains unclear.[50]

In Congressional testimony, former STRATCOM Commander General Kevin P. Chilton described CPGS as a "niche capability" for use in a limited and discrete set of scenarios.[51] Possible scenarios for future CPGS use might include strikes against the following types of targets: an adversary poised to launch a missile or missiles (possibly armed with a nuclear, chemical or biological weapon) at the United States or its allies; a fleeting terrorist target with a limited strike window; a shipment of nuclear, chemical or biological materials; or other time-dependent, high-value targets during a conflict. Proponents of CPGS argue that this capability will provide the president with an option in a crisis that adversaries will view as a more credible threat than nuclear weapons.[52]

Although many subject matter experts and military thinkers interviewed for this research project support development of CPGS as a niche capability, critics note that other states could mistake a CPGS strike for a nuclear strike, and alert their own nuclear forces in response. The Obama administration has sought to reduce this concern by pursuing boost-glide technology, which has a different trajectory than ballistic missiles. Some experts state, however, that the boost phase of such a weapon (prior to its glide toward a target) will appear similar to the profile of a ballistic missile, and that the system's ability to take a nonlinear path toward targets is viewed as extremely destabilizing by some states because there is no way to reliably predict the weapon's target. Critics also charge that the information and intelligence required for a CPGS strike will only be available in situations where the United States will have other assets that can launch a prompt attack.[53] Furthermore, they also note that the best means of attacking many important targets—for example, terrorist leadership cells—are weapons that do not completely destroy all evidence associated with the target.[54]

Peer and Near-Peer Adversaries. CPGS does not have a significant role in deterring or prevailing over peer or near-peer actors. It is possible that CPGS could make a minor contribution to the deterrence of peers and near-peers. There is a danger to the United States, however, that peer or near-peer adversaries may not agree with the U.S. assessment that CPGS is a "niche" capability. If these types of adversaries fear that the United States may be more willing to use CPGS than nuclear weapons in a nuclear crisis or conflict—that is, that CPGS will prevent the United States from being "self-deterred"—and, further, that U.S. forces possess CPGS in sufficient numbers to destroy significant numbers of their nuclear forces, they may conclude that their current force structure and posture no longer deters the United States from launching an attack on their nuclear arsenals. As a result, peer or near-peer adversaries might seek to expand or improve their nuclear arsenals, attempt to develop other capabilities to match or defeat CPGS, alter their doctrines regarding crisis escalation, or take other steps negatively affecting strategic stability with the United States and other global nuclear powers.

Deterring Regional Power Adversaries and ANSAs. Threat scenarios involving regional power actors and ANSAs led to the development of the U.S. CPGS program. The 2010 NPR states "any future U.S. conventionally armed long-range ballistic missile systems are designed to address newly emerging regional threats."[55]

The knowledge that the United States can precisely hit any target it values within an hour may deter regional power adversaries and ANSAs from undertaking actions detrimental to U.S. interests. In addition, these types of geopolitical actors may consider the threat posed by CPGS as more credible than that posed by nuclear weapons, as the former allows the United States to launch an attack that will not cross the nuclear threshold and will not result in fallout or significant collateral damage. Moreover, the United States has shown its willingness to use conventional forces repeatedly since the end of the Cold War, adding to the credibility of possible use for CPGS. Within this context, CPGS supplements the *promptness* and *accuracy* of nuclear forces. CPGS possess both of these key qualitative characteristics, and represents a non-nuclear alternative for some of the key targets associated with regional powers. However, the additional marginal benefits to current U.S. deterrent strategies reliant upon nuclear weapons must be weighed against the possibility that CPGS could undermine strategic stability with peers or near-peers, and its overall monetary cost in comparison to existing systems.

CPGS may also deter regional adversaries by denying them the ability to employ certain strategies. CPGS, for example, may deny an adversary the ability to launch a surprise attack against an ally.[56] CPGS may also contribute to deterrence through its ability to strike targets that are difficult or costly to attack with other forms of conventional military power.

In this respect CPGS may fill a gap in current conventional deterrence capabilities. This may prove particularly important in the future, as U.S. adversaries continue to devote resources to improving both active and passive defenses against U.S. air and naval power projection capabilities.

Prevailing Over Regional Power Adversaries and ANSAs. The 2010 NPR suggests that CPGS "may be particularly valuable for the defeat of time-urgent regional threats."[57] In conflict scenarios involving regional powers and ANSAs, CPGS could supplement the *promptness* and *accuracy* of nuclear forces. In a conflict, U.S. commanders equipped with CPGS and actionable intelligence could rapidly strike key regional power nuclear weapon or leadership targets, even if they were distant from other U.S. forces and well protected by active defenses such as air-defense systems.

CPGS could also complement the qualitative characteristic *variety of yield options*, representing a rapid, long-range conventional strike option whose destructive power is less than that of low-yield warheads, and which does not result in radioactive fallout. Its addition to the arsenal could provide a new, non-nuclear weapon capable of performing some of the missions previously reserved for nuclear forces.

Assuring Allies. CPGS may also provide another capability in the toolkit for assuring allies. The 2010 NPR highlights the value of CPGS vis-à-vis allies, stating that the United States will seek to "strengthen regional security architectures and reinforce security commitments to allies and partners by maintaining an effective nuclear umbrella while placing increased reliance on non-nuclear deterrence capabilities (e.g., missile defenses and conventional long-range missiles)."[58] Allies are likely to oppose nuclear strikes in regions where radioactive fallout could harm large numbers of civilians within the adversary state and in states beyond the target, and may favor CPGS as a means to deliver a rapid, accurate, and effective attack against high-value targets without risking widespread collateral damage. The assurance of allies represents another objective where CPGS, through the capabilities it provides, could supplement the *promptness* and *accuracy* of nuclear forces. The use of CPGS in defense of an ally, however, is not without risk. If an adversary targeted with this weapon cannot compete with the United States symmetrically, for example, it may seek to retaliate against the United States or its allies.

IX. SUMMARY: IMPACT OF FORCE REDUCTIONS ON QUALITATIVE NUCLEAR CHARACTERISTICS TO DETER, PREVAIL, AND ASSURE

An assessment of the total results of the analysis of the qualitative characteristics of nuclear forces required for achieving deter, prevail, and objectives reveals the following findings:

9.1 Deter

- The relative importance of key qualitative characteristics for deterrence objectives changes little as nuclear forces are reduced. At a fundamental level, deterrence is in the eye of the beholder. This analysis finds that the level of reductions considered by this research project does little to change adversary perceptions regarding the risks faced in attempting to use nuclear forces to challenge or combat a nuclear-armed United States.
- The Tier 1 qualitative characteristics for deterring peer and near-peer adversaries are nearly identical at New START levels and become identical at lower numbers: *ability to defeat defenses*, *ability to reconstitute*, and *survivability*. As the United States and its peer adversaries reduce their forces, a near-peer—particularly one with a small but capable nuclear complex—will increasingly take on the characteristics of a peer adversary.
- The Tier 1 qualitative characteristics for deterring regional powers and ANSAs are very similar, sharing *accuracy* and *promptness* at New START levels and at lower numbers.

Comparing deterrence of major nuclear powers (peer and near-peer) against deterrence of actors with small numbers of weapons (regional powers and ANSAs) indicates there are two distinct sets of qualitative characteristics required for deterrence.

Major powers are deterred by an opponent's nuclear force that can survive an initial strike (*survivability*), reconfigure to respond to challenges and last through a prolonged conflict (*ability to reconstitute*), and destroy significant numbers of their own forces even when they are protected by active and passive defenses (*ability to defeat defenses*). A nuclear force that maintains these characteristics in strength is a force that can severely damage any adversary, including those with large nuclear forces, regardless of the nuclear strategies they employ. As numbers of forces decline, maintaining *survivability* is particularly important for deterring major nuclear powers. At low numbers, enough forces must survive to still credibly threaten an adversary that can field significant numbers of nuclear forces, particularly if that adversary calculates it can win a nuclear conflict despite absorbing a handful of nuclear strikes from a reduced U.S. force

whose numbers are further whittled down by an attack. In addition, as numbers decline, every weapon within the remaining arsenal assumes strategic significance for maintaining deterrence with major nuclear powers, placing a premium on the *ability to reconstitute*.

Geopolitical actors with smaller numbers of forces, however, are deterred by a nuclear force that can quickly erase their ability to use a nuclear weapon to asymmetrically challenge the United States, gain an edge over their neighbors, or otherwise bolster their regime. They likely conclude their forces are at risk due to the *accuracy* and *promptness* of U.S. nuclear delivery systems, and may hesitate to assemble, deploy, and utilize their limited nuclear options for fear the United States will destroy them before they are even put into play within a crisis or conflict.

9.2 Prevail

- At New START levels, the Tier 1 characteristics for prevailing over peer and near-peer adversaries differ. As numbers decline, however, they become identical: *ability to defeat defenses*, *survivability*, and *ability to signal*.
- The Tier 1 qualitative characteristics for prevailing over regional powers and ANSAs are identical, sharing *accuracy*, *promptness*, and a *variety of yield options* at New START levels and at lower numbers.

As was observed for the requirements of the deterrence objective, two separate sets of qualitative characteristics are required for prevailing over nuclear-armed adversaries: one set for major nuclear powers (peer and near-peer), and a second set for regional powers and ANSAs.

Any conflict between a peer or near-peer adversary and the United States that risks involving nuclear forces could rapidly escalate into a war with unacceptable costs. In the event such a conflict were to occur, the *ability to signal* would be vital to quickly ending the war on terms favorable to the United States, ensuring the conflict does not continue indefinitely or result in an adversary launching a massive attack.

While the conflict is underway, however, the *ability to defeat defenses* and *survivability* are vital to providing an offensive/defensive balance to nuclear forces critical to U.S. efforts to neutralize an opponent's nuclear arsenal. The *ability to defeat defenses* ensures a reduced force is still highly effective in striking an adversary's nuclear force. If this characteristic is maintained at lower numbers, the United States will reduce the need to assign multiple nuclear weapons to certain types of adversary nuclear targets protected by active and/or passive defenses. *Survivability* is also critical to boosting the force's overall capabilities to carry on a fight, allowing delivery systems to continue functioning despite the stresses of nuclear conflict.

These characteristics differ from the qualitative characteristics needed for prevailing over a regional power or ANSA in a conflict involving nuclear forces. Both in terms of the forces available to them and their strategic objectives, regional powers and ANSAs are highly unlikely to directly challenge the United States in a nuclear conflict. Their asymmetric employment of nuclear weapons (most likely against a soft target) and efforts to hide and defend nuclear assets requires the United States to field nuclear forces that can destroy a nuclear weapon or other related target without causing massive damage or large amounts of fallout. This requires a low-yield nuclear weapon (*variety of yield options*) that will not stray off target (*accuracy*).

9.3 Assure

- The qualitative characteristics that assure allies remain unchanged at New START levels or lower numbers, with *ability to signal*, *ability to reconstitute*, and *promptness* remaining this objective's most important characteristics.
- This set of qualitative characteristics differs from those identified as vital to deter and prevail missions.

Allies are aware of the global reach of the U.S. nuclear arsenal. Although U.S. allies are not monolithic, this analysis finds that they feel most secure when U.S. nuclear forces are visibly present, and, furthermore, can rapidly and visibly demonstrate an increase in operational tempo and/or numbers in response to a crisis within their region.

* * * * *

A comparison of the findings across the deter, prevail, and assure objectives indicates that there are three different sets of qualitative characteristics required for nuclear forces to achieve these distinct national strategic objectives: one set for deterring and prevailing over peers and near-peers, one set for deterring and prevailing over regional powers and ANSAs, and a third set for assuring allies. Furthermore, comparing results across the three objectives reveals considerable variation, with no one qualitative characteristic repeatedly assessed as always vital or always unnecessary for the three objectives considered by this analysis. These analytic results identify an enduring requirement, at New START levels or lower numbers, for a nuclear force featuring a diverse range of qualitative characteristics.

X. CONCLUSION AND IMPLICATIONS FOR FUTURE ARMS CONTROL NEGOTIATIONS

This analysis focused on answering the following questions:

- At New START levels, what qualitative characteristics of U.S. nuclear forces are most critical to deterring potential adversaries, prevailing in future conflicts involving nuclear forces, and assuring allies?
- Do these characteristics change in relative importance at lower numbers?
- As nuclear forces are reduced, how does the introduction of advanced capabilities such as missile defenses or CPGS affect the relative importance of nuclear forces' qualitative characteristics?
- What are the implications of the above for future arms control negotiations?

10.1 Key Findings

The investigation of these questions resulted in the following findings:

1. Today's key qualitative characteristics remain critical to tomorrow's smaller nuclear force. Force reductions will not significantly change the key qualitative characteristics required to ensure the United States achieves deter, prevail, and assure objectives. Qualities required at New START levels remain critically important at lower levels of nuclear forces. Even if reductions are carried out in tandem with a peer adversary or adversaries, the qualitative requirements of a U.S. nuclear force with global responsibilities and committed to strategies targeting adversary nuclear forces remain essentially the same. Tomorrow's nuclear forces will be asked to achieve the same objectives as today's, but may have to do more with less (such as operate within an environment with a greater number of nuclear-armed adversaries). Any future reductions in quantity must be accomplished in a manner that does not significantly weaken the qualities—described as qualitative characteristics in this analysis—associated with the U.S. New START nuclear force.

2. A reduced nuclear arsenal must meet three differing sets of force requirements. This research project finds that, as U.S. nuclear forces are reduced, there begin to emerge three differing sets of key qualitative characteristics required to achieve deter, prevail, and assure objectives:

a. Deterring and prevailing over major nuclear powers (peer and near-peer adversaries) requires an assured second-strike capability provided by a nuclear force with the qualitative

characteristics *ability to defeat defenses*, *ability to reconstitute*, and *survivability*.

b. Deterring and prevailing over geopolitical actors with a small number of nuclear weapons, such as regional powers and ANSAs, requires the ability to hold their limited arsenals, key leadership, and other high-value targets (to include fleeting targets) at risk, while also limiting collateral damage. This requires a nuclear force with the qualitative characteristics *accuracy*, *promptness*, and *variety of yield options*.

c. Assuring allies requires nuclear forces with the qualitative characteristics *ability to signal*, *promptness*, and *ability to reconstitute*.

Although there is some overlap in qualitative requirements across these three sets, no two sets are identical. In terms of presently fielded systems, no monad or dyad can provide a future reduced nuclear force with the full range of qualitative characteristics required to meet these three differing sets of requirements. At lower levels of nuclear forces, the United States will likely continue to require three or four different delivery systems to achieve its national strategic objectives for nuclear forces.

3. As numbers are reduced, survivability becomes increasingly important, particularly with respect to deterring and prevailing over major nuclear powers. This analysis determined that the relative importance of certain qualitative characteristics of nuclear forces that are critical to key national objectives at New START levels—such as *promptness*, *ability to defeat defenses*, and *variety of yield options*—will remain largely unchanged as a result of reductions. These characteristics will be essential to ensuring that a reduced nuclear force can continue to meet the requirements of future missions to deter, prevail, and assure.

In regard to deterring and prevailing over major nuclear powers, *survivability* was the one characteristic whose relative importance significantly increased as numbers decline. Nuclear forces that can survive an adversary's nuclear strike and mount a decisive response—whether due to their physical properties, their deployment, posture, or a combination of factors—are vital to the maintenance of deterrence. As numbers of nuclear forces are reduced, the importance of *survivability* grows, particularly in regard to ensuring stable relationships between major nuclear powers—whose ranks may increase as the U.S. nuclear force gets smaller.

As arsenals decline, a major power might conclude that the cumulative costs of a nuclear exchange also decline. Maintaining highly survivable forces even as overall numbers are reduced enhances stability by preserving the ability of the United States and its remaining forces to threaten all powers, including those retaining significant numbers of forces.

An adversary must know that it would face unacceptable costs if it were to launch a nuclear attack on the United States or its allies.

4. A near-peer should be brought into nuclear arms control talks when its arsenal, whether due to near-peer modernization efforts, U.S.-peer force reductions, or a combination of the two, can threaten a strategically significant strike against U.S. nuclear forces. The relative capabilities of near-peer adversaries will increase if the United States and a peer agree to field smaller arsenals. Pursuing further reductions may lead to the United States facing additional "peer adversaries," as the distinction between current peer and near-peer adversaries will eventually collapse at lower numbers—particularly if states in the latter category build up their forces. If this occurs, the qualitative characteristics for deterring and prevailing over former near-peer adversaries will shift to those required to deter and prevail over a peer.

As noted above, *survivability* is a linchpin of deterrence and is also vital to prevailing in a nuclear conflict. If U.S.-peer reductions continue, the threat posed by a near-peer to the *survivability* of U.S. nuclear forces will increase. When this threat reaches a tipping point where a near-peer's nuclear forces can launch a strategically significant strike against the United States, calling into question the deterrent value of a reduced U.S. nuclear force, the United States should invite this "new peer" to join strategic nuclear arms control negotiations.

5. Reductions may strain those qualitative characteristics viewed as foundational to fielding a viable nuclear force. The first major finding of this report was identified at an early stage of research and led to the categorization of qualitative characteristics as either "variable" or "foundational." The team found widespread agreement across military, scientific, and policy communities that, if the United States is to continue fielding nuclear forces into the future, there are a number of key foundational qualitative characteristics of nuclear forces (*command and control*, *reliability*, *safety/security/surety*, and *sustainability*) that cannot be compromised under any circumstances. Moreover, members of these communities expressed serious concerns regarding the possibility that future reductions to nuclear forces might significantly strain the ability of the nuclear complex to maintain the specialized personnel, institutional memory, equipment, and facilities required to underwrite these foundational characteristics. The experts involved in this research project repeatedly noted that current delivery systems and warheads were designed (and in many cases built and fielded) decades ago, and in most cases replacement systems are still in the concept stage of development. This presents the military services with significant and growing challenges in regard to maintaining, equipping, and operating these systems.

6. Missile defenses and CPGS can complement but not supplement nuclear forces. Both systems can buy the United States and its allies valuable time within nuclear crises or conflicts, reducing the need for *promptness* from a nuclear force. While complementing other key qualitative characteristics such as *ability to signal* and *survivability*, however, missile defenses are limited, and CPGS will remain a niche capability. As presently configured (missile defenses) and conceptualized (CPGS), they can only address in part the complex and diverse requirements of deter, prevail, and assure objectives. Nuclear forces currently represent the only military option capable of deterring and defeating a full spectrum of adversary nuclear forces.

10.2 Implications for Future Arms Control Negotiations

These findings have a number of implications for future nuclear arms control negotiations:[59]

1. Numbers alone should not determine arms control negotiating positions. Qualitative and quantitative considerations should both be taken into account in discussions and decisions regarding future nuclear force reductions. Discussions of nuclear arms control agreements frequently focus on issues related to establishing numerical limits for delivery systems or warheads. This analysis finds, however, that qualitative requirements remain relatively unchanged as numbers decline. This finding points to a critical challenge for future U.S. arms control negotiators considering reductions below New START numbers: reduce quantity without fundamentally changing the qualities currently required to meet all the missions nuclear weapons are expected to accomplish.

In the current international geopolitical environment, the threat matrix shaping deter, prevail, and assure requirements may change prior to or even during negotiations. During the Cold War, the United States could engage in arms control talks while primarily focused on one or two potential adversaries. Future rounds of negotiations, however, will have to take into account the fact that a number of potential adversaries may possess or be developing nuclear weapons. The U.S. nuclear umbrella may also extend to more countries, expanding assurance requirements. As a result, although the United States will not face, in the foreseeable future, an adversary armed with tens of thousands of nuclear weapons, a future reduced nuclear force must retain the capability to deter a number of potential adversaries fielding nuclear forces of widely varying sizes and capabilities, and defending dispersed allies facing a broad range of nuclear threats.

These factors do not rule out future reductions. Many of the subject matter experts interviewed for this research project, for example, stated that the United States could probably consider moderate reductions to nuclear forces—via an arms control agreement with a peer—below the limits of

New START without losing key qualitative characteristics associated with deter, prevail, or assure objectives. Many subject matter experts also noted, however, that along a path to lower numbers of nuclear forces there will be a point where quantity itself becomes a qualitative characteristic; that is, the reduced size of the nuclear force will fundamentally constrain the qualities it brings to the table. As a result, any proposal of future numerical limits should reflect a cautious analysis of the impact of quantitative reductions on the qualitative characteristics of the forces that remain, and whether these qualities are sufficient to address a spectrum of potential nuclear adversaries and respond to a range of possible futures.

2. Negotiators must protect the qualitative diversity of U.S. nuclear forces by preserving the ability to field a range of delivery systems and warheads. This analysis identified seven of the eight variable qualitative characteristics as critically important (ranked within Tier 1) in at least one deter, prevail, or assure scenario.[60] Furthermore, no characteristic repeatedly ranked as unimportant or irrelevant. At lower numbers, maintaining a broad range of qualitative characteristics remains vital to deter, prevail, and assure.

This finding indicates that future reductions should not degrade or eliminate the qualitative characteristics that allow the United States to field a "flexible" and "diverse" nuclear force. As positive adjectives, these terms often describe aspects of an effective delivery system and/or of an ideal force, but they are not always clearly defined. This analysis suggests that these terms refer to two different types of options in regard to nuclear forces: destructive power, as represented by warhead yield, and manner of delivery, as represented by differing delivery systems and the means they employ to reach targets. The U.S. nuclear arsenal must be flexible in terms of the kinetic force it applies to targets, to include a range of warhead yields. U.S. nuclear forces must also be diverse in regard to means of delivery, to include prompt ballistic systems capable of defeating passive and active defenses, and air breathing systems that can visibly signal U.S. intent to adversaries and allies, loiter nearby, or chase certain targets, and are capable of carrying different weapon types.

The preservation of the qualitative characteristics that ensure a flexible and diverse force provides a number of parameters for future arms control negotiations. U.S. negotiators should generally avoid limits on nuclear forces other than those mutually agreed upon. For example, the United States should strongly consider rejecting any proposal to eliminate a class or type of delivery system. Retaining a variety of launch platforms (land, sea, and air) and weapons profiles (ballistic, cruise, and gravity) ensures that U.S. nuclear forces maintain a range of qualitative characteristics. The United States should also generally oppose any effort to limit force structure options. While limitations to an adversary's force

structure may be desirable, a corresponding treaty mandated restriction upon the United States would likely result in compromising important qualitative characteristics of U.S. forces.

The current projected timelines for fielding the next generation of U.S. delivery systems indicate that for the at least the next decade the United States will continue to rely upon the systems within the present arsenal: Minuteman III, Ohio SSBNs, bombers (B-52Hs and B-2As), and DCA (F-15s, F-16s, and F-35s).[61] The qualitative characteristics required for deter, prevail, and assure missions thus must continue to be met by the current capabilities provided by these systems. An assessment matching capabilities to qualitative requirements must also acknowledge the limitations of these systems. Any consideration of future reductions must address the question of whether all these systems can be maintained within a smaller nuclear force. If the answer is no, negotiators will need to determine if the remaining delivery systems can cover the qualitative characteristics lost when a system is eliminated. Significantly, no single system in the U.S. nuclear arsenal today provides the full range of qualitative characteristics required by deter, prevail, and assure objectives. Future negotiations must preserve the ability of the United States to field a combination of systems to address a range of qualitative requirements.

3. As numbers are reduced, the United States must take steps to protect the qualitative characteristic of survivability within future arms control negotiations. In the past, some arms control negotiations have considered, and some treaties implemented, concepts that traded aspects of nuclear force *survivability* for greater transparency and increased stability (for example, by taking steps to ensure that each side felt confident it could hold the other party's arsenal at risk). As numbers are reduced, however, the United States must ensure that its negotiators understand and protect the *survivability* of its nuclear forces.

As numbers of forces decrease, *survivability* becomes particularly important with regard to deterring and prevailing over peer adversaries. The number of peer adversaries may grow in the future if other states continue to build up their nuclear arsenals while the United States continues to reduce. A peer can pose an existential nuclear threat to the United States. Protecting the *survivability* of U.S. nuclear forces, however, will guarantee that even at reduced numbers the United States can deliver a strategically significant strike capable of severely damaging a peer's ability to wage nuclear war. If a peer adversary's leadership does not have full confidence it can use nuclear attacks to neutralize or eliminate the U.S. arsenal, it will have little incentive to launch a strike against the United States. At low numbers, maintaining highly survivable forces fosters strategic stability between parties with numerically similar arsenals, with each side retaining the capability—even if an attack, accident, or some other event eliminates or

sidelines part of its force—to ensure that its remaining delivery systems and warheads can cause unacceptable damage to an adversary.

One means by which arms control negotiators can protect the *survivability* of nuclear forces is by opposing measures that limit deployment patterns. While arms control agreements limiting force deployments at the strategic level may encourage stable relations between nuclear-armed powers (by, for example, creating buffer zones preventing the deployment of nuclear forces to potential flashpoints), retaining ambiguity and unpredictability regarding deployments at the tactical level is important to protecting the *survivability* of nuclear forces. Limiting deployment of forces risks making these forces easier to locate and attack.

4. If U.S.-peer reductions reach a level where a near-peer can pose a threat to the survivability of the negotiating parties' nuclear forces, the United States should take steps to include that new peer competitor in subsequent rounds of nuclear arms control talks.

President Obama's 2009 Prague speech catalyzed discussion and analysis of the possibility that a future round of negotiations regarding nuclear arms control may include multiple states parties discussing reductions to their national arsenals.

As discussed in Sections V and VI, a near-peer that invests in its nuclear complex and in modernizing its forces may represent a "breakout" threat to the United States as the latter's nuclear forces decline. Similarly, a near-peer breakout would also jeopardize the nuclear forces of a peer adversary. Regardless of the breakout potential of a near-peer, if U.S.-peer reductions continue, at some point a near-peer will become a peer.

In either case, as numbers are reduced, the United States should take steps to bring a near-peer to the negotiating table at the point when the latter's forces can pose a threat to the *survivability* of the overall U.S. nuclear force, calling into question whether the United States can effectively deter a near-peer that now assumes the same status as a peer adversary. Furthermore, it is likely that a near-peer will resist overtures to directly participate in nuclear arms control talks until it believes it has the capability to deliver a knockout blow to the nuclear forces of major nuclear powers. Until this point a near-peer may not feel confident that it can reduce its forces without compromising the deterrent value of its arsenal.

5. The United States must ensure that future arms control negotiations do not negatively impact "foundational" characteristics of nuclear forces associated with the design, production, and maintenance of key components by the U.S. nuclear complex.

As noted in Section 3.4, this analysis categorized several key qualitative characteristics as "foundational." While all the characteristics considered by this analysis are important, these four (*command and control*, *reliability*, *safety/security/surety*, and *sustainability*) are absolutely vital to

maintaining the confidence of national leadership in the utility of the arsenal. Future U.S. nuclear arms control negotiating teams must ensure these characteristics are protected in any future agreement. Future arms control agreements, for example, may devote increasing attention to national nuclear complexes. The United States may need to carefully balance the benefits of steps intended to slow or halt foreign nuclear production cycles against the costs imposed by these agreements on U.S. national laboratories, and the possible consequences of any accord that could impact their ability to design and build pits and other vital components for nuclear warheads.

6. The United States should not limit missile defenses or CPGS in a future arms control agreement, but should consider whether confidence-building measures (CBMs) regarding these systems might improve the prospects of future nuclear arms control negotiations. With U.S. national missile defenses now operational, and CPGS currently in research and development, one or both of these systems are likely to play a key role within future nuclear arms control negotiations.

This analysis finds that both systems play a complementary role with U.S. nuclear forces, but cannot supplement all the key qualitative characteristics of the latter. Against an adversary with a limited nuclear ballistic missile force, effective missile defenses can buy the United States valuable time to consider a broad range of responses, reducing the need for *promptness*. Similarly, CPGS may one day provide a conventional offensive capability that also reduces the need for the nuclear force to possess this qualitative characteristic, giving decision-makers a prompt means of attacking an adversary wherever it is located without having to use a nuclear option. Beyond *promptness*, however, both systems, as presently configured, were found to provide only a limited ability to substitute for other vital characteristics of nuclear forces; this analysis concludes that to date only nuclear forces can effectively deter and prevail over adversary nuclear forces. Significantly, U.S. missile defenses can only defeat one means of adversary nuclear delivery, providing only a partial shield against possible nuclear attacks.

Any system with the potential to boost or complement the capabilities of U.S. nuclear forces, even to a limited degree, is likely to concern an adversary. During the negotiation of New START, the United States categorically ruled out any treaty provisions limiting its current missile defense architecture, and it is unlikely to change this position in the future. If successfully developed and fielded, for several years CPGS will likely represent a capability unique to the United States, and the United States would probably oppose any effort to limit or eliminate this type of weapon.

This does not, however, necessarily take missile defenses or CPGS completely off the table from future rounds of nuclear arms control talks.

While the United States would likely oppose limitations to these capabilities, in the interest of strategic stability it might choose to propose steps to allay the fears of other nuclear states that U.S. military technological innovation has put their deterrent capabilities at risk. In order to make progress on talks leading to nuclear force reductions, the United States might propose CBMs in regard to these systems, following templates provided by earlier treaties and agreements. These CBMs might include:

- Exchanging information on facilities housing these systems, and the numbers of these systems located at each base or site. Similar information is already exchanged with other parties for the CFE and New START treaties.
- Exchanging information related to strategies or doctrines involving these forces, similar to the general doctrinal information exchanged as part of the Vienna Document agreement.
- Providing some limited exchange of information regarding system launch data, similar to the exchange of telemetry information under New START.
- Allowing some form of observation or on-site inspection of missile defense or CPGS systems upon initial installation or deployment, perhaps using New START's "exhibition of a new type" as a template.

These types of CBMs might convince a major nuclear power that, in terms of numbers and capabilities, U.S. missile defenses or CPGS would not upset the nuclear balance between them and the United States. For an adversary fielding or developing equivalent systems, such CBMs might also provide information of value to the United States.

APPENDIX A: ANALYSIS OF QUALITATIVE CHARACTERISTICS FOR DETER, PREVAIL, AND ASSURE OBJECTIVES

A.1 Introduction

This report focuses on the qualitative characteristics of current U.S. nuclear forces that are most critical for deterring potential adversaries, prevailing in future conflicts involving nuclear forces, and assuring allies. It also analyzes how these characteristics change in relative importance at lower numbers. The research team crafted and executed a framework of analysis informed by primary and secondary sources, more than 60 interviews, and two expert workshops. This framework identifies the most important qualitative characteristics for achieving a specific deter, prevail, or assure objective for a range of geopolitical actors (peer, near-peer, regional power, armed non-state actor, and ally) at New START force levels and at lower numbers. This framework is divided into three Tiers representing a spectrum ranging from most valuable characteristics (Tier 1) to characteristics of lesser relative importance (Tiers 2 and 3). The eight qualitative characteristics are then placed into one of the three Tiers, with each Tier limited to no more than three characteristics.

The main body of the report focuses on the qualitative characteristics placed in Tier 1 by the report's analysis; that is, those characteristics assessed as most critical to the achievement of deter, prevail, and assure objectives. In conducting its analysis, however, the research team completed a comprehensive assessment of the relative importance of all eight qualitative characteristics identified as variables for each of the nine scenarios included in this report. This complete analysis, including the rationale regarding placement within Tiers 1, 2, or 3 for each qualitative characteristic, is presented here. The discussion of Tier 1 qualitative characteristics is identical to that found in the main report, but the discussion of the analysis leading to the placement of characteristics in Tiers 2 and 3 for each of the scenarios is only found in this appendix.

A.2 Deterring Adversaries

Deterring a Peer Adversary at New START Numbers. The number and diversity of nuclear forces fielded by a peer adversary permit it to employ a range of nuclear strategies. A peer can use its nuclear forces to deter or combat U.S. forces (both conventional and nuclear) in the field, beyond its borders, and in circumstances where nuclear weapons are not necessarily a "last resort." A peer adversary could fight and possibly survive a major nuclear conflict with the United States.

Tier 1. At New START levels of nuclear forces, the most important qualitative characteristics for deterring a peer adversary are the *ability to defeat defenses*, *survivability*, and *ability to reconstitute* (Fig. A.1).

The *ability to defeat defenses* supports the basic tenets of deterrence theory—being able to credibly threaten adversary targets. The ability to defeat defenses is vital in deterring peers, because a peer adversary has the national industrial and technical base to develop and deploy robust active defenses, such as anti-aircraft and (limited) missile defense systems. A peer also has the resources and know-how to harden a broad range of targets, to include key military, civilian, and communication facilities. In order to deter such an adversary, the United States must be able to guarantee the destruction of key targets despite the adversary's efforts to defend them.

Figure A.1: Deter a Peer Adversary at NST Numbers		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Signal	Ability to Retarget
Ability to Reconstitute	Accuracy	Variety of Yield Options
Survivability	Promptness	

Survivability is another critical factor for maintaining stable deterrence against a nuclear peer. Failing to safeguard and maintain the survivability of nuclear forces in the face of an opponent whose own forces are capable, both in quantity and quality, of simultaneously attacking nuclear forces, command and control nodes, and key supporting infrastructure, permits an adversary to contemplate launching a disarming first strike.

The *ability to reconstitute* forces is also critically important for deterring a peer adversary. In the near term, a peer adversary is the only type of adversary capable of significantly escalating the risk posed to U.S. nuclear forces through measures such as uploading ballistic missiles or mobilizing large numbers of de-alerted or inactive nuclear forces. A peer adversary undertaking these actions could upend the nuclear balance with the United States, throwing the ability of U.S. nuclear forces to deter it into doubt. By retaining the capability to match these moves, the United States ensures that a peer adversary will be unable to use a sudden change in its nuclear posture or numbers of fielded forces to gain the upper hand. At the same time, the United States must retain sufficient nuclear capabilities to ensure it can deter a range of additional actors that may not be involved in the current crisis.

Tier 2. Three qualitative characteristics fall into the Tier 2 category for deterrence of a peer adversary. The *promptness* of U.S. nuclear forces promotes deterrence against a peer by granting the United States the capability to swiftly respond to any provocation. But the deterrent value of this characteristic is uncertain and linked with a peer adversary's perception of the risk posed by the size and speed of America's nuclear forces. If a peer

adversary believes its forces are not particularly survivable against current U.S. nuclear capabilities, it may fear that the United States could rapidly launch an attack to eliminate its own forces. A peer adversary that feels vulnerable to an all-out attack delivered with little notice may feel compelled to launch a pre-emptive attack. However, if a peer adversary believes that its forces (or a large part of its forces) are highly survivable against an American nuclear attack, the *promptness* of U.S. forces may not deter it, as it may believe its arsenal can survive a U.S. "bolt from the blue" and respond with a devastating counterattack.

Accuracy, especially when combined with *promptness*, contributes to deterrence by putting an adversary's leadership, command and control centers, and nuclear forces at risk. For a peer, however, its deterrent value is also uncertain. Similar to *promptness*, the *accuracy* of U.S. forces can deter a peer adversary because it may view this characteristic (particularly when combined with characteristics such as *ability to defeat defenses*) as allowing the United States to match it weapon for weapon—that is, each U.S. nuclear weapon fired has a high probability of striking and destroying its intended target. If a peer adversary views its forces as highly survivable, however, it may willingly absorb a fast *and* accurate first strike, believing its defenses will allow many of its delivery systems to remain operational, granting it the capability to respond with a major nuclear attack.

The *ability to signal* provides a means to show resolve with nuclear weapons without engaging in armed conflict. The United States can signal that it is willing to match, counter, and combat the nuclear forces of a peer adversary through means such as visibly deploying nuclear forces to forward operating areas. Whether this deters a peer from undertaking a particular course of action, or merely confirms to a peer that it can move forward with its plans because the United States can match but not decisively defeat its nuclear forces, however, is difficult to determine.

Tier 3. The two qualitative characteristics assessed as less important for deterring peer competitors are *variety of yield options* and *ability to retarget*. A peer adversary can match the United States in developing, building, and fielding nuclear weapons with a range of yields. The United States' ability to reduce or increase yield does not deter a peer adversary, who may believe it can fight and win a nuclear war with the United States regardless of the sizes of warheads employed or the overall scale of the conflict. The *ability to retarget* weapons is also relatively less important, as this characteristic does not improve the deterrence posture of the United States due to the peer adversary's large and varied target set.

Deterring a Peer Adversary at Lower Numbers. As the number of nuclear weapons in the U.S. nuclear arsenal declines, the most important qualitative characteristics for deterring peer adversaries remain unchanged. At lower numbers, the qualitative characteristics *ability to defeat defenses*,

ability to reconstitute, and *survivability* remain critically important to deterring peer adversaries (Fig. A.2).[62]

Tier 1. As stated above, this analysis assumes that any U.S. reductions will occur in tandem with a peer. Even if the United States and a peer adversary undergo significant reductions, however, a peer will keep a large number of deployed nuclear forces. The *ability to defeat defenses* remains key to peer deterrence. Reductions, even if implemented equally, will reduce the ability of the United States to destroy peer targets. In addition, as nuclear arsenals are reduced, the incentives to build up both active and passive defenses to compensate for lower numbers are high for both sides. Deterrence is weakened if a peer adversary concludes that arms reductions lower the potential costs of nuclear conflict. Maintaining the *ability to defeat defenses* at lower numbers stabilizes the U.S.-peer deterrence relationship, ensuring that the peer remains at risk of sustaining significant-to-devastating losses if it initiates a nuclear conflict.

Figure A.2:
Deter a Peer Adversary at Lower Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Signal	Ability to Retarget
Ability to Reconstitute	Accuracy	Promptness
Survivability	Variety of Yield Options	

The general scope of reductions under a future arms control treaty considered by this analysis still permits a peer to maintain a large hedge force and robust nuclear complex. A peer will retain the capability to rapidly change its number of deployed forces, force posture, and introduce force modifications or even new platforms. As nuclear force levels decline, any change involving even a small number of forces may become strategically significant. Within this environment, maintaining an *ability to reconstitute* forces is a significant bulwark against deterrence failure.

In addition, with parity in numbers maintained, but the overall numbers and types of platforms and warheads reduced, a peer adversary attempting to seek an advantage is likely to carefully weigh whether any part of the United States' remaining nuclear forces is a "weak link" that could be significantly degraded by strikes using only a small number of nuclear weapons. Taking steps to protect or enhance the *survivability* of a reduced nuclear force is vital to deterring a peer adversary at lower numbers.

Tier 2. At lower numbers, *accuracy* and the *ability to signal* remain Tier 2 characteristics for deterring peer adversaries. As numbers decline, a peer adversary will likely play close attention to any U.S. signals regarding its equivalently reduced force. Whether a signal is clearly

received, however, is another matter, particularly as lower numbers drive all adversaries—peers included—to view each individual weapon as more valuable. At lower numbers, the *ability to signal* remains a characteristic that may have a high or a low deterrent value.

As noted above, this analysis assumes that the relative parity between a peer adversary's nuclear forces and U.S. forces will remain at lower numbers. In such a scenario, the *accuracy* of U.S. forces will remain linked with an adversary's assessment—on a system by system basis—of whether the low CEP of U.S. forces is strategically significant or unimportant. Its deterrent value will also vary broadly depending on a peer adversary's current threat assessment.

These characteristics are joined by *variety of yield options*, which becomes more important at lower numbers. As numbers go lower, the research team assesses that the likelihood of an all-out conflict between a peer and the United States declines. Any nuclear conflict at lower numbers will be limited in scope and weaponry, in part because each side will have a greater awareness that other nuclear powers now—by relative comparison—possess strategically significant arsenals of their own. Either state could foresee scenarios where "victory" over the other might leave them relatively weaker than a near-peer nuclear power. Within this context, a limited nuclear conflict will likely require smaller nuclear weapons, leading to *variety of yield options* moving up one level in our Tier rankings.

Tier 3. The Tier 3 characteristics for lower force numbers are the *ability to retarget* and *promptness*. The research team assesses the reduction of numbers of peer and U.S. arsenals as reducing the (already very low) likelihood of nuclear conflict between the two; *if* a conflict were to occur, however, it would be limited in nature. Within this environment, neither side would face "use-it-or-lose it" pressure, and *promptness* would not play a significant role in deterrence. The *ability to retarget*, which is important for deterring and prevailing over an adversary whose forces are primarily or solely mobile, does not have great weight for the deterrence of a peer. Fielding both a wide range of fixed and mobile systems, and also possessing defenses that can reduce the effectiveness of any force that "loiters" or "hunts" for targets prior to a final decision to fire, a peer adversary is not particularly deterred by the *ability to retarget*.

Deterring a Near-Peer Adversary at New START Numbers. The nuclear capabilities of a near-peer permit it to threaten a number of targets on the U.S. homeland, but it lacks the numbers to pose a significant threat to U.S. nuclear forces. Within a potential nuclear conflict, United States nuclear forces significantly outnumber those of a near-peer. A near-peer, however, is the only adversary besides a peer that is largely self-sufficient in designing and manufacturing delivery systems and warheads. It may have the potential to build up its limited arsenal relatively quickly.

Tier 1. The most critical qualitative characteristics for deterring a near-peer adversary are the *ability to reconstitute, ability to defeat defenses,* and the *ability to signal* (Fig. A.3).

A near-peer's capability to expand its nuclear forces elevates the importance of the *ability to reconstitute* nuclear forces for the purpose of deterrence. If a near-peer is capable of rapidly accelerating efforts to build up its nuclear arsenal, it may conclude that in a relatively short amount of time it can reach parity with U.S. nuclear forces (also referred to as a "breakout" scenario). Maintaining the *ability to reconstitute* nuclear forces ensures that the United States can respond to any near-peer expansion of its nuclear arsenal and retain a significant edge over this type of adversary.

Figure A.3:
Deter a Near-Peer Adversary at NST Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Accuracy	Ability to Retarget
Ability to Reconstitute	Promptness	Variety of Yield Options
Ability to Signal	Survivability	

A near-peer's nuclear forces, which include both fixed and mobile ballistic systems, are quantitatively inferior to those of a peer adversary but qualitatively similar. It fields highly capable, possibly well-defended, and hard to locate nuclear forces. This might lead a near-peer to speculate that a part of its arsenal could survive an initial attack from a numerically superior foe. Ensuring that the United States maintains nuclear forces with a robust *ability to defeat defenses* is important to deterring a near-peer, convincing this type of adversary that the United States has the capability to launch a disarming strike that holds its entire arsenal at risk.

The *ability to signal* is also critical for deterring a near-peer. Although it cannot match U.S. nuclear forces overall and only possesses a limited number of long-range delivery systems, a near-peer might believe it could use its nuclear forces to challenge the United States in a theater conflict or crisis. In these types of scenarios, a near-peer could bring a much broader range of nuclear forces to bear against forward deployed U.S. forces. A near-peer could also attempt to use its nuclear forces to change the stakes of a regional conflict in its favor. In addition, a near-peer may calculate that the communication of a nuclear threat against the U.S. homeland will slow or halt U.S. intervention within their region, granting them a free hand. Clear signals of resolve sent in response via U.S. nuclear forces, however, could convince a near-peer to de-escalate and otherwise abandon destabilizing courses of action.

Tier 2. While still important to the deterrence of a near-peer adversary, three characteristics—*accuracy*, *promptness*, and *survivability*—fall into Tier 2. A near-peer adversary will likely assume a high degree of *accuracy* for the entirety of the U.S. nuclear force. The build-up of their defenses is, in part, recognition that it may face an opponent with very accurate nuclear forces. If a near-peer is highly confident in its defenses, however, it may not be completely deterred by the *accuracy* of U.S. nuclear forces, believing that it can "ride out" an attack.

Similar to a peer adversary, the *promptness* of the delivery of a nuclear weapon also has less bearing on the deterrence of a near-peer adversary than Tier 1 characteristics. This is due to the fact that the United States maintains a credible second-strike capability in any scenario involving a near-peer adversary. This includes a "bolt from the blue" that unleashes its full nuclear force against the United States. Whether slow or fast, U.S. nuclear forces are assured of an opportunity to respond with overwhelming force to any attack from a near-peer.

The second strike capability of the United States also places the *survivability* of nuclear forces in Tier 2 when considering deterrence of a near-peer adversary. Even if caught by surprise, and even if a near-peer's forces proved highly accurate and lethal, enough U.S. forces would survive an initial near-peer attack to counter-attack with devastating consequences. *Survivability*, however, becomes more important within any near-peer "breakout" scenario.

Tier 3. The two qualitative characteristics deemed of lesser importance for near-peer deterrence are the *ability to retarget* and the possession of a *variety of yield options*. A near-peer's range of capabilities, and strength of its defenses, are such that the flexibility these characteristics grant to U.S. nuclear forces could complicate, but not defeat, a near-peer's ambitions. A near-peer views its ability to expand its range of nuclear capabilities and strengthen its defenses as measures complicating U.S. nuclear forces' ability to effectively counter its regional ambitions. Consequently, the inherent flexibility and dexterity that these two characteristics provide U.S. nuclear forces are of limited deterrent value, especially compared to other characteristics that hold targets at risk more effectively.

Deterring a Near-Peer Adversary at Lower Numbers.

Tier 1. The most critical qualitative characteristics for deterring a near-peer adversary at lower numbers are the *ability to defeat defenses*, the *ability to reconstitute*, and *survivability* (Fig. A.4).

Should the United States reduce its nuclear forces while a near-peer remains at current levels, a near-peer's numerical disadvantage vis-à-vis the United States, while still significant, would become less acute. As discussed above, with a capable indigenous nuclear complex backing its current fielded forces, a near-peer may contemplate taking steps to close the gap between itself and a reduced U.S. nuclear force. U.S.-peer reductions may be one of several factors considered by a near-peer weighing the decision to expand its nuclear arsenal, and the size, scope, and speed of this expansion. The *ability to reconstitute* will remain important to deterring a near-peer at lower numbers, granting U.S. forces the flexibility to respond to any attempt by a near-peer to "breakout" and become a nuclear superpower following a future round of U.S.-peer reductions. The *ability to defeat defenses* also maintains its position as a Tier 1 qualitative characteristic. Convincing a near-peer the United States will rapidly overwhelm its nuclear forces (including its mobile forces) within a conflict, despite its efforts to defend them, remains essential to deterring this type of adversary.

Figure A.4:
Deter a Near-Peer Adversary at Lower Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Signal	Ability to Retarget
Ability to Reconstitute	Promptness	Accuracy
Survivability	Variety of Yield Options	

At lower numbers, *survivability* becomes more of a concern due to a near-peer adversary's ability to hold at risk a larger percentage of U.S. nuclear forces. At New START levels, this percentage was low enough to place *survivability* in Tier 2. At lower numbers, however, the increase in risk from a near-peer to U.S. nuclear forces, particularly those stationed or deployed outside the United States for extended deterrence purposes, makes *survivability* of those U.S. forces more important.

Significantly, as a result of this shift, the three characteristics that are most important for deterring a near-peer adversary at lower numbers are the same as those for deterring a peer adversary. At lower numbers, the two categories of peer and near-peer begin to blend into one. Following U.S.-peer reductions, a near-peer remains significantly behind the numbers of U.S. forces, but its calculations of risk and cost-benefit analysis of scenarios involving nuclear forces begin to change in its favor. As a result, the deterrence requirements of a near-peer increasingly mirror those of a peer well before a near-peer reaches numerical parity with the United States.

Tier 2. Other changes can be seen in the movement of some of the Tier 2 characteristics: *ability to signal*, *promptness*, and *variety of yield options*. Due to the elevation of *survivability* to Tier 1 status for deterring a near-peer, the *ability to signal* was moved to Tier 2. However, the ability to visibly demonstrate resolve remains important even at lower numbers. Thus, this demotion is more representative of a rise in stature of *survivability* at lower numbers than any decrease in importance of the *ability to signal*.

At lower numbers, the credibility of the U.S. resolve to use nuclear forces may begin to wane in the eyes of its adversaries, to include a near-peer. For example, if a future reduced U.S. arsenal is limited to high-yield weapons, or if low-yield weapons are only available on platforms susceptible to an adversary's active defenses (such as dual-capable aircraft and bombers) an adversary may conclude that the United States is self-deterred or incapable of seriously damaging it (or both). At lower numbers, a *variety of yield options* provides an increased credibility to the U.S. nuclear deterrent that warrants an increase from its Tier 3 position at New START numbers.

Promptness remains in Tier 2. While a near-peer may be concerned that U.S. nuclear forces are, in general, more prompt than its own, its value for deterrence purposes is not as high as the qualitative characteristics in Tier 1. The speed of a U.S. response remains of lesser relative importance than characteristics equipping U.S. forces to penetrate a near-peer's most sophisticated defenses, survive its most effective nuclear strikes, and counter any breakout efforts by this type of adversary. By granting the United States an advantage in a conflict of any duration, whether short or long, and allowing U.S. forces to respond decisively even if a near-peer launches a pre-emptive strike, the three qualitative characteristics in Tier 1 ensure that *promptness* remains a Tier 2 characteristic. It remains above Tier 3, however, as it continues to provide an immediate existential threat to a near-peer's nuclear arsenal in response to any act of aggression by this type of adversary.

Tier 3. The short timeline and overwhelming numbers associated with a U.S. response to a nuclear attack is a greater deterrent to a near-peer than any calculus of the *accuracy* of the forces themselves. A near-peer is likely to recognize that, barring a breakout scenario, even at lower numbers the United States can afford to devote multiple weapons to many key targets associated with its own arsenal. Joining *accuracy* in Tier 3 is the *ability to retarget*. This placement is unchanged from its position at New START numbers. Even after U.S. forces are reduced, the perceived strength of a near-peer's defenses and its combination of dispersed fixed and mobile systems diminishes this characteristic's deterrent utility.

Deterring a Regional Adversary at New START Numbers. Limited in number, the nuclear forces of regional powers are closely held by state leaders, who view them as vital to regime survival but also vulnerable

to attack. The armed forces of regional powers have limited opportunities to train with nuclear weapons, command and control systems are not robust, and nuclear strategies and doctrines remain nascent or undeveloped among senior military officials and policymakers.

The nuclear strategy of a regional power focuses on using nuclear forces to shift the regional balance of power, counter U.S. conventional superiority, and protect the ruling regime. For this type of adversary, nuclear weapons may serve as anti-access weapons, providing a capability that may deter the United States from taking actions within their region. A regional power may also threaten to use nuclear weapons to intimidate or attack a U.S. regional ally in an effort to either fracture the alliance or otherwise complicate U.S. or joint operations in theater. Further, a regional power may view nuclear weapons as giving it the ability to terminate a regional conventional conflict where it faces potential defeat, particularly if the core regime is under threat.

A regional power could launch a small nuclear attack on U.S. allies or forward deployed U.S. forces, and may have the capability (albeit very limited) to strike the United States, therefore necessitating the use of deterrence strategies that include nuclear forces. A regional power adversary's small number of long-range ballistic systems grant it the capability to launch a very limited nuclear attack against the United States, but the reliability and accuracy of its missiles is not high and its forces are not particularly prompt or responsive.

Tier 1. At New START levels, the key qualitative characteristics of nuclear forces for deterring a regional power are the *ability to defeat defenses*, *accuracy*, and *promptness* (Fig. A.5).

Figure A.5:
Deter a Regional Adversary at NST Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Accuracy	Ability to Signal	Survivability
Promptness	Variety of Yield Options	

Regional powers attach great importance to their nuclear programs. For a regional power, the development of a nuclear weapons program is time-intensive, expensive, and risky. They accept these costs, however, in exchange for enhancing regime security, establishing their position as a major regional power, and gaining a coveted place in the global nuclear club.

While the nuclear weapons programs of regional powers are threats the United States must prepare to address, they also represent vulnerabilities

the United States can exploit for the purposes of deterrence. A regional power that recognizes the United States can readily destroy its nuclear complex or small handful of delivery systems with a precise nuclear strike is unlikely to seek a nuclear confrontation. This highlights the importance of *accuracy*, coupled with excellent intelligence gathering and assessment capabilities, for deterring regional powers. With regional actors determined to protect their investment from both internal and external threats by building or acquiring active and passive defenses (to include hardened, deeply buried nuclear facilities) the *ability to defeat defenses* is also essential to holding these assets at risk and represents a key characteristic underpinning regional deterrence.

> For this type of adversary, the ruling regime views nuclear forces as vital to its influence and survival. If a regional power believes the United States is unable to quickly intervene in a distant conflict, it may believe it can use its nuclear forces to intimidate or attack neighboring or nearby states before the United States can respond. However, if regional powers believe the United States can use its nuclear forces to pre-empt or immediately reply to any provocation, it will hesitate—and likely decide against—putting its regime and nuclear forces at risk. Thus, the ability to swiftly strike a regime's key leadership or nuclear forces before they move from a particular location or while in transit between facilities is a critical element of deterrence in a regional scenario. A regional power is likely to view a prompt and devastating strike on its ruling regime as an unacceptable risk. The fear of a swift attack that eliminates its nuclear forces and makes the regime instantly vulnerable to coercion or subsequent attacks will likely deter a regional power from using its scarce nuclear assets. The ability to hold fleeting targets at risk, whether these targets are directly associated with the regime or its highly valued nuclear forces, underscores the importance of *promptness* to regional deterrence.[63]

Tier 2. The *ability to retarget*, *ability to signal*, and *variety of yield options* are Tier 2 qualitative characteristics for deterrence of regional adversaries. The location of regional adversaries, and their arsenals, is likely near or adjacent to the territory of U.S. allies and/or U.S. overseas military bases. If a regional adversary believes the only U.S. nuclear response to its act of aggression is high-yield warheads that produce significant fallout, it may view the United States as being self-deterred. Maintaining a *variety of yield options* to ensure the U.S. arsenal includes low-yield warheads capable of striking targets while also limiting the amount of fallout and collateral damage may enhance regional deterrence by making the threat of use more credible.

Regional adversaries may also question U.S. commitment to use nuclear forces to defend allied interests. The *ability to signal* may

strengthen regional deterrence and help mitigate conflict escalation by providing a visible demonstration of U.S. determination to provide a nuclear umbrella over allies and its forward deployed forces. In peacetime, for example, the United States can hold joint exercises with regional allies that include nuclear-capable platforms and/or deploy U.S. nuclear forces in-theater in a visible manner. The ability of regional adversaries to interpret U.S. signals accurately, however, is difficult to ascertain, and even carefully tailored messages may elicit unexpected responses. As a result, the relative value of *ability to signal* as an element of deterrence is less than that of the characteristics in Tier 1. Finally, the *ability to retarget* may have some influence on the mindset of regional adversaries. While some targets are likely fixed, U.S. forces may increasingly face regional adversaries with mobile assets, such as mobile ballistic missiles or mobile command and control centers. In these circumstances, the ability of U.S. forces to change the desired point of impact for a weapon while a delivery system is in flight may deter a regional adversary by providing a counter to efforts to move or hide its nuclear forces.

Tier 3. The *ability to reconstitute forces* and *survivability* are Tier 3 characteristics for deterring regional adversaries. This type of adversary's arsenal is significantly smaller than that of the United States. The *ability to reconstitute* nuclear forces, and the *survivability* of these forces, do not play a critical role in deterrence at current force levels because of this inherent asymmetry.

Deterring a Regional Adversary at Lower Numbers. At numbers moderately below New START levels, the key characteristics for deterring regional actors remain the same (Fig. A.6).[64] Even after significant reductions, the fundamental quantitative and qualitative asymmetry in favor of U.S. nuclear forces remains unchanged. The nuclear forces of regional powers will remain key symbols of state power, carefully husbanded to guarantee the integrity of the state against external invaders. U.S. nuclear forces that retain *accuracy* and the *ability to defeat defenses* can continue to deter nuclear adventurism by regional powers, even if overall U.S. numbers decline. In addition, *promptness* will guarantee that a regional power does not mistake a reduction in the size of the U.S. force for a reduction in its speed of response, preventing it from

Figure A.6:
Deter a Regional Adversary at Lower Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Accuracy	Ability to Signal	Survivability
Promptness	Variety of Yield Options	

contemplating a pre-emptive or early strike against the U.S. homeland or U.S. interests abroad.

Deterring ANSAs at New START Numbers. Although ANSAs are diverse in size, capabilities, and motivation, their common lack of international recognition as a sovereign entity has significant political, legal, and financial ramifications that condition their operations and their interactions with recognized states. Some ANSAs have proven capable of mounting sophisticated military operations, creating and maintaining transnational revenue streams, and securing a degree of social and political legitimacy in the eyes of certain groups and even some state government.

Few, however, are able to maintain a permanent headquarters, and all lack the military resources to pose a direct challenge to the United States. In a conventional or nuclear crisis or conflict with the United States, an ANSA must rely on asymmetric means of warfare. Most ANSAs, however, are not "irrational" or prone to take significant risks in their use of force, particularly in regard to scarce, valuable capabilities. An ANSA in possession of a nuclear weapon might not necessarily use it immediately.

U.S. efforts to address nuclear terrorism have primarily focused on measures to prevent and deter state governments from aiding or abetting ANSAs attempting to acquire nuclear materials or weapons. As noted in the 2010 NPR, however, the United States will "hold accountable any state, terrorist group, or other non-state actor that supports or enables terrorist efforts to obtain or use weapons of mass destruction."[65]

ANSAs have strategic assets—personnel, weapons, money, and other resources—that they require to survive and operate within the geopolitical environment. As such, the threat of force, up to and including the threat of nuclear force, can deter ANSAs. The credibility of this threat may vary broadly between different ANSAs. An ANSA operating within a city, for example, may conclude that it is safe from nuclear strikes because the collateral damage resulting from such an attack would be unacceptable to the United States. Many ANSAs, however, have sought to establish bases and training facilities outside of populated areas in an effort to evade state authorities.

Figure A.7: Deter an ANSA at NST Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Accuracy	Ability to Retarget	Ability to Defeat Defenses
Promptness	Ability to Signal	Ability to Reconstitute
Variety of Yield Options		Survivability

Tier 1. ANSAs are characterized by their fluidity, mobility, and lack of transparency. In order for U.S. nuclear forces to deter an ANSA, the group must believe these forces can launch quickly, are highly accurate, and will not cause significant damage to civilian populations. The latter is particularly important in those circumstances where ANSAs operate within a host state that is unable to eject them or is unaware of their presence. As a result, the most important qualitative characteristics for deterring an ANSA are *accuracy*, *promptness*, and *variety of yield options* (Fig. A.7). Together, these characteristics ensure that the United States could, if necessary, threaten an ANSA nuclear target (to include a fleeting target, such as a nuclear device hidden aboard a truck or ship) with a rapidly launched strike utilizing a low-yield weapon to limit fallout and civilian casualties.

Tier 2. The *ability to retarget* and the *ability to signal* are Tier 2 qualitative characteristics for deterring ANSAs. Lacking embassies, eager to keep their command and control systems secret, and perhaps even determined to hide the identities of their leaders, ANSAs pose special problems with regard to direct communications. Many ANSAs, however, are adept at using the Internet and other forms of electronic media, and devote time and resources to propaganda and publicity. Moreover, those ANSAs opposing the United States often give indications that they are paying close attention to American military and political developments. The *ability to signal* may represent an important qualitative characteristic for deterring some ANSAs; in certain situations the United States can attempt to communicate to a particular adversary that U.S. nuclear forces are prepared and/or positioned for rolling back and countering the group's actions. It may be difficult to confirm, however, that an ANSA has received and understood the message, placing this characteristic in Tier 2. The *ability to retarget* may have some deterrent value for ANSAs, as they often represent "fleeting" targets; the ability of the United States to pursue mobile forces may prevent them from undertaking certain types of attacks. ANSAs, however, are often on the move regardless of who is chasing them, so the fact that U.S. nuclear forces have the flexibility provided by this capability to divert or pursue may not necessarily deter groups within this category.

Tier 3. As an ANSA is unlikely to have any means by which to put significant numbers of U.S. nuclear forces at risk, the *survivability* of U.S. forces is of little concern to deterring these groups. Furthermore, an ANSA is unlikely to devote consideration to how many nuclear forces are assigned to attack it, or the options at the disposal of the United States in regard to these forces. Lacking any capability in terms of active defenses, ANSAs are not particularly deterred by U.S. nuclear forces' *ability to defeat defenses*, although they may have some ability to acquire or use passive defenses (such as utilizing caves and other natural terrain features or constructing tunnels). The *ability to reconstitute* is another qualitative characteristic that

is relatively unimportant to deterring an ANSA. This type of adversary is unlikely to view its actions as leading to a significant nuclear conflict where the generation or regeneration of U.S. forces might play a role in the outcome.

Deterring an ANSA at Lower Numbers. A nuclear-armed ANSA is unlikely to change its cost-benefit analysis of nuclear conflict, or its risk assessment of the nuclear threat posed by the United States if U.S. nuclear forces are reduced. The quantitative and qualitative gap between its nuclear forces and those of the United States is so wide that even significant reductions by the United States do not alter the key characteristics vital to deterring an ANSA (Fig. A.8).[66] ANSA deterrence continues to require *accuracy*, *promptness*, and a *variety of yield options*—characteristics necessary for the United States to field a nuclear force capable of holding the limited, possibly mobile, and often or always hidden nuclear weapons of an ANSA at risk.

Figure A.8: Deter an ANSA at Lower Numbers		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Accuracy	Ability to Retarget	Ability to Defeat Defenses
Promptness	Ability to Signal	Ability to Reconstitute
Variety of Yield Options		Survivability

A.3 Prevailing Over Adversaries

If deterrence fails and the United States becomes engaged in a conflict involving nuclear forces, its employment strategies are guided by a number of key priorities, to include: preventing an adversary from striking the U.S. homeland, U.S. forward deployed forces, and U.S. allies; eliminating an opponent's nuclear forces; and minimizing civilian casualties. This analysis defines "prevail" in nuclear conflict as successfully eliminating an adversary's ability to conduct nuclear attacks while minimizing casualties and damage to the U.S. homeland, forward forces, allies, and civilians.

Prevailing Over a Peer Adversary at New START Numbers.

Tier 1. Should deterrence fail and the United States engage in a nuclear conflict with a peer adversary, the qualitative characteristics *ability to defeat defenses*, *promptness*, and *survivability* are of paramount importance (Fig. A.9).

The ability to penetrate adversary defenses and destroy intended targets is of vital importance in a nuclear conflict with a peer. Every successful strike against a peer's nuclear forces—many of which may be protected by extensive active and passive defenses—destroys highly-capable delivery systems and warheads that can cause significant damage to the United States and its allies. *Promptness* is also important in a nuclear

conflict with a peer, as this type of adversary possesses the capability to strike a wide range of U.S. targets quickly and accurately. Maintaining U.S. forces that can launch upon very short notice (if given warning of an imminent strike) guards against the possibility a peer could knock out many of the United States' nuclear forces with a surprise attack. In addition, *promptness* increases the likelihood of striking an adversary's mobile systems. *Survivability* is also critical to prevailing in a nuclear conflict with a peer. A peer adversary is capable of using a range of delivery systems and launching many warheads against the United States while retaining significant nuclear forces to fire additional salvos or otherwise continue fighting beyond one or possibly even several nuclear exchanges. Forces that can both survive the vagaries of a conflict that is likely to strain critical infrastructure and command and control (even for forces not directly attacked) and also conceivably survive a targeted nuclear strike are essential to prevailing against an adversary that can qualitatively and quantitatively match U.S. nuclear forces.

Figure A.9:
Prevail Over a Peer Adversary at NST Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Promptness	Ability to Signal	Variety of Yield Options
Survivability	Accuracy	

Tier 2. The three Tier 2 characteristics for prevailing in a nuclear conflict with a peer include the *ability to retarget, ability to signal,* and *accuracy.* The *ability to retarget* is a valuable characteristic for countering a peer adversary's mobile nuclear delivery systems. During a conflict these missiles will move to evade possible attack, and delivery systems carrying weapons targeted against these moving aim points will need the ability to rapidly retarget. Furthermore, this capability provides command authorities with additional time if the conflict situation changes before the delivery of a nuclear strike. Once a conflict begins, decision-makers can use the *ability to signal* to indicate either further escalation or de-escalation. The ability to credibly signal de-escalation, for example, could greatly decrease the level of destruction of a nuclear conflict fought with a peer. *Accuracy* is valuable for targeting the peer adversary's nuclear forces; with the two sides at near parity, it is important to make every strike against an adversary's nuclear forces count. If U.S. commanders are forced to use multiple weapons or multiple strikes against a peer's delivery systems because of any shortcomings in *accuracy,* the United States may struggle to prevail in a nuclear conflict with a peer.

Tier 3. The two characteristics of lesser importance during a conflict with a peer nuclear power are *ability to reconstitute* and *variety of yield options*. Once a conflict with a peer adversary is underway, it is unlikely the United States will have time to upload or regenerate forces, rendering the *ability to reconstitute* forces in order to respond to geopolitical change less relevant. In addition, within a conflict the United States may find it difficult to control escalation or signal resolve by using a lower yield weapon. However, in a nuclear conflict with a peer competitor both sides will have such a large number of weapons that neither is likely to prioritize adjusting the destructive capability of their respective warheads. If there is a peer adversary target that must be destroyed, planners are more likely to default to the use of high-yield weapons.

Prevailing Over a Peer Adversary at Lower Numbers.

Tier 1. At lower numbers, the *ability to defeat defenses* and *survivability* remain vital to prevailing over a peer adversary in a nuclear conflict (Fig. A.10). Against an opponent with an equal number of weapons, U.S. nuclear forces must have the capability to attack and destroy opposing forces on a one-for-one basis (or better, if possible, such as conducting a successful attack with one warhead on a delivery vehicle carrying multiple warheads). As peer arsenals get smaller, it will be strongly incentivized to build up active and passive defenses to protect its smaller arsenal, and the *ability to defeat defenses* will remain essential to defeating a peer's nuclear forces in a nuclear conflict.

Figure A.10:
Prevail Over a Peer Adversary at Lower Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Reconstitute	Ability to Retarget
Ability to Signal	Accuracy	Promptness
Survivability	Variety of Yield Options	

Survivability remains a Tier 1 characteristic; within a nuclear conflict, a peer adversary will similarly seek to maximize the damage each nuclear weapon causes to opposing nuclear forces. As numbers go lower, although each side maintains numerical parity, if for any reason one side's forces are more survivable (for example, one side may possess an advantage in its ability to disperse forces, or in its capabilities for equipping forces to evade detection), this qualitative edge may begin to alter the dynamics of

conflict. If the United States emphasizes *survivability* at lower numbers, a peer adversary may need to devote multiple weapons to attacking a single highly survivable delivery system. As forces are reduced, this scenario can place a peer adversary at a distinct disadvantage. For example, if a peer attempted to launch a pre-emptive strike with a large number of weapons but failed to disable or destroy many of the United States' nuclear forces, including significant numbers of delivery systems carrying (or capable of carrying) multiple warheads, it will likely find itself at a significant disadvantage for the remainder of the conflict.

This analysis finds that lower numbers increase the importance of the *ability to signal* for prevailing over a peer. Any peer-U.S. nuclear conflict has the potential to end inconclusively, with each side suffering massive damage and casualties. Prevailing within a peer nuclear conflict requires the ability to communicate escalation and de-escalation; at a minimum, *ability to signal* is important to prevent nuclear exchanges from dragging out beyond the point of either side achieving any militarily significant objective or clear resolution to the conflict.

Tier 2. At lower numbers, the *ability to reconstitute* grows in importance for prevailing over a peer adversary. As force numbers are reduced, this characteristic increases in importance because the value of each weapon vis-à-vis a peer adversary increases at lower numbers. Strategically significant increases to a nuclear arsenal become less costly and less time-consuming at lower numbers, raising this characteristic from Tier 3 to Tier 2. *Variety of yield options* also moves from Tier 3 to Tier 2. At lower numbers, conflicts involving nuclear weapons are likely limited conflicts. Within these types of conflicts the ability to field a variety of yield options becomes more important in deterring a peer adversary. A peer adversary is likely to view lower yield weapons as more credible than high-yield weapons, recognizing U.S. concerns regarding collateral damage and sharing an interest in preventing a conflict from becoming an all-out nuclear war. *Accuracy* remains in this Tier at lower numbers; at lower numbers it remains important to make each strike count by destroying targets associated with a peer's nuclear forces.

Tier 3. The Tier 3 characteristics for lower force numbers are the *ability to retarget* and *promptness*. Both characteristics can contribute to the quick use of nuclear weapons in conflict. Within most limited conflict scenarios, U.S. leaders are likely to take time making decisions regarding any nuclear attack against a peer, and will not necessarily face use-it-or-lose-it pressures.

Prevailing Over a Near-Peer Adversary at New START Numbers.

Tier 1. Should deterrence fail with a near-peer, the *ability to defeat defenses, accuracy,* and *promptness* are critically important to prevailing over this type of adversary (Fig. A.11).

A near-peer faces the threat of having its nuclear forces significantly degraded, and perhaps even effectively destroyed, during an initial exchange with the United States. As such, in a nuclear conflict scenario a near-peer may conclude there are significant incentives to employing a pre-emptive strike against the United States, fearing that a failure to do so will result in the United States destroying its arsenal (with weapons to spare) before it can play any meaningful role in the conflict. U.S. nuclear forces must possess the ability to quickly reach and precisely destroy a near-peer's strike capabilities, including its mobile systems.

Figure A.11:
Prevail Over a Near-Peer Adversary at NST Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Retarget	Ability to Reconstitute
Accuracy	Ability to Signal	Survivability
Promptness	Variety of Yield Options	

A near-peer does not have the same number of nuclear forces as a peer adversary, but its depth and breadth of active and passive defenses approaches that of a peer. The United States' *ability to defeat defenses* is important, to include active defenses such as anti-air systems and passive defenses such as hardened launch facilities. *Accuracy* is vital to destroying a near-peer's nuclear forces; a near-peer's mix of fixed and mobile systems and substantial nuclear complex present a diverse and disparate target set. Carrying out an attack aimed at disabling and dismantling a near-peer's ability to wage nuclear war will require a closely coordinated, highly precise series of nuclear attacks. *Promptness* is also a key characteristic for prevailing over a near-peer, which will recognize that it cannot hope to win a protracted nuclear conflict with the United States. Whether hoping to surprise the United States prior to the initiation of hostilities, attempting to prevent U.S. intervention in a regional conflict, or trying to reverse the tide of a conventional conflict going against it, a near-peer's attempt to launch a nuclear strike against the United States or its allies is likely to be both quick and stealthy. To prevent a possible preemptive strike, U.S. nuclear forces must retain the capability to promptly destroy a near-peer's nuclear forces.

Tier 2. The three Tier 2 characteristics for prevailing over a near-peer adversary are the *ability to retarget*, the *ability to signal*, and the possession of a *variety of yield options*. As with a peer adversary, the *ability to retarget* is important to ensuring that all second strike capabilities, to include mobile systems, are eliminated. The *ability to signal* remains important in a conflict scenario with a near-peer adversary, although it is not

of the same level of importance as in a deterrent posture. As with a peer adversary, once hostilities are initiated with a near-peer, the use of signaling can forestall further escalation of a conflict. Even after the introduction of nuclear weapons to the crisis, signaling can still play a role in de-escalating the crisis by means of target selection, posturing of remaining strategic forces, and communication of intent.

A nuclear exchange with a near-peer adversary will likely require a limited number of weapons; that number may need to include, however, both high-yield and low-yield weapons. In such circumstances, it is important to maintain an arsenal with a *variety of yield options.* Although neither as numerous or as dispersed as a peer adversary, a near-peer's numbers and distribution of forces will likely include hardened, sheltered nuclear forces distant from cities and bases or key command-and-control nodes near population centers or allied or neutral borders. The capability to use a *variety of yields* provides options for using relatively higher-yield weapons to destroy hardened targets and lower-yield weapons on targets where fallout risks causing significant collateral damage. The use of lower-yield weapons may also allow a near-peer to retain the capacity for national leadership to communicate to its remaining forces, even if relatively few survive after the early exchanges of a nuclear conflict, allowing near-peer forces to stand down prior to a negotiated end to hostilities.

Tier 3. If a near-peer's nuclear forces remain significantly below those of the United States, the two characteristics deemed of lesser importance to prevailing over this type of adversary are the *ability to reconstitute* and *survivability*. The *ability to reconstitute* is not of high value to prevailing over a near-peer because a nuclear conflict with this type of adversary is likely short in duration. In addition, with the United States currently maintaining a strategically significant numerical advantage that allows it to absorb a large first strike and still retain more than sufficient forces to destroy a near-peer's nuclear forces, *survivability* is a Tier 3 characteristic for U.S. forces facing off against a near-peer.

Prevailing Over a Near-Peer Adversary at Lower Numbers.

Tier 1. The most important characteristics for prevailing over a near-peer adversary are the *ability to defeat defenses*, the *ability to signal*, and *survivability* (Fig. A.12). This set of Tier 1 qualitative characteristics differs from the set identified above for prevailing over a near-peer at New START levels, with *ability to defeat defenses* and *ability to signal* replacing *accuracy* and *promptness*.

Following this shift, the Tier 1 qualitative characteristics for prevailing over a near-peer at lower numbers become identical to the Tier 1 qualitative characteristics for prevailing over a peer adversary. Just as the Tier 1 qualitative characteristics for deterring a peer and near-peer adversary become the same at lower levels of nuclear forces, the Tier 1 characteristics

for prevailing over these adversaries also become identical as forces are reduced. The fact that the characteristics for deterring and prevailing over these adversaries become identical at lower numbers demonstrates that the categories collapse from two distinct categories into one as numbers decrease.

The rationale for categorizing *ability to defeat defenses* and *ability to signal* as Tier 1 characteristics for prevailing over a near-peer at lower numbers is the same as the rationale for identifying these characteristics as critical for prevailing over a peer (see Section 6.2). *Ability to signal*, placed in Tier 2 at New START levels, moves up to Tier 1 for prevailing over a near-peer at lower numbers.[67] *Survivability* also increases in importance in prevail scenarios for both a peer and near-peer. Significantly, however, this analysis finds that *survivability* makes a more dramatic leap in the latter scenario. Whereas for a peer adversary, *survivability* shifts from Tier 2 to Tier 1 as numbers decline, for a near-peer the characteristic vaults from Tier 3 to Tier 1.

Figure A.12: Prevail Over a Near-Peer Adversary at Lower Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Accuracy	Ability to Reconstitute
Ability to Signal	Promptness	Ability to Retarget
Survivability	Variety of Yield Options	

An implicit finding that can be drawn from this development is that a threshold exists at some lower number of forces where *survivability*—heretofore not a serious concern for the United States when facing a near-peer adversary—begins to come into play when considering the requirements for successfully attacking and destroying a near-peer's nuclear forces. This is important to bilateral nuclear arms control negotiations with a peer adversary. If peer-U.S. reductions reach a level where a near-peer (particularly one building up its forces) can pose a threat to the *survivability* of the negotiating parties' nuclear forces, this recognition may lead to the initiation of multilateral nuclear arms control talks that include a near-peer at the negotiating table.

At lower numbers of nuclear forces, the United States ability to ensure the timely destruction of a near-peer arsenal while minimizing damage to itself is reduced. This diminution of capacity reduces the importance of *promptness*, so long as the *survivability* of U.S. nuclear forces remains ensured. With *survivability* elevated to Tier 1, at lower numbers the relative importance of *promptness* for prevailing over a near-peer drops to Tier 2.

Tier 2. Prevailing over near-peer and peer adversaries at lower numbers share two Tier 2 characteristics in common: *accuracy* and *variety of yield options*. When combined these two characteristics provide the flexibility to utilize nuclear forces for a wide range of contingencies, to include destroying hardened targets requiring high-yield weapons and attacking targets close to civilian populations that may require lower-yield weapons to limit potential fallout. As noted above, the remaining Tier 2 characteristic for near-peer adversaries is *promptness*. The disparity between U.S. nuclear forces and those of a near-peer, while smaller at lower numbers, still allows the United States to retain enough weapons to overwhelm a near-peer's remaining forces even if the latter strikes first.

Tier 3. The utility of regenerating forces in the midst of conflict with a near-peer adversary is minimal, especially as the United States will maintain numeric superiority even at lower numbers, placing *ability to reconstitute* in Tier 3. This disparity, even if the U.S. reduces its forces, also makes it unlikely a near-peer launches an all-out attack early within a conflict; left with no or very few weapons, the near-peer would still face significant numbers of U.S. nuclear forces. Instead, a near-peer is likely to keep a conflict limited in scope, resulting in the placement of the *ability to retarget* in Tier 3. While useful in all-out conflict where the United States needs to track and eliminate most or all of a near-peer's mobile forces, this characteristic is less vital in a limited conflict with a near-peer. Within such a conflict, a near-peer is likely to use its fixed forces early in order to keep its more survivable mobile forces in reserve. In this scenario, the *ability to retarget* is less important in the critical early stages of the conflict.

Prevailing Over a Regional Adversary at New START Numbers. Should deterrence fail, the United States must prepare to respond and succeed in a regional contingency or conflict involving nuclear forces. Many of the capabilities identified as Tier 1, 2, and 3 for regional deterrence retain the same relative value for prevailing over a regional adversary in a conflict involving the use of nuclear forces. This reflects the fact that the latter's nuclear forces are relatively small in number and have a very limited capability (or no capability) to directly threaten the United States. Those characteristics that deter regional powers by putting their limited nuclear forces at risk (viewed as their only guarantee of survival) would also lead to these forces being rapidly eliminated by the United States in any conflict with a nuclear dimension—to be followed by a swift defeat by the armed forces of the United States and its regional allies.

In the assessment of the research team, the only two qualitative characteristics that change in value between the "deter" and "prevail" matrixes at New START force levels for this scenario are *variety of yield options* and the *ability to defeat defenses*.

Maintaining a *variety of yield options* rises in importance when regional deterrence fails and the United States must engage in armed

conflict. Although regional actors are unlikely to differentiate between various yields when deterring threats, the United States will seek to damage or defeat highly valued assets with minimal impact to civilians, nearby allies and partners, and U.S. assets. The importance of the *ability to defeat defenses*, however, is reduced. For nuclear operations at current force levels, even if a regional power devotes considerable resources to defending key assets the United States possesses more than enough numbers to achieve the desired effect against this adversary (for example, U.S. forces could devote, if necessary, multiple warheads to defeat a regional power's hardened targets). Although military commanders always prefer to defeat a target during the first attempt, given the size of current U.S. nuclear forces it is not essential for prevailing over a regional power.

Figure A.13:
Prevail Over a Regional Adversary at NST Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Survivability
Variety of Yield Options	Ability to Signal	

Tier 1. *Accuracy*, *promptness*, and *variety of yield options* are Tier 1 characteristics for prevailing over a regional adversary (Fig. A.13). *Variety of yield options* rises in importance when regional deterrence fails and the United States must engage in armed conflict. Although regional adversaries are unlikely to differentiate between various yields when deterring threats, the United States will seek to damage or defeat highly valued assets with minimal impact to civilians, nearby allies and partners, or U.S. assets.

Accuracy and *promptness* ensure that U.S. nuclear forces can quickly destroy a regional adversary's small nuclear forces without using significant numbers of weapons, and prevent it from conducting any strikes of its own against the United States or allied targets. Together with *variety of yield options*, these characteristics also ensure that a U.S. nuclear response can remain limited and will not result in large amounts of fallout.

Tier 2. *Ability to defeat defenses*, *ability to retarget*, and the *ability to signal* are Tier 2 characteristics for prevailing over a regional adversary.

Regional adversaries are likely to devote significant resources to defending their limited nuclear forces, to include investing in robust passive and active defenses. The *ability to defeat defenses* is important for prevailing over a regional adversary, but it does not rise to Tier 1 because at current force levels the United States possesses enough forces to conduct repeated strikes on any of a regional adversary's hardened targets that

successfully survive an initial attack. While defeating a hard and deeply buried asset during the first attempt is ideal, given the size of current U.S. nuclear forces it is not essential for destroying a regional adversary's nuclear forces.

A regional adversary is also likely to take steps to move its forces or key parts of its command-and-control systems. The *ability to retarget*—as with *ability to defeat defenses*—is an important qualitative characteristic, but its importance is mitigated by the large numerical advantage enjoyed by the United States. At New START numbers, the United States can use multiple delivery systems and weapons to target all regional adversary nuclear forces, whether fixed or mobile.

The *ability to signal* also has utility in nuclear conflicts with a regional power, although its level of importance is not enough to supplant the characteristics in Tier 1. The stress of a nuclear crisis or conflict may have a negative impact on the ability of a regional adversary to maintain cohesiveness within its military chain of command and between government and military leaders, and may also affect its ability to communicate with other states. The *ability to signal* with nuclear forces may play a key role in conflict termination, as a regional adversary may only partly understand or receive other diplomatic or military signals. Attempting to signal with nuclear forces, however, may also carry some risk in regard to a party that is at a significant disadvantage within any conflict. The latter may conclude, for example, that the United States is intent on destroying or humiliating it (if it interprets the signal as escalation) or that the United States is so concerned about any damage or further damage to itself and its allies that it is willing to sue for peace (if it interprets the signal as de-escalation).

Tier 3. The *ability to reconstitute* and *survivability* are Tier 3 characteristics for prevailing over a regional adversary. Due to the broad gap in numbers between the nuclear forces of a regional adversary and the United States, any conflict involving these forces is likely to be short in duration and only use a small part of the latter's arsenal. The United States will not have to reconstitute its forces for any conflict scenario involving a regional adversary. This numerical disparity also places *survivability* in Tier 3; on a system-by-system basis, even if a regional adversary launched a highly successful and lethal strike against the United States, due to its overall numerical advantage the large number of surviving delivery systems allow the United States to easily prevail using only a fraction of its remaining forces.

Figure A.14:
Prevail Over a Regional Adversary at Lower Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Survivability
Variety of Yield Options	Ability to Signal	

Prevailing over a Regional Adversary at Lower Numbers. As numbers of nuclear forces

moderately decline, the relative value of the qualitative characteristics required for prevailing over a regional power in a nuclear conflict remain unchanged. *Accuracy*, *promptness*, and *variety of yield options* continue to remain critical (Fig. A.14).[68] Even at reduced numbers, U.S. nuclear forces remain qualitatively and quantitatively superior to the limited nuclear forces of a regional power. This force imbalance will continue to put pressure on a regional power to consider pre-emptive strikes to gain some value out of a force likely to be completely wiped out by the United States once major hostilities were underway (if the United States perceived a nuclear threat). To respond to a regional power preparing to cross the nuclear threshold—while also limiting collateral damage—the United States will retain a need within a reduced arsenal for prompt, accurate weapons with a range of yields, with low-yield weapons favored for a regional scenario to reduce the impact of the conflict on nearby allies.

Prevailing over an ANSA at New START Numbers.

Tier 1. Mobile, opaque, and committed to asymmetric forms of warfare, ANSAs pose a number of unique challenges within any conflict involving nuclear forces. Prevailing over an ANSA requires *prompt* and *accurate* nuclear forces with a *variety of yield options*. If possible, the United States would seek to use non-nuclear means to destroy a nuclear weapon or weapons in the hands of an ANSA. Moreover, the United States would also consider excellent real-time intelligence, surveillance, and reconnaissance data fixing the location of an ANSA as a prerequisite to readying a nuclear strike against this type of adversary. If such a target were identified and confirmed, however, speed and precision would be of the essence. In addition, with ANSAs often operating without the knowledge or consent of the host community or state, the United States may consider the use of a low-yield nuclear weapon to eliminate the ANSA nuclear threat.

Tier 2. *Ability to defeat defenses* and *ability to retarget* are Tier 2 characteristics for prevailing over an ANSA. ANSAs are unlikely to have sophisticated active defenses, but will seek to employ passive defenses (e.g. sheltering in a network of caves). Because the former are limited or nonexistent, but the latter may provide them significant protection, the *ability to defeat defenses* is placed in Tier 2. The *ability to retarget* is

Figure A.15:
Prevail Over an ANSA at NST Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Ability to Signal
Variety of Yield Options		Survivability

potentially important within the types of scenarios where the United States might contemplate using a nuclear weapon against an ANSA. Given the likelihood that a key part of an ANSA's defense strategy is embedding itself within an unwilling (or unaware) host state, the relative importance of the *ability to retarget* does not change the prioritization of the qualitative characteristics placed within Tier 1 above, as these characteristics ensure the effective calibration, targeting, and execution of any strike. As a result, *ability to retarget*—while a desired characteristic for combating a nuclear-armed ANSA—is placed in Tier 2.

Tier 3. The *survivability* of U.S. nuclear forces is not an issue within a nuclear contingency or conflict with an ANSA; even in the unlikely event an ANSA mounted an attack on U.S. nuclear forces—whether by conventional or unconventional means—it would lack the resources to wage an attack on the scale required to threaten U.S. second strike capabilities.

Furthermore, once a conflict with an ANSA is underway, the *ability to signal* is of limited utility. In any armed conflict with the United States, an ANSA is likely to assume it faces the possible threat of being overwhelmed and destroyed by U.S. forces, whether conventional or nuclear. Any signals sent by the United States in regard to nuclear forces are unlikely to change its threat calculus. The stress of a conflict, particularly one that involves nuclear forces, may also affect the ability of an ANSA to receive, process, and respond to any form of signal.

The *ability to reconstitute forces* would not play a significant role in combating or defeating an ANSA. Any conflict is likely to involve only a small number of nuclear forces and warheads at the very low end of the spectrum of destructive power available across the U.S. arsenal. The United States would not need to reconstitute its nuclear forces during a nuclear contingency or conflict involving an ANSA.

Prevailing Over an ANSA at Lower Numbers. Similar to a regional power, the gap between the numbers of nuclear forces in the possession of the United States and a nuclear-armed ANSA remain enormous even if U.S. nuclear forces experience dramatic reductions. Moreover, an ANSA's nuclear strategy—remain opaque, operate covertly, and use its limited forces on a high-profile strike—is not linked to an adversary's numbers of nuclear forces. At lower numbers,

Figure A.16:
Prevail Over an ANSA at Lower Numbers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
Promptness	Ability to Retarget	Ability to Signal
Variety of Yield Options		Survivability

promptness, *accuracy*, and a *variety of yield options* remain the key qualitative characteristics for prevailing over an ANSA determined to initiate a nuclear conflict with the United States. These qualities are imperative to any nuclear strike aimed against an adversary whose nuclear operations will likely only present small, fleeting targets within environments where limiting fallout is essential.

A.4 Assuring Allies

For nearly 60 years U.S. nuclear forces have assured allies and partners that the United States is committed to their defense and will employ all necessary means to deter nuclear-armed aggressors. This commitment to "extend" nuclear deterrence is an important component of the U.S. relationship with a number of key states, including several that might otherwise pursue their own nuclear weapon programs. In addition, the list of potential adversaries included in U.S. deterrence calculations—and of concerns to U.S. allies—continues to grow.

Assuring Allies at New START Numbers.

Tier 1. The *ability to signal*, *promptness*, and *ability to reconstitute* are Tier 1 qualitative characteristics for assuring U.S. allies (Fig. A.17). The research team recognized that the requirements of extended deterrence differ from those required to deter or prevail over potential adversaries.

U.S. allies include NATO member states in Europe as well as allies and partners across Asia and the Middle East. While each relationship with individual allies possesses its own political considerations that impact the ability to provide a credible extended nuclear deterrent, several overarching qualitative characteristics apply to any ally under the U.S. nuclear umbrella. The United States' ability to assure an ally that it can and will protect them can only succeed if both the ally and their potential adversaries perceive the potential use of these nuclear forces as credible. For many allies, the *ability to signal* is the most important qualitative characteristic of U.S. nuclear forces. They want the United States to visibly communicate to all parties that U.S nuclear forces will defend America's allies against external threats. Nuclear forces capable of clearly signaling intent to both allies and adversaries strongly reinforce U.S. declaratory policy and openly demonstrate that the United States is prepared to fulfill its extended deterrence commitments.

Figure A.17: Assure Allies at NST Numbers		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Reconstitute	Ability to Defeat Defenses	Ability to Retarget
Ability to Signal	Accuracy	Survivability
Promptness	Variety of Yield Options	

Lower Numbers

Allies facing nuclear-armed adversaries also desire protection from nuclear forces that can act quickly in response to any nuclear threat, placing *promptness* in Tier 1 for the purposes of assurance. In addition, U.S. nuclear forces' *ability to reconstitute* in a manner ensuring that a crisis abroad (or an issue with a delivery system or warhead type) does not result in gaps of coverage in terms of geography or adversary forces is also important to allies. This qualitative characteristic assures allies by demonstrating that the United States has the ability to mobilize additional forces and configure them to address a broad range of threats (Fig. A..17).

Tier 2. The *ability to defeat defenses*, *accuracy*, and *variety of yield options* fall under Tier 2 for assuring allies. Allies have an interest in the United States maintaining a *variety of yield options* and fielding forces with high *accuracy*. They are acutely aware of the consequences of nuclear conflict within their respective regions. Nuclear fallout from a regional conflict, for example, will have a much greater impact on local U.S. allies than on the United States. If deterrence failed and a nuclear crisis or conflict appeared likely to occur, many allies would press the United States to limit its planning to small numbers of accurate, low-yield weapons in order to limit fallout and collateral damage. Allies also recognize the value of the *ability to defeat defenses*; they want the United States to have a highly lethal force that can assuredly destroy adversary arsenals, to include adversaries that develop robust passive and active defenses. Allies, however, are first and foremost concerned that the United States clearly and continuously demonstrates the will to use its nuclear forces to come to their aid in a crisis. The *ability to defeat defenses* is of secondary importance to allies in comparison to the Tier 1 qualitative characteristics that visibly demonstrates they are under the U.S. nuclear umbrella.

Tier 3. This analysis assessed *ability to retarget* and *survivability* as the qualitative characteristics least important to the assurance of U.S. allies. For these states, characteristics associated with the United States prevailing within a major, protracted nuclear conflict are less relevant than those that they associate more closely with ensuring deterrence does not fail within their region (or if it does, keeps the conflict short and limited). For allies, the degree to which U.S. nuclear forces are visible is more important than the degree to which they are invulnerable.

Assuring Allies at Lower Numbers. At numbers moderately below New START levels, the research team determined there was no change in the relative value of qualitative characteristics associated with the objective of assuring U.S. allies (Fig. A.18). *Ability to signal*, *promptness*, and the *ability to reconstitute* remain the key qualitative characteristics for U.S. nuclear guarantees to its allies. These characteristics are unlikely to change unless U.S. nuclear forces are reduced to very lower numbers below the levels considered by this report's analysis. Subject matter experts interviewed for this report repeatedly emphasized that the United States' ability to visibly demonstrate political will to use nuclear force to uphold extended deterrence commitments will remain of primary importance to U.S. allies and partners, even at lower numbers. The *ability to signal* continues to be the key characteristic of nuclear forces enabling the United States to convey this commitment. The *ability to reconstitute* and *promptness* also maintain their importance as Tier 1 characteristics. Together these three qualitative characteristics give U.S. allies confidence that the United States, as promised, will clearly, quickly, and effectively respond in the event they face a nuclear threat.

Figure A.18: Assure Allies at Lower Numbers		
Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Reconstitute	Ability to Defeat Defenses	Ability to Retarget
Ability to Signal	Accuracy	Survivability
Promptness	Variety of Yield Options	

A.5. Graphical Depiction of Movement between Tiers across Scenarios

The following two charts display the overall movement of qualitative characteristics across Tiers as the United States moves from New START numbers of nuclear weapons to lower numbers. To assist with tracking the movement and location of characteristics, and to aid with comparisons across missions and/or adversaries, each qualitative characteristic is displayed below in a different color (the colors have no intrinsic meaning; they are simply useful in helping the reader follow the characteristics across charts). The first chart (Fig. A.19) displays deter and assure missions, the second (Fig. A.20) the requirements for prevailing in a conflict should deterrence fail. As there is no prevail mission associated with allies, this category of geopolitical actor drops off the second chart. The lack of arrows for some actors is due to the fact that there is no change identified as the United States moves from New START numbers of nuclear weapons to lower numbers.

Actors	Figure A.19: Movement from NST Numbers to Lower Numbers: Deter and Assure		
	Tier 1 (most important)	Tier 2	Tier 3 (least important)
Peer	Ability to Defeat Defenses Ability to Reconstitute Survivability	Ability to Signal ← Accuracy Promptness →	Ability to Retarget Variety of Yield Options
Near-Peer	Ability to Defeat Defenses Ability to Reconstitute Ability to Signal → ←	Accuracy → Promptness ← Survivability	Ability to Retarget Variety of Yield Options
Regional	Ability to Defeat Defenses Accuracy Promptness	Ability to Retarget Ability to Signal Variety of Yield Options	Ability to Reconstitute Survivability
ANSAs	Accuracy Promptness Variety of Yield Options	Ability to Retarget Ability to Signal	Ability to Defeat Defenses Ability to Reconstitute Survivability
Allies	Ability to Reconstitute Ability to Signal Promptness	Ability to Defeat Defenses Accuracy Variety of Yield Options	Ability to Retarget Survivability

Actors	Figure A.20: Movement from NST Levels to Lower Levels: Prevail		
	Tier 1 (most important)	Tier 2	Tier 3 (least important)
Peer	Ability to Defeat Defenses		Ability to Reconstitute
		Ability to Retarget	
	Promptness		
		Ability to Signal	
	Survivability		Variety of Yield Options
		Accuracy	
Near-Peer	Ability to Defeat Defenses		Ability to Reconstitute
		Ability to Retarget	
	Accuracy		
			Survivability
		Ability to Signal	
	Promptness		
		Variety of Yield Options	
Regional	Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
	Promptness	Ability to Retarget	Survivability
	Variety of Yield Options	Ability to Signal	
ANSAs	Accuracy	Ability to Defeat Defenses	Ability to Reconstitute
	Promptness	Ability to Retarget	Ability to Signal
	Variety of Yield Options		Survivability

APPENDIX B: QUALITATIVE CHARACTERISTICS OF NUCLEAR FORCES AND CURRENT U.S. DELIEVERY SYSTEMS

This appendix discusses each of the four types of current U.S. nuclear delivery systems in terms of the eight variable characteristics highlighted in the Qualitative Characteristics final report. The four types of systems are intercontinental ballistic missiles, submarine-launched ballistic missiles, bombers, and dual-capable aircraft.

B.1 Intercontinental Ballistic Missiles (ICBMs)

The United States fields 450 Minuteman III ICBMs deployed across the central plains of the continental United States. There are currently three wings of 150 missiles each at Minot AFB, North Dakota, Malmstrom AFB, Montana, and FE Warren AFB, Wyoming. Under New START, it is anticipated that the United States will retain a maximum of 420 deployed Minuteman IIIs.[69]

Accuracy: U.S. ICBMs are highly accurate. During the Cold War, U.S. ICBMs were generally viewed as more accurate than their Soviet counterparts.[70]

Ability to Defeat Defense: At present, ICBMs are not vulnerable to air defenses and are able to overcome many passive defenses due to the reentry vehicle's speed at terminal velocity and the yield of its warhead. The Minuteman III has a range of over 6,000 miles.[71] With these capabilities, ICBMs are able to credibly hold large categories of adversary targets at risk, although overflight concerns may limit the use of ICBMs against certain adversaries.

Promptness: The ICBM force is the most prompt delivery system of the U.S. nuclear triad, taking approximately one minute to launch following the confirmed receipt of a command to fire.[72] The Minuteman III travels 15,000 miles per hour at burnout.[73] Thus, its time to target is only 15-30 minutes before striking targets in Eurasia.

Ability to Reconstitute: The Minuteman III can carry more than one warhead. As stated by the 2010 NPR, the United States will move to a "deMIRVed" ICBM force, with each Minuteman III carrying only one warhead.[74] It remains possible, however, to upload additional warheads on each Minuteman III.[75] The upload time for doing so would be days, months, or years depending on factors such as weather, safety and security considerations, and the need to sustain a survivable deterrent capability while uploading operations were underway.[76]

Ability to Retarget: ICBMs are not currently targeted against any adversary. Instead, their warheads are targeted against "open ocean areas" as a confidence building measure with the Russian Federation, and to minimize damage in case of accidental launch. According to the 2010 NPR, ICBMs and SLBMs will continue the practice of open-ocean targeting, with

an ability to rapidly input new targeting data prior to launch.[77] ICBMs are not able to retarget in flight.

Signaling: ICBMs have a lower visible signaling capability compared to the bomber force; as a fixed system, it cannot deploy to other locations. However, the United States could deliver signals regarding the delivery system via other means. For example, the president could announce the abandonment of open-ocean targeting for ICBMs. In addition, loading or unloading missiles from silos, while time-consuming, could send a strong escalation or de-escalation signal to an adversary in possession of satellites capable of monitoring U.S. ICBM fields. For this type of adversary, significantly increasing the numbers and types of key vehicles on ICBM bases, such as vehicles associated with maintenance crews or deliveries of vital supplies, could also send signal an increase in the readiness of the ICBM force.

Survivability: Land-based ICBMs embody a formidable second-strike capacity. Every individual missile silo is hardened with heavy blast doors and buried in the earth. The promptness of ICBMs also boosts the survivability of this delivery system due to its ability to rapidly launch in the face of an incoming enemy attack. Moreover, the dispersal of missile fields across western CONUS creates a targeting dilemma for potential adversaries, who must employ multiple warheads against each individual missile silo to guarantee its destruction.

Variety of Yield Options: In accordance with the 2010 NPR, the entire ICBM force is slated to carry a single W87 warhead.[78] Minutemen IIIs can also carry the W62 or W78 warheads.[79]

B.2 Ballistic Missile Submarines (SSBNs)

The United States operates fourteen *Ohio* class ballistic missile submarines, with four "boats" on patrol at any given time. Under the NST it is anticipated that nuclear submarines will carry a fleet total of approximately 240 missiles (with 1,070 warheads) by 2017.[80] U.S. SSBNs carry Trident II (D-5) submarine-launched ballistic missiles (SLBMs).[81]

Accuracy: The U.S. Navy states that SSBNs are "designed specifically for … precision delivery of nuclear warheads."[82] Without providing specific details regarding CEP, a 1993 Congressional Budget Office report noted that the deployment of the Trident II "improved [SLBM] accuracy dramatically …. for the first time [an SLBM was] on an equal footing with the most modern land-based missiles."[83]

Ability to Defeat Defenses: SLBMs are not vulnerable to air defenses. The Trident II's range is 7,456 miles; as such, for many targets these weapons can be launched from the safety of U.S. waters.[84]

Promptness: An SSBN on patrol can launch its missiles relatively quickly after receiving an order to fire. In order to receive the specific order the submarine must surface, however, so an SLBM is less prompt than an

ICBM, and may be more or less prompt than a bomber depending on the location of the aircraft relative to the target.

Ability to Reconstitute: Each SSBN currently carries up to 24 Trident II SLBMs with up to 8 re-entry vehicles per missile, for a maximum total of 192 warheads per boat. The United States plans to reduce the number of SLBM tubes from 24 to 20 on all 14 submarines within the current fleet.[85] New START stipulates that SLBM launch tubes are eliminated "by removing all missile launch tube hatches, their associated superstructure fairings, and, if applicable, gas generators."[86] Although the treaty does not require removing the entire tubes, these procedures are intended to prevent them from carrying or launching ballistic missiles. It may be possible, albeit likely time-consuming and expensive, to restore the eliminated launch tubes at some point in the future (in the unlikely event the United States felt it were necessary to increase the number of SLBMs carried by the submarine fleet in order to address geopolitical change). Reconstituting SLBM tubes "eliminated" by New START is likely easier than creating new ICBM silos, however.

Ability to Retarget: SLBMs have no pre-set targets when the submarines go on patrol but are capable of rapid retargeting using secure at-sea communication links. Once in flight, SLBMs cannot change their target.

Signaling: Nuclear submarines have low visible signaling capability compared to the bomber force, which can be forward deployed. A submarine could surface in order to signal resolve, but this action would undermine its survivability. In order to signal to adversaries and allies, the president could announce that additional submarines have gone on patrol, but adversaries (and allies) would not be able to independently verify the credibility of this statement.

Survivability: The 2010 NPR states that submarines at sea are traditionally considered the most survivable leg of the U.S. nuclear triad.[87] Submarines on patrol are currently viewed as essentially undetectable by potential adversaries. The NPR indicates, however, that although there appear to be "no viable near or mid-term threats to the survivability" of U.S. nuclear submarines, such threats "cannot be ruled out" in the future.[88]

Nuclear submarines are most vulnerable when they are in port. SSBNs spend approximately 77 days at sea and 35 days back in port on each rotation.[89] Every nine years the submarines must go into overhaul for an extended period of time. The United States' two submarine ports (and primary locations for overhaul) are located at Bangor, Washington and King's Bay, Georgia. A reduction in nuclear forces that leads to the elimination of one of these facilities (for cost savings or other purposes) could have significant strategic consequences. First, the vulnerability of the SSBNs would increase by only having one port for docking. Second, the ships would face increased challenges in meeting the requirements of both Atlantic and Pacific patrolling missions.

Variety of Yield Options: SLBMs carry two different warheads: the W76 and the W88. Each missile must be loaded with either the W76 or W88 warhead, but SSBNs can carry a mixture of missiles of each warhead type.

B.3 Heavy Bombers

The 2010 Nuclear Posture Review (NPR) states that the long-range bomber, defined as "heavy bomber" in the first Strategic Arms Reduction Treaty (START), remains an important leg of the U.S. nuclear triad, as it represents the best delivery system for signaling U.S. intent in a crisis.[90] Bombers also provide a critical hedge against any potential failures in U.S. nuclear ballistic missile forces. The United States utilizes two bomber platforms for nuclear weapon delivery: the B-52H and B-2A. There are currently 76 operational and 2 test B-52Hs located at Minot Air Force Base, North Dakota, Barksdale Air Force Base, Louisiana, and Edwards Air Force Base, California, and 18 operational and 2 test B-2As located at Whiteman and Edwards Air Force Bases.[91]

Accuracy. Bombers can deliver weapon systems with high levels of accuracy, although traditionally the ICBM and SLBM legs are considered more accurate. Continual improvements to weapons guidance systems for cruise missiles and gravity bombs have increased the accuracy of bombers.

Ability to Defeat Defenses. The bomber's ability to defeat defenses compared to other weapon platforms is mixed. Bombers have greater difficulty in penetrating enemy air defenses than SLBMs or ICBMs. The B-2A bomber has a higher probability than the B-52H in penetrating active defenses due to its low-observable stealth technology and capability for low-altitude, terrain-following missions. There are plans, however, to replace the B-52H fleet's current radar, which would permit it to fly low-level flight patterns.[92]

Promptness. The period of time needed for heavy bombers to reach most targets is significantly greater than for ICBMs or SLBMs. The B-52H has an unrefueled range of 7,652 nautical miles and can fly at speeds up to 650 miles per hour.[93] The B-2A has an approximate unrefueled range of 6,500 nautical miles and flies at high subsonic speed.[94] The promptness of bombers also depends upon their alert status. The 2010 NPR upheld an earlier decision not to keep nuclear-capable heavy bombers on full alert, and their readiness status may vary from base to base.[95]

Ability to Reconstitute: Heavy bombers have the ability to reconstitute in that the alert status of aircraft can be changed in reaction to any geopolitical situation. This includes preparing as much of the bomber force as necessary for operational missions.

Ability to Retarget: The ability to retarget is a historical strength of the bomber in comparison to other nuclear delivery systems, as bombers can be recalled or have their targets modified once in flight. This characteristic

will be further enhanced in the future, as the USAF is planning modifications to the B-52H through the Combat Network Communications Technology (CONECT) program. This upgrade program will include improvements enabling weapon retargeting during flight.[96]

Ability to Signal: One key advantage of the bomber is its usefulness to political leaders for signaling purposes. Since bombers can be dispersed to various locations around the world within a relatively short period of time (typically less than 24 hours) and then later recalled, they serve as an effective signaling tool. The forward deployment of heavy bombers, for example, can visibly demonstrate U.S. resolve and commitment to allies in a way that ICBMs and SLBMs cannot.

Survivability: The survivability of bombers compared to ICBMs and SLBMs is low, particularly when heavy bombers are located at their primary airbases, leaving them susceptible to an adversary's first strike. However, the survivability of bombers increases if aircraft are generated, placed on alert, or dispersed to alternate airfields.

Variety of Yield Options: The B-52H and the B-2A can carry the B-61 mods 7 and 11, and the B-83 mods 0 and 1, "strategic" nuclear bombs.[97] The B-52H can also carry AGM-129A cruise missiles.[98] B-52Hs can carry a payload of approximately 70,000 lbs of mixed ordinance (such as bombs, mines, and missiles), which includes the ability to carry up to 20 air-launched cruise missiles (ALCMs). B-2As can carry a payload of approximately 40,000 lbs.[99]

B.4 Dual Capable Aircraft (DCA)

The 2010 NPR announced the planned retirement of the Navy's nuclear-equipped Tomahawk cruise missile (TLAM-N), leaving Air Force dual capable aircraft (DCA)[100] as the only remaining delivery system for U.S. tactical nuclear weapons.[101] The U.S. DCA fleet currently consists of F-15Es and F-16C/Ds, which were first produced in 1988 and 1981, respectively. In the future the F-35 Joint Strike Fighter will replace these aircraft.[102]

DCA are capable of carrying both conventional and nuclear payloads, specifically the B61 nuclear gravity bomb, of which the U.S. has various types (mods 3, 4, and 10 are the tactical variants).[103] The United States plans to conduct a full-scope Life Extension Program (LEP) on the B61 to ensure its functionality with the F-35 and to make enhancements to surety features.[104] Per the NPR, the first production of the LEP B61 is expected to begin in fiscal year 2017.[105]

DCA serve a unique role in the nuclear mission. In addition to being the only remaining non-strategic nuclear delivery system, they underscore U.S. extended deterrence commitments, particularly in NATO. DCA are forward deployed, along with a small number of B61 bombs, in the European theater in support of NATO nuclear mission.

Accuracy: DCA are capable of flying at low altitudes, day or night, in all weather conditions, and are highly maneuverable. The F-15E is equipped with the low-altitude navigation and targeting infrared for night (LANTIRN) system that provides high levels of accuracy in weapons delivery.[106] The combination of these capabilities may increase the chances of DCA penetrating enemy air defenses and delivering an accurate, precise strike on a target.

Ability to Defeat Defenses: The ability of DCA to defeat robust active and passive defenses is questionable. DCA would require significant conventional air support to conduct a nuclear strike mission. They lack a nuclear stand-off capability and can only employ gravity bombs. There is significant risk to aircrew within a hostile environment, particularly against adversaries with modern air defense systems.

Promptness: The F-15E and F-16 can fly a maximum unrefueled range of 2,000-2,400 miles, requiring aerial refueling to fly further. As such, DCA are not considered prompt systems for the employment of nuclear weapons, although they can be forward deployed to reduce flight time.

Ability to Reconstitute: Reconstitution—the ability to generate DCA forces (and the necessary air support) in a no-warning contingency scenario, and the ability to upload those DCA—requires some lead-time. NATO DCA readiness, for example, is measured in months.[107]

Ability to Retarget: DCA provide flexibility to the U.S. nuclear force through their ability to change the desired point of impact of an attack while the aircraft is in flight. This allows DCA to be responsive to changes in the operational environment, such as adversary movement or repositioning of assets.

Ability to Signal: In peacetime, DCA can facilitate transparency and predictability by maintaining regular day-to-day operations. In times of crisis, the forward deployment of additional DCA worldwide can provide a valuable signal of U.S. resolve and commitment.

Survivability: The survivability of DCA is relatively low as long as aircraft are not placed on alert. Current DCA air bases are well known and can be targeted in a time of war.

Variety of Yield Options: DCA can carry three versions of the B-61 gravity bomb (mods 3, 4, or 10).[108]

APPENDIX C: IMPACT OF ARMS CONTROL ON INDIVIDUAL QUATLITATIVE CHARACTERISTCIS

C.1 Introduction

This project assessed the impact of nuclear force reductions on eight qualitative characteristics of nuclear forces in terms of their relative importance to each other. All of these characteristics are important, but as

numbers are reduced it may become difficult or impossible to maintain all eight in strength. In the future, U.S. arms control negotiators may consider whether regulating or limiting one or a small handful of qualitative characteristics within a mutually binding pact with other nuclear states can improve U.S. national security, promote strategic stability between nuclear powers, reduce the risk of future nuclear conflict, or achieve other positive outcomes.

This appendix addresses the potential impact of arms control provisions on each of the research project's eight variable characteristics, taking past arms control treaties and agreements as models for identifying the types of provisions likely to be included in a future nuclear arms control treaty. It does not weigh the merits of implementing any of the arms control measures discussed below; they are provided merely to illustrate and/or discuss the general relationship between arms control agreements and qualitative characteristics of nuclear forces.

C.2 Ability to Defeat Defenses

A number of technologies exist that are directly associated with improving the ability of delivery systems and warheads to defeat active defenses, including ballistic missile penetration aids, MIRV capabilities, and "stealth" materials. Stealth materials, for example, prevent radars from observing or tracking aircraft entering sovereign airspace, improving their ability to slip unnoticed through air defense networks and launch attacks on targets deep within an opponent's territory. Arms control provisions limiting or banning any of these technologies would degrade the ability of signatory states' nuclear forces to defeat defenses.

C.3 Ability to Reconstitute

Numerical ceilings for forces limit the *ability to reconstitute*, as forces can only be deployed or replaced up to a certain number as specified within an agreement. Arms control treaties or agreements may seek to improve strategic stability by reducing numbers of forces without necessarily reducing the parties' *ability to reconstitute*. For example, two sides may reach an agreement to reduce the number of deployed delivery systems and/or warheads, removing them from operational bases and placing them in storage areas (this type of agreement would also reduce the *promptness* of nuclear forces, as discussed below). Such measures do not necessarily have a significant impact on the *ability to reconstitute* forces, however, if returning delivery systems or warheads to operational status is not a complex or lengthy process. Treaty language requiring procedures that irreversibly damage or dismantle delivery systems or warheads, permanently removing them from a state's arsenal, weaken this qualitative characteristic.[109] An alternative to limiting reconstitution is taking measures to increase transparency regarding the reconstitution of forces—or lack thereof—in order to promote stability between major nuclear powers.

C.4 Ability to Retarget

At present bombers and DCA are the only delivery systems capable of retargeting in flight. Arms control agreements cutting the numbers of bombers or DCA, or limiting or banning certain types of aircraft within these categories, reduce or eliminate this qualitative characteristic within a nuclear force.[110]

C.5 Ability to Signal

Nuclear powers may communicate signals in a variety of ways, to include rhetoric, changing the alert levels of forces, or redeploying nuclear forces. In the past, U.S. decision-makers have used the movement of bombers from U.S. territory to overseas bases to visibly signal U.S. resolve to both adversaries and allies. For this reason, any future treaty or agreement limiting or banning the bomber's nuclear mission—or eliminating bombers—may reduce the ability to visibly signal intent or a change in posture. An arms control treaty or agreement placing limits on the numbers of forces within certain geographic areas (such as the CFE Treaty's overall limits on numbers of different types of military forces in central Europe), or entirely banning the presence of nuclear forces in a specific region, could hinder the ability of nuclear forces to signal through forward deployments to other countries.[111]

C.6 Accuracy

To date, no arms control agreement has featured provisions regarding the qualitative characteristic of *accuracy*. This qualitative characteristic is not measurable or verifiable using current techniques and technologies. Nuclear powers with a very stable strategic relationship and an extremely high degree of confidence in the *accuracy* of their respective delivery systems might consider some type of exchange of information on the CEP of their delivery systems as a confidence-building measure. This level of transparency, however, is beyond most nuclear states, as an exchange of information revealing that one side had less accurate systems could upset the strategic balance between non-allied nuclear powers.

The United States is extremely unlikely to consider any future arms control agreement trading or marginalizing the *accuracy* of its nuclear forces.

C.7 Promptness

Negotiators attempting to reduce tensions between nuclear powers could seek to reduce the *promptness* of nuclear forces by drafting treaty provisions or agreements taking these forces off alert status, although the definition of "alert" may vary from system to system.[112] Furthermore, an arms control agreement could take an additional step to significantly reduce *promptness* by mandating that nuclear warheads remain physically separate from delivery systems.

C.8 Survivability

The *survivability* of nuclear forces rests on a number of factors, to include the physical properties of the delivery systems, their operating environments, and their defenses. Arms control agreements can seek to increase the vulnerability of the negotiating parties' nuclear forces by limiting or banning certain types of defenses geared to boost the *survivability* of these forces. The 1972 Anti-Ballistic Missile Treaty (and its 1974 Protocol), for example, limited signatory missile defense systems to one site with no more than 100 interceptors. Other steps to reduce *survivability* could include provisions to keep some or all of a certain type of nuclear force out of an operating environment that might increase its chances of launching a nuclear strike in time of conflict; for example, an agreement could keep bombers in hangers and submarines in port or in dry dock.

Measures providing information regarding the location and/or readiness of nuclear forces also exchange a degree of *survivability* for greater mutual transparency. All parties involved may feel more secure with greater information on other states' nuclear forces, but each is also more vulnerable as all participants have more data regarding when, where, and how to launch attacks capable of knocking out significant numbers of another state's delivery systems. For example, banning shrouding of nuclear warheads from a treaty including on-site inspections of nuclear forces would provide states' parties information on exactly how many warheads were carried by each inspected delivery system.

C.9 Variety of Yield Options

Traditionally, the United States keeps most information regarding weapon yields classified. There is precedent, however, for limiting the yield of nuclear weapons tests. The 1974 Threshold Test Ban Treaty limited nuclear tests to 150 kilotons or lower. Conceivably, a future arms control treaty could restrict the *variety of yield options* within a nuclear arsenal; for example, state parties to a future pact could agree to a ceiling for nuclear weapon yields, eliminating (or pledging not to build) any warheads above this limit.

Precedent also exists for eliminating an entire class of weapons—the 1987 INF treaty eliminated all missiles with a range of 500 to 5,500 kilometers. If an arms control agreement eliminated a class of weapons—such as tactical nuclear weapons—it might also effectively limit the *variety of yield options* within an arsenal (in this example, by eliminating an entire type of lower-yield warheads).

With *variety of yield options* representing an area relatively unaffected by arms control, future efforts to increase the transparency of nuclear arsenals may lead to calls for nuclear states to provide information regarding the yield of their warheads. The impact of this type of CBM on strategic stability may ultimately depend on the general state of relations

between the nuclear states considering such an agreement. A nuclear state may view another nuclear state's *variety of yield options* as a positive indication the latter is concerned about maintaining control over the escalation of a nuclear conflict, and as such is a stable, responsible nuclear power. If the two states do not enjoy good relations, however, the former may view the latter's *variety of yield options* as reflecting a willingness to cross the nuclear threshold early within a conflict and/or blur the distinction between conventional and nuclear wars.

APPENDIX D: QUALITATIVE CHARACTERISTICS OF NUCLEAR FORCES AND MAINTAINING STRATEGIC STABILITY

D.1 Maintaining Strategic Stability with Major Nuclear Powers

According to the 2010 NPR, a key role of U.S. nuclear forces is to "maintain strategic stability" with major nuclear powers. While "maintain stability" was not a scenario considered within the research project, during the course of the analysis it became apparent that the relationship between nuclear weapons and strategic stability could be assessed using a similar methodological approach as that employed for determining the key qualitative characteristics of nuclear forces associated with deter, prevail, and assure objectives. Accordingly, this appendix discusses strategic stability and the qualitative characteristics of nuclear forces that are important to establishing and maintaining a managed and transparent deterrence posture between states.

Strategic stability between non-allied nuclear powers entails each power balancing the capability to attack another state's nuclear forces with a nuclear posture and policies that ensure the latter party does not conclude its nuclear forces are held at an unacceptable level of risk. In the past, nuclear strategists generally linked the concept of strategic stability with postures that ensure mutual vulnerability. In addition, many arms control negotiators view "stability" as rooted in a relationship continuously cultivated between nuclear powers, rather than as the outcome of a discrete decision or policy.

The arms control initiatives between the United States and the Soviet Union during the Cold War, and the United States and the Russian Federation since the 1990s, attempted to negotiate a managed, transparent form of nuclear deterrence between the two states, while also establishing procedures and mechanisms for sustaining this arrangement. Both states accepted a status quo of nuclear forces; in terms of numbers and force posture, each side reduced its nuclear forces, but also retained the capability to cause great devastation to the other.

Legally-binding treaties, and their associated verification regimes and confidence-building measures, made this status quo transparent (at least to a degree considered acceptable by both sides upon ratification). This status quo was also managed through communication procedures, such as the notifications exchanged between the Nuclear Risk Reduction Centers in Washington and Moscow, and processes of adjudication, such as New START's Bilateral Consultative Commission. In time, the establishment of regularized diplomatic procedures made exchanges of information, and the resolution of disputes regarding the implementation of arms control treaties, routine. As a result, while in principle deterrence between the two states remained dependent upon each retaining the ability to use nuclear weapons to destroy the other, in practice nuclear deterrence between the two parties in

the 1990s operated in a different manner from deterrence in the 1950s and 1960s.

Some aspects of strategic stability, including symmetries of capabilities between adversaries, cannot be captured with the qualitative characteristics of one side's arsenal alone. Nonetheless, the qualitative characteristics that best promote strategic stability between major nuclear powers are those that maintain mutual vulnerability and communicate intent regarding nuclear forces. In contrast, qualities that aid first strike attacks are harmful to strategic stability, raising the possibility that one party might consider it possibly to pre-emptively attack, and disarm or destroy, the other party or parties.

Tier 1: The Tier 1 characteristics for strategic stability, therefore, are the *ability to signal*, the *ability to defeat defenses*, and *survivability*. The *ability to signal* promotes stability by providing means for each side to communicate their intent to the other. This intent could be escalation or de-escalation. The ability to credibly signal restraint is especially important for promoting stability in periods of tension.

Figure D.1: Maintaining Strategic Stability with Major Nuclear Powers

Tier 1 (most important)	Tier 2	Tier 3 (least important)
Ability to Defeat Defenses	Ability to Reconstitute	Ability to Retarget
Ability to Signal	Variety of Yield Options	Accuracy
Survivability		Promptness

In addition, the ability of nuclear weapons to penetrate defenses, if shared by both sides, creates a sense of mutual vulnerability. Neither side can presume their defenses, whether active or passive, will prevent destruction from an incoming attack. Furthermore, the presence of highly survivable forces on both sides contributes to strategic stability by disincentivizing first strike attacks, ensuring that such an attack will be met with a punishing response.

Tier 2: The Tier 2 qualitative characteristics for strategic stability are the *ability to reconstitute forces* and *variety of yield options*. The ability to deploy nuclear forces carrying a range of yields, including lower yield weapons that may be viewed by some parties as more "usable," could lead to nuclear conflict being viewed as more likely by all parties. On the other hand, some parties view large-yield warheads—particularly if they are the only type, or majority type, of warhead within a national arsenal—as inherently threatening and therefore destabilizing. As such, fielding a *variety of yield options* might be viewed as stabilizing, granting states a range of options and offering protection against technical[113] or strategic[114] deterrence failure.

Similarly, another party could view the ability of a state to reconstitute forces as either stabilizing or destabilizing. It might be viewed as stabilizing if the observer believed the ability of a nuclear force to adapt to geopolitical change ensured that the state in question would never feel compelled to take risky actions due to a fear it might "lose" its capabilities. Other parties, however, might consider this qualitative characteristic to be destabilizing, assessing that it granted a potential adversary the capability to rapidly upgrade or expand its forces, giving it an edge over other states. Transparency measures may address this concern by building confidence that each side was aware of the other's reconstitution capabilities. With both qualitative characteristics having the potential to contribute to stability or instability, they are placed within Tier 2.

Tier 3: For the purposes of establishing strategic stability between nuclear states, the qualitative characteristics *accuracy*, *promptness*, and *ability to retarget* are placed in Tier 3. All of these characteristics support quick, precise strikes. They are potentially destabilizing because a nuclear-armed state could view these characteristics as permitting a potential adversary to launch a decapitating first strike against its leadership and command and control infrastructure. Accurate weapons also increase the viability of attacks against opposing nuclear forces, even at lower yields, because the overpressure generated is greater than with less accurate weapons of the same yield.

D.2 Strategic Stability and Force Reductions

At lower numbers, the relative importance of qualitative characteristics for the purposes of strategic stability remains the same; characteristics retain their placement in the same Tiers. Although their relative relationships to each other remain the same, however, at lower numbers Tier 1 characteristics may require greater emphasis, as maintaining characteristics in strength becomes increasingly difficult. For example, at lower numbers a potential adversary may view a first strike as potentially useful for destroying a significant portion of the U.S. arsenal even if it could not plausibly destroy all U.S. weapons. *Survivability* is just as important for strategic stability at lower numbers as it is for current numbers, but at lower numbers it is possible the calculus of adversaries may change. A smaller U.S. arsenal may be perceived as less survivable and therefore appear more enticing to an adversary considering a first strike. Maintaining the *ability to signal* may also be reduced at lower numbers if those delivery systems whose deployment or alert status is more readily observed are reduced or eliminated.

The one characteristic that could potentially increase in importance for maintaining strategic stability at lower numbers is the *ability to reconstitute*. At lower numbers each additional new weapon will have greater impact than a weapon added to current numbers. If an adversary

were to consider a break-out scenario in reaction to geopolitical changes vis-à-vis the United States or another state, the United States may want to match this state numerically in order to maintain stability. For the reductions contemplated by this research project, however, and given current adversary policies and capabilities, the research team does not view *ability to reconstitute* as changing in terms of its relative importance.

Promoting strategic stability goes beyond the characteristics of nuclear arsenals to the communication, confidence-building exercises, and transparency measures that exist between nuclear states. These activities may be further complicated at lower numbers if there are more states within the "peer" category of potential adversaries. Maintaining strategic stability with the USSR was challenging during the Cold War, but the two parties were primarily concerned with establishing a stable relationship between each other's nuclear forces. At low numbers the United States may need to establish strategic stability with more than one nuclear power, to include powers that may have an interest in strategic stability with the United States but not with each other. Furthermore, there is no guarantee that at low numbers other nuclear powers will accept the general "template" of nuclear arms control established over the years between the United States and Russia, or abide by the broader framework of global nuclear non-proliferation and testing treaties. If reductions by major nuclear powers lead to several states possessing limited nuclear arsenals of roughly equivalent sizes, these and other factors will present a complex challenge to future negotiations seeking to build confidence, encourage transparency, and establish strategic stability across a multi-polar nuclear environment.

APPENDIX E: ABSTRACTS OF SELECTED BACKGROUND RESEARCH MATERIALS

The following abstracts highlight background readings used in the research for this project. We list sources in two categories: 1) nuclear forces, and 2) missile defenses and conventional prompt global strike systems. For information on documents and other secondary materials cited within footnotes in the main report and appendixes, see "Appendix F: Works Cited," below.

E.1 Abstracts: Nuclear Forces

Blair, Bruce, Victor Esin, Matthew McKinzie, Valery Yarynich, and Pavel Zolotarev. "Smaller and Safer," *Foreign Affairs*, Vol. 89, No. 5 (Sept/Oct 2010), pp. 9-16.

Summary: In the next round of arms control talks the United States and Russia need to pursue deeper cuts, to include tactical weapons, and negotiate lower levels of launch readiness. Based on running hundreds of computer simulations with different variables related to force structure, alertness-posture, accuracy, yields, etc., the authors found both sides could limit their strategic arsenals to 1000 warheads with no more than 500 launchers without weakening security. De-alerting would help stabilize deterrence at these numbers (they assume both sides de-alert). The authors state that deterrence is stable because both sides would still have a second strike capability after an initial attack (they assume the first country loses its ICBMs without using them if one side secretly re-alerts its ICBMs). With their model they found that missile defense would not upset deterrence or stability if each side had no more than 100 interceptors.

Chalmers, Malcolm. "Nuclear Narratives, Reflections on Declaratory Policy." *Royal Service Institute:* Whitehall Report 1-10, 2010. http://www.rusi.org/downloads/assets/WHR_Nuclear_Narratives.pdf

Summary: The author lays out possible options for strengthening negative security assurances that nuclear weapon states give to non-nuclear weapons states. He examines whether a more restrictive declaratory policy might have a role to play in developing multilateral arms control between the five recognized nuclear-weapon states. The author argues that a policy of "No First Use" of nuclear weapons under any circumstances may be a step too far, both for public opinion in NATO countries and for those nuclear-weapon states (especially Russia) who are concerned about conventional inferiority. The paper also suggests that proposals for nuclear powers to state the "sole purpose" of

nuclear weapons is deterring the use of these weapons by others are both too narrow and too wide in conception. As an alternative, the author suggests that the central purpose of arms control between nuclear-weapon states should be twofold: to reduce reliance on nuclear weapons while also reducing concerns over counter-force capabilities. He also suggests that the NPT nuclear-weapon states should together commit to the acceptance of "mutual vulnerability" with a commitment to use nuclear weapons only as a "very last resort."

Deutch, John. "A Nuclear Posture for Today," *Foreign Affairs*, Vol. 84, No. 1 (Jan/Feb 2005), pp. 49-60.

Summary: Deutch argues that the United States has still not changed its nuclear posture to reflect the post-Cold War world. Over the last decade the nuclear threat has changed; preventing non-state actors or "rogue nations" from getting nuclear weapons and using them against the United States is as important as deterring major attacks. The current posture does not reflect this shift, nor does it take into account how U.S. nuclear policies impact other governments. Reducing the U.S. arsenal would not change the calculus of an Iran or North Korea, but it would help the United States as it seeks global cooperation in promoting nonproliferation and nuclear security. The United States has conventional superiority and thus it should reduce its nuclear arsenal to promote nonproliferation around the world. While reducing the United States should still maintain a credible deterrent. His suggestion for force structure: 9 Trident submarines each with 16 D-5 missiles with 8 nuclear warheads each. Three submarines would be at sea at a time, placing a total of 384 warheads on alert. Another 200 warheads (on ICBMs, cruise missiles, and air platforms for flexibility) would supplement the sea-based deterrent. The total is less than 1000 warheads.

Donley, Michael. "Reinvigorating the Nuclear Enterprise: A Critical Air Force Mission." Remarks at the Center for Strategic and International Studies, Washington, DC, 12 November 2008. http://www.csis.org/media/csis/events/081112_donley_transcript.pdf

Summary: Secretary Donley lays out the Air Force response to the Minot and Taiwan fuses crises. The nuclear enterprise must be focused on eliminating risk. He describes the new A10 directorate within USAF, consolidation of nuclear sustainment matters at Kirtland AFB, and the establishment of Air Force Global Strike Command. He reemphasizes Secretary of Defense Gates' remarks concerning the need for a safe and reliable nuclear deterrent and stresses that efforts to

recommit to that mission are not focused on increasing the size of the nuclear arsenal.

Forsyth, Jr., James Wood, Col B. Chance Saltzman, and Gary Schaub, Jr. "Remembrance of Things Past," *Strategic Studies Quarterly* (Spring 2010), pp. 74-89.

Summary: The authors begin from the proposition that nuclear weapons deter by compelling leaders to behave cautiously in the face of danger and that this restraint strengthens stability. The authors believe that nuclear weapons enhance general deterrence. They do so by "sanctuarizing" the states that possess them, ensuring that incentives for aggression against a nuclear-armed state never outweigh possible costs. However, the question arises as to how many weapons are needed to effectively "sanctuarize." The doctrine of proportional deterrence promotes the idea that a defender would need to possess enough survivable nuclear forces to inflict damage on the aggressor roughly equivalent to the gains the aggressor hopes to achieve. Thus, proportional deterrence answers the question of "how much is enough" by equating it with the value of a defender's territory. The authors propose a minimum deterrence strategy based on a force of 311 weapons dispersed on 100 single warhead Minuteman III s, 192 de-MIRVed Trident SLBMs on 12 SSBNs, each carrying 24 missiles (with 8 boats on patrol at any time), and 19 B-2s (B-52s would be converted to a solely conventional role). The authors believe that the United States can implement this strategy and force structure unilaterally, and that any perceived advantage held by the Russians would still leave their cities at risk in a "bolt from the blue" scenario. Furthermore, the authors believe those who push for a large nuclear arsenal due to the multiple contingencies the United States must cover are ignoring the conventional superiority of US forces. The authors also state that the perceived value of the nuclear triad may be illusory if one accepts that it is the political value of nuclear weapons that truly matter. In their estimation the sizing of nuclear forces should be based primarily on the requirements for a stable and reliable nuclear deterrent. All other considerations, including industrial base support, crew force management, and training, are secondary.

Gates, Robert. "Nuclear Weapons and Deterrence in the 21st Century." Remarks at the Carnegie Endowment for International Peace, Washington, DC, 28 October 2008. http://www.carnegieendowment.org/files/1028_transcrip_gates_checked.pdf

Summary: In light of movement toward nuclear disarmament, Secretary Gates reminds audience that nuclear weapons are necessary to deter potential adversaries and reassure "over two dozen allies and partners." He recalls President Clinton's "lead and hedge" strategy of leading the way on arsenal reductions, but hedging against the dangers of an unpredictable world. He highlights that Russia is placing more reliance on its nuclear weapons in face of monetary and demographic constraints on conventional forces. He emphasizes the current safety, reliability, and security of the nuclear arsenal. However, he characterizes the long term prognosis as "bleak." Maintaining a credible deterrent, while reducing weapons in the stockpile, is impossible without resorting to testing or the pursuit of a modernization program. He states that the proposed RRW program is not about new capabilities, but rather the "future credibility of our strategic deterrent."

Grotto, Andrew and Joe Cirincione. "Orientating the 2009 Nuclear Posture Review: A Roadmap." A Publication of the *Center for American Progress*: 17 November 2008. http://www.americanprogress.org/issues/2008/11/nuclear_posture_review.html

Summary: The authors argue that the goals of the next NPR should be as follows: refocus the U.S. nuclear deterrent, strengthen our position in nonproliferation regimes, and overtly signal our change of course to the world. The emerging consensus that the current nuclear weapons posture strains our ability to prevent nuclear terrorism and proliferation is based two propositions: the outdated influence of Cold War assumptions and the fact that many countries consider compliance with the NPT's Article VI as a necessary precondition for further nonproliferation cooperation. The report outlines how the next NPR should be structured and sequenced. Its key policy issues are divided into three areas: deterrence and doctrine, force structure and the nuclear weapons complex, and nonproliferation and arms control. Appendices include reviews of the last two NPRs and a history of strategic arms control.

Johnson, Dana J., Christopher J. Bowie, Robert P. Haffa. "Triad, Dyad, Monad? Shaping the U.S. Force of the Future," *Mitchell Report 5*, Mitchell Institute for Airpower Studies (December 2009).

Summary: The authors conclude that SLBMs and ICBMs should form a future nuclear weapons "dyad," and that the bomber force should be phased out of the nuclear mission. The report focuses on deterring peer and near-peer states, discounting the threat posed by regional states and

non-state actors (although presuming future force planning will adequately address these challenges). "Spider" charts are used to depict the relative value of strategic systems in meeting a range of attributes deemed appropriate for deterring and maintaining stability with peer and near-peer states. The authors considered various postures, to include a monad of SLBMs; dyads of SLBMs and bombers, SLBMs and ICBMs, or ICBMs and bombers; and the existing triad. Their conclusion is that a dyad of SLBMs and ICBMs provides clear advantages over other options.

Kaplan, Robert. "Living with a Nuclear Iran," *The Atlantic Monthly* (September 2010).

Summary: The author acknowledges the relevance of Henry Kissinger's book, *Nuclear Weapons and Foreign Policy*, in today's international strategic environment, particularly in dealing with Iran. Kissinger's 1957 book described a world of increased globalization and the role nuclear weapons play in providing states the power to change regional and global balances of power absent military action. While status quo powers (e.g., United States) view negotiations as a means to reduce tension, revolutionary powers (e.g., Iran, DPRK) view such talks as a useful tactic to gain time and secure other benefits. As such, Kissinger argued that limited nuclear war was not only possible, but that the United States should be prepared to wage such a war. Kaplan notes that Kissinger's basic arguments have become increasingly relevant as the "nuclear club" expands, and he concludes that U.S. readiness and willingness to wage limited war, even limited nuclear war, may serve as the ultimate deterrent.

Lieber, Keir A. and Daryl G. Press. "Superiority Complex: Why America's Growing Nuclear Supremacy May Make War with China More Likely," *The Atlantic Monthly*, Vol. 300, No. 1 (July/August 2007), pp. 86-92.

Summary: This article examines how advances in U.S. counterforce capabilities may exacerbate relations with China. The authors assert that changes in U.S. nuclear force posture since the 1980s—to include an expansion of targeting guidance, increased strategic presence in the Pacific, and missile defense plans for Chinese contingencies—indicate an increasing likelihood of a U.S.-China strategic rivalry. The authors highlight the limited yet destructive nuclear capabilities of China that complicate U.S. decision-making (e.g., China's 18 ICBMs that carry 4 megaton warheads and approximately 60 short-range nuclear missiles), but note that China's future force of mobile ICBMs and ballistic-missile submarines may cause further difficulties. Additionally, the increased

accuracy and sophistication of U.S. nuclear and conventional weapons and American efforts to secure nuclear primacy may disrupt strategic stability with China and provoke an arms race.

Lieber, Keir A. and Daryl G. Press. "The End of MAD? The Nuclear Dimension of U.S. Primacy", *International Security*, Vol. 30, No. 4 (Spring 2006), pp. 7–44.

Summary: Lieber and Press make a straightforward argument: the age of Mutual Assured Destruction (MAD) is coming to an end because the United States is close to attaining nuclear primacy vis-à-vis Russia and China. Based on simulations they conducted of U.S. first strikes on Russia (the harder case) they make three empirical claims. First, the strategic nuclear balance has shifted dramatically since the end of the Cold War, and the United States now stands on the cusp of nuclear primacy. Second, the shift in the balance of power has two primary sources: the decline of the Russian nuclear arsenal and the steady growth in U.S. nuclear capabilities. For U.S. capabilities they cite the increasing accuracy and lethality (hard-target capabilities) of the Trident II (D-5) SLBM, the Minuteman guidance system which is as accurate as the MX system, and improved avionics in the B-2 that allow radar avoidance at low altitudes. Third, the trajectory of nuclear developments suggests that the nuclear balance will shift further in favor of the United States in the coming years. Russia and China will face tremendous incentives to reestablish MAD, but doing so will require substantial sums of money and years of sustained effort.

Lieber, Keir and Daryl G. Press. "The Nukes We Need," *Foreign Affairs* (Nov/Dec 2009), pp. 39-51.

Summary: The United States should judge its nuclear force not against the relatively easy mission of peacetime deterrence but against the demanding mission of deterring escalation during a conventional conflict. Simply counting U.S. warheads or measuring U.S. capabilities in regard to attacking opposing nuclear forces will not reveal what type of arsenal is needed for deterrence in the twenty-first century. The only way to determine the right type of arsenal is to work through the grim logic of deterrence: to consider what actions will need to be deterred, what threats will need to be issued, and what capabilities will be needed to back up those threats. The current U.S. arsenal includes a mix of accurate high- and low-yield warheads, offering a wide range of retaliatory options, including the ability to launch precise, very low-casualty nuclear counterforce strikes. The United States must preserve

that mix of capabilities (especially the low-yield weapons) as it cuts the size of its nuclear force.

The United States should ensure that it has three distinct capabilities in regard to nuclear forces. First, it still needs some high-yield nuclear weapons (such as those deployed on land-based missiles and in submarines), although fewer than it currently possesses. The United States also needs conventional counterforce weapons. For the third leg of the U.S. strategic force, the United States should retain the lowest-yield warheads in its nuclear arsenal and (if it has not already done so) enhance their accuracy. If the low-yield nuclear bombs and cruise missiles, which reportedly use inertial guidance systems, were even half as accurate as their conventional, GPS-guided cousins, they could match the effectiveness of high-yield nuclear weapons while inflicting casualties more akin to those caused by conventional bombs.

Any analyst or policymaker who proposes a nuclear posture for the United States must answer four fundamental questions: What enemy actions are to be deterred? Under what circumstances might these actions be taken? What threats would a U.S. president wish to issue? And does the proposed arsenal give the president the ability to carry out those threats?

Lodal, Jan, James M. Acton, Hans M. Kristensen, Matthew McKinzie, and Ivan Oelrich; and Keir A. Lieber and Daryl G. Press. "Second Strike: Is the U.S. Nuclear Arsenal Outmoded?" *Foreign Affairs*, Vol. 89, No. 2 (Mar/Apr 2010), pp. 145-152.

Summary: This article is a response to the article by Keir Lieber and Daryl Press, "The Nukes We Need" (summarized above).

Jan Lodal responds: The United States has the flexibility to carry out low-yield counterforce attacks with the B-61 warhead in a B-2 bomber. Lieber and Press attack a straw man when arguing for flexibility at lower yields. Furthermore, their plan for a disarming counterforce attack against 20 Chinese ICBMs fails to account for the many weapons we do not know of within China. They also fail to address terrorists acquiring a nuclear weapon.

James M. Acton responds: Lieber and Press' plan only makes sense if the United States faced an adversary solely armed with silo-based missiles. But even then the incentive would be for that adversary to fire first, knowing of the U.S. capability to destroy the silos. No nuclear

state, however, has an arsenal solely consisting of silo-based missiles. China, Iran, and North Korea are all developing road-mobile missiles, which are very difficult to detect. The United States would be better to maintain a relationship of mutual vulnerability with China as it did with the Soviet Union. With Iran and North Korea the United States should give the regimes reason for restraint by not seeking regime change. Counterforce goals will only make nonproliferation harder to achieve.

Hans M. Kristensen, Matthew McKinzie, and Ivan Oelrich respond: These authors criticize the model used by Lieber and Press: airbursts would not have the shock waves to damage missile silos. With only 20 B-2 bombers multiple waves of attack would have to occur to ensure the silos are destroyed. Most planners would not share Lieber and Press' confidence of success.

Lieber and Press reply: Acton and Lodal assume adversaries can be convinced to accept perpetual vulnerability. The challenge is to deter nuclear escalation during conventional wars when these adversaries have the incentive to use them for survival. They argue their model is in fact conservative and 3000 psi is sufficient to destroy hardened silos. Lieber and Press argue Kristensen, McKinzie, and Oelrich are wrong that an airburst cannot destroy a silo.

Lowther, Adam B. "Should the United States Maintain the Nuclear Triad." *Air & Space Power* 24 (2): 23-29, Summer 2010. http://www.airpower.maxwell.af.mil/airchronicles/apj/apj10/sum10/04lowther.html

Summary: The author provides historical background into the development of the U.S. nuclear triad and frames the current debate between those who seek to maintain the nuclear triad and those arguing for the dismantlement of the triad in favor of a monad (SLBMs) as part of a larger complete disarmament goal. The author proposes an alternative counterview to those wishing to abolish the nuclear triad in favor of a monad. First, he argues that to achieve effective deterrence, the United States must have the capability and credibility to create a desired psychological effect, which a nuclear monad cannot achieve. Second, he argues that the ability to signal intent is vital to deterrence, and eliminating the bomber leg of the triad would diminish this capability. Third, he states that ICBMs provide two distinct benefits that SLBMs do not. Their expense raises the cost of entry, which may prove too costly for some potential proliferators, and their strong counterstrike ability increases risks for an adversary. Finally, the author argues that if the United States were to move to a SBLM-focused

nuclear monad, adversaries would know that half of the nuclear arsenal would be in port at any given time, leaving nuclear assets vulnerable to attack.

Murdock, Clark A., Jessica M. Yeats, Linton F. Brooks, M. Elaine Bunn, Franklin C. Miller, James L. Schoff. "Exploring the Nuclear Posture Implications of Extended Deterrence and Assurance," *Workshop Proceeding and Key Takeaways*, CSIS.

Summary: This report is an assessment of the U.S. security umbrella. The authors organized groups of experts to discuss U.S. extended deterrence. As recorded by the report, expert opinions on extended deterrence varied widely. The authors set out a framework in which they examine both the credibility of the deterrent from the perspective of both the "deteree" and the state under the umbrella, the "assuree." If the deterrent is not credible, assurance will not work, but a credible deterrent does not guarantee successful assurance. The credibility of both relationships is highly symbiotic. Credibility is in the eyes of three different beholders: allies and security partners; potential aggressors; and the American public, the U.S. Congress, the military, and government officials. The authors take a "credibility-based approach" to accessing deterrence, as there is no objective way to assess the effect of changes to the nuclear posture on extended deterrence. The credibility of deterrence and extended deterrence depends on a spectrum of factors affecting adversary perceptions of U.S. *capabilities* and *intentions*.

The report uses Linton Brooks' approach for assessing the capability implications of extended deterrence: "[The] inherent force structure needs [of extended deterrence] are…U.S. strategic forces that are perceived as second to none…flexible…reliable and effective…and by effective defenses… [But the] force structure bottom line [is]: except for these inherent features, [the] U.S. should wean allies from the belief that a specific force structure is required for extended deterrence."

Three principal factors explain why the requirements for assuring an ally can be distinct from (and, in some cases, greater than) the requirements for deterring the ally's potential aggressors. First, the degree to which assurance is affected by the elements of extended deterrence is a function of how the ally perceives and interprets U.S. words and actions vis-à-vis the deteree. Second, because assurance is a mutually beneficial relationship, it requires mechanisms—and, potentially, capabilities that underwrite those mechanisms—of participation and/or burden-sharing to bring the ally "into the act" of

extending deterrence. Third, because the choice to remain non-nuclear is based on the ally's assessment of their security needs in a longer-term context, perceived challenges to the credibility of U.S. deterrence capabilities in the long-term could have shorter-term consequences for assurance. The authors emphasize that assurance must be based on consultations with each security partner. Assurance depends on what U.S. allies *believe* is needed for extended deterrence, not what U.S. policy makers or policy experts think is needed.

Office of the Secretary of Defense. *Nuclear Matters: A Practical Guide,* ODATSD(NM) (2007).

Summary: This reference book provides an overview of the U.S. nuclear weapons program and current activities associated with sustaining the U.S. nuclear deterrent. Topics include nuclear weapons life-cycle activities, force structure and stockpile composition, infrastructure and stockpile stewardship, nuclear weapons surety, C2 and use control, and the Nuclear Weapons Council, to name a few. Appendices also provide information on nuclear weapons effects, survivability, and testing. Chapter 3 on Nuclear Weapons Program Force Structure lists both advantages and disadvantages of U.S. nuclear weapons delivery systems and provides historical summary tables of nuclear warheads and bombs. Appendix H is a Glossary of key terms and definitions.

Payne, Keith. "How Much is Enough?: A Goal-Driven Approach to Defining Key Principles for Measuring the Adequacy of U.S. Strategic Forces," *National Institute for Public Policy* (January 2010).

Summary: Payne declares that the lingering Cold War deterrence model gives an undue amount of confidence in a formula that presumes a codified linkage between a specified number of nuclear weapons and their deterrent effect. Payne believes deterrence has too many unknowns to warrant such confidence. Furthermore, Payne believes the role of nuclear weapons in deterrence is in flux. The Cold War's legacy arsenal of high-yield weapons may create a "less believable" deterrent threat with its assured destruction standard not fitting with today's "controlled threat" standard. This points to the prospective value of both advanced non-nuclear and highly discriminate nuclear weapons. Payne also moves away from the Cold War mindset of assured destruction by advocating for civil defense measures to increase damage limitation. While many Cold War strategists viewed these types of measures as destabilizing, Payne declares that defenses do not upset stability as long as offensive forces maintain deterrence stability against

a first strike. Payne believes that given fluctuating strategic priorities, the United States should not be "locked in" to a force structure codified by arms control that is incompatible with shifting U.S. needs. Specifically, strategic force platforms should allow for uploading and downloading weapons as necessary to assure, deter, dissuade, and defend in a dynamic threat environment.

Payne, Keith. "On Nuclear Deterrence and Assurance," *Strategic Studies Quarterly* (Spring 2009), pp. 43-80.

Summary: Payne takes on those commentators that believe that nuclear weapons now offer little or no added value for deterrence over nonnuclear capabilities. Payne believes the argument of nuclear weapons having a limited combat role is spurious due to the fact that what is important for force requirements in warfighting will likely differ from those of deterrence and assurance. Deterrence relies upon the opponent's belief that the U.S. threat is credible. Similarly, assurance relies upon allies' perceptions. Payne presents examples in which nuclear weapons play an important role in both deterrence (the first Gulf War) and assurance (North Korea). Payne argues that the credibility of U.S. nuclear threats is of paramount importance. Payne believes low-yield and accurate nuclear weapons may create a more "believable" deterrent threat, particularly in an era where crises are more likely to be regional and a non-threat to national survival. Such scenarios would place a premium on controlling the threatened damage rather than on how much damage can be threatened. Payne believes nuclear disarmament proponents emphasize the risks of maintaining nuclear capabilities but are silent on the risks of their elimination. Furthermore, he points out the irony that the ability to reduce nuclear weapons may depend on the capability to quickly restore nuclear forces as dictated by geostrategic requirements. Payne defends the 2001 Nuclear Posture Review as an attempt to prudently prepare for deep reductions in nuclear weapons. Criticism of the 2001 NPR was based on outdated "balance-of-terror" metrics that could not take into account newly identified requirements of assurance, deterrence, and dissuasion. Payne asserts that the 2001 NPR was not a rejection of deterrence, but rather an intentional redefining away from a mindset that was uniquely framed for the Cold War standoff. Payne believes this mindset will continue to be a source of dangerous and confused policy guidance.

Pifer, Steven, Richard C. Bush, Vanda Felbab-Brown, Martin S. Indyk, Michael O'Hanlon and Kenneth M. Pollack. "U.S. Nuclear and Extended Deterrence: Considerations and Challenges," *Brookings*, Arms Control Series Paper 3, May 2010.

http://www.brookings.edu/~/media/Files/rc/papers/2010/06_nuclear_deterrence/06_nuclear_deterrence.pdf

Summary: The primary contributions of this paper are examining the future of extended deterrence for Europe, East Asia and the Middle East.

NATO: During the 2010 NPR process the administration strongly considered the positions of U.S. allies in Europe, but largely left NATO policy to the then-upcoming NATO policy review because the United States does not view these decisions as unilateral. There are a number of reasons to reconsider NATO's nuclear posture. First, President Obama has signaled a desire to reduce the salience of nuclear weapons. Second, the decline in Russian conventional forces means U.S. nuclear weapons in Europe have little military value in responding to a conventional attack. Third, interest in nuclear weapons in Europe is waning among a number of Western European allies.

A potential change in policy must address a number of challenges. First, policy changes could influence individual nations' decisions to proliferate; Turkey is of special concern. U.S. weapons in Europe could reassure Turkey if Iran develops nuclear weapons. Next, the European public is engaging in an active debate over U.S. weapons in Europe. A number of German and Dutch elder statesmen have signed on to the nuclear zero movement. A final challenge is the different views over the Russian threat among European allies. Some allies, including Germany and the Netherlands, do not view the presence of U.S. tactical nuclear weapons as necessary for extended deterrence. Eastern European nations, however, including Latvia, Poland, and the Czech Republic, would prefer the United States maintain some weapons on European soil. Some of these allies are unsecure about NATO's Article V commitment and nuclear weapons provide additional reassurance.

In terms of arms control, tactical weapons in Europe could provide a bargaining chip for the next round of negotiations with Russia. The authors warn however, that Europe should not become so attached to the bargaining value of these weapons that they keep them around perpetually. They suggest one approach would be for NATO to avoid unilateral reductions in the near-term, while seeing how the next round of U.S.-Russian nuclear arms reductions negotiations play out and retaining the option of revisiting the issue at a later point. If they are removed it should be done as the result of a negotiated agreement or a grand political gesture, not as the result of haphazard national decisions.

East Asia: Unlike Europe, U.S. extended deterrence in East Asia is based on bilateral relationships and agreements, so any nuclear debate there will be viewed mainly through a bilateral lens. Also in contrast to Europe, the United States does not have any nuclear weapons on the soil of Asian nations. In a 2009 defense white paper Australia recommitted the country to the status quo of the United States providing extended deterrence. Some conservatives have suggested that with the growth of China and India, Australia should consider the Japanese hedging option, while progressives, including Gareth Evans, are committed to global reductions of nuclear weapons. South Korea is primarily concerned with the way in which the United States handles the North Korean program. They do not want to see a policy of "managed proliferation." At the request of South Korea, the United Stated reaffirmed its commitment to extended deterrence for South Korea in 2009. This request represents a concern among some in South Korea about the credibility of extended deterrence. The United States has not given an explicit pledge to come to Taiwan's defense with conventional or nuclear forces, "rather they must have faith in American support." In Japan, the mainstream view "has been continued reliance on the U.S. nuclear deterrent as an indispensable component of Japanese defense policy." Japan has, however, sought at times to supplement its reliance on the U.S. deterrent by conducting periodic studies on developing a nuclear deterrent and building up its own conventional capabilities. For the 2010 NPT review conference the Japanese PM suggested three steps to promote nonproliferation: "no first use" of nuclear weapons; no use of nuclear weapons against non-nuclear weapons states; and a treaty establishing a nuclear-weapons-free zone in Northeast Asia. Another Japanese leader suggested these are the steps that would allow Japan to eventually "escape from the [American] nuclear umbrella." Notably, the new Foreign Minister Okada "disavowed efforts during the spring of 2009 by security-minded Japanese diplomats to persuade the Perry-Schlesinger Commission to keep nuclear-capable Tomahawk SLCMs operational," because they were "a key component of the U.S. nuclear umbrella."

Middle East: In the Middle East, the primary challenge to the United States is addressing the Iranian threat in a manner that keeps other states in the region from proliferating. Egypt, Saudi Arabia, the United Arab Emirates and Turkey are all obvious candidates to develop nuclear weapons. According to the authors "scholarly work on extended deterrence has consistently found that would-be aggressors focus on the regional balance of power in their neighborhood, not the overall balance of power." This means U.S. conventional forces are necessary in the

region to avoid an Iranian attempt at a military *fait accompli*, although this is complicated by antipathy toward U.S. forces in the region.

For the regimes allied with the United States in the region the threat from Iran is not just nuclear, but internal subversion to their governments. Israel is concerned that with a nuclear deterrent Iran will be more emboldened to press Hizballah, Hamas, Palestinian Islamic Jihad and its other Palestinian allies to attack Israel both more frequently and with much greater ferocity. Convincing Israel not to attack Iran's nuclear program would likely require a higher degree of commitment to Israeli defense from the United States. Establishing extended deterrence for the Middle East will be extremely complicated for the United States. The authors suggest extended deterrence in this area will require creative approaches on four vectors: laying out clear redlines for Iranian behavior whether conventional, nuclear or asymmetric; making clear commitments to U.S. allies in the Middle East, which may require formal defense pacts or a new regional alliance; strengthening American allies through aiding the development of counterinsurgency and counter-terrorist capabilities, as well as promoting government reform; and seeking assurance that the nations protected under extended deterrence will not proliferate.

Deterring chemical and biological weapons use: The authors support the NPR's position of not maintaining ambiguity about the potential use of nuclear weapons against chemical and biological weapons. These weapons can be countered with conventional forces, though the authors recognize this position is taken while only considering current biological and chemical weapons capabilities. Additional uses for nuclear weapons could arise in the future as capabilities improve and become more dangerous.

Deterring Non-State Actors: Though some terrorists cannot be deterred, many organizations that use terrorism as a means to achieve goals have interests that can be held at risk. The paper provides a number of historic and modern examples, to include: FARC, Tamil Tigers, the Irish Republic Army, the Red Brigades, Hamas (Palestine), and Hizballah (Lebanon). The authors suggest the United States could declare a policy that if any criminal group were to participate in nuclear smuggling, it would automatically be elevated to the highest priority among non-state actors for the United States to target and destroy, deterring many such groups from participating in this type of activity. With entities like Al Qaida, deterrence must focus on the potential actors who would supply nuclear material, since they cannot be deterred.

Reif, Kingston, Travis Sharp and Kirk Bansak. "Pruning the Nuclear Triad? Pros and Cons of Bombers, Missiles, and Submarines." A publication of the *Center for Arms Control and Non-Proliferation*: 3 December 2009. http://armscontrolcenter.org/policy/nuclearweapons/articles/120309_nuclear_triad_pros_cons/

Summary: This publication outlines the pros and cons of each leg of the current U.S. nuclear triad: bombers, ICBMs and SLBMs. The authors also suggest potential areas to prune in the nuclear arsenal. On bombers, the authors argue that since U.S. nuclear submarines and Russian ICBMs are the most valued legs of each respective triad, neither will be eliminated in the near future. Therefore, reducing the number of nuclear bombers is a more conceivable option for both nations. On ICBMs, the authors state that the inherent vulnerability of immobile ICBMs creates an unneeded "use or lose" pressure. SLBMs can be relied upon instead to provide a credible deterrence, eliminating the needed for ICBMs. On SLBMs, the authors state that while pursuing a policy of "minimum deterrence" might entail reductions to all three legs of the triad, a safe and secure SLBM force seems destined to remain the centerpiece of deterrence for years to come.

E.2 Abstracts: Missile Defenses and Conventional Prompt Global Strike Systems

Cimbala, Stephen J. "Matrix of Nonlinearity: Minimum Deterrence, Missile Defense, and Nuclear Arms Reductions." *Joint Force Quarterly* 62 (3): 110-116, 2011. http://www.ndu.edu/press/lib/images/jfq-62/JFQ62_110-116_Cimbala.pdf

Summary: Cimbala considers the political and military backdrop for a transition to a post-New START regime of minimum deterrence by the United States and Russia, examining the idea minimum deterrence and the variables involved in nuclear strategy. He also analyzes whether a minimum deterrence regime at either 1,000 or 500 deployed strategic nuclear weapons could provide nuclear security and stability for the United States and Russia. Ballistic missile defense are examined and the author discusses how they might complicate offensive reductions. Cimbala suggests that if relations between the United States and Russia continue to improve, the probability for an agreed minimum deterrence standard increases and will become the benchmark for future bilateral negotiations. However, the overlap between minimum deterrence and missile defense may prove to be too complicated and could keep U.S.,

NATO, and Russian negotiators engaged in political/technical struggles for the foreseeable future.

Diakov, Anatoly, Eugene Miasnikov and Timur Kadyshev. "Nuclear Reductions After New START: Obstacles and Opportunities." *Arms Control Today*: May 2011. http://www.armscontrol.org/act/2011_05/Miasnikov

Summary: The authors analyze what they see as the critical factors for making deeper nuclear reductions in the future between the United States and Russia. They argue that the three most important issues are ballistic missile defense, nonstrategic nuclear weapons, and conventional strategic arms, noting that ballistic missile defenses are of primary importance. The lack of progress on missile defense will likely block dialogue on tactical weapons and conventional strategic arms, as well as any further reductions of strategic nuclear arms. The authors outline Russian concerns vis-à-vis missile defense and state that renewing confidence building measures and other efforts to develop cooperation are necessary. The United States has already proposed a series of cooperation initiatives, such as exchanging launch information and setting up a joint data-fusion center. If implemented, these activities could serve as the basis for further cooperation in missile defense as well as other areas.

Payne, Keith A. "Maintaining a Flexible and Resilient Capabilities for Nuclear Deterrence." *Strategic Studies Quarterly:* 13-19, Summer 2011.

Summary: Payne notes that while many have attempted to judge the adequacy of U.S. nuclear forces and nuclear deterrent capabilities, deterrence is not a physical science and there is no basis for definitive judgment in this area. He argues that assessments on deterrence capabilities reside in the ability to be able to predict the mindset of foreign decision makers. Factors determining deterrence have as much as to do with an opponent's perceptions, values and decision-making process as the number and types of nuclear forces the United States maintains.

Regarding missile defense, Payne states that U.S. defensive capabilities can benefit deterrence credibility in some cases, citing Herman Kahn's rationale that if the United States itself is vulnerable to destruction, our deterrence commitments to others will seem less credible. Payne also notes, however, that U.S. defensive capabilities can be irrelevant to deterrence, and that it depends upon the opponent and the context on whether missile defense has any impact on deterrent creditability.

Bunn, M. Elaine and Vincent A. Manzo. "Conventional Prompt Global Strike: Strategic Asset or Unusable Liability?", *National Defense University*, February 2011.
http://www.ndu.edu/press/lib/pdf/StrForum/SF-263.pdf

Summary: The report states that a CPGS capability would be a valuable strategic asset for some fleeting, denied, and difficult-to-reach targets. It would fill a gap in U.S. conventional strike capability in some plausible high-risk scenarios, contribute to a more versatile and credible U.S. strategic posture, and potentially enhance deterrence across a diverse spectrum of threats. A small number of CPGS systems would not significantly affect the size of the U.S. deployed nuclear arsenal or substitute for the ability of nuclear weapons to hold large sets of hard, deeply buried, or mobile targets at risk. A key concern is the risk that either Russia or China might launch its nuclear forces due to uncertainty about the target of an ambiguous U.S. strike using CPGS. Assuming functioning early warning systems, the Conventional Trident Modification (CTM) mitigates this risk better than the conventional strike missile (CSM) because Russian and Chinese officials would be better able to assess quickly whether a CTM would land on their territory.

Gerson, Michael S. "Conventional Deterrence in the Second Nuclear Age," *Parameters*, 2009.
http://www.carlisle.army.mil/usawc/parameters/Articles/09autumn/gerson.pdf

Summary: The current CPGS debate focuses primarily on the use of conventional weapons for "deterrence by punishment," the threat to impose unacceptable costs, such as the destruction of an adversary's strategic and high-value targets, in response to unwanted actions. Yet, one of the most important contributions of conventional forces is "deterrence by denial," the threat to deny an adversary the ability to achieve its military and political objectives through aggression. If some early strategists were accused of "conventionalization" by treating nuclear weapons merely as more powerful and effective tools of war, the current debate regarding conventional contributions to deterrence may be accused of "nuclearization" in that it treats conventional capabilities merely as a substitute for nuclear weapons. This article examines how U.S. conventional military power can be used to deter conventional aggression against friends and allies by threatening to deny an adversary its best chance of success on the battlefield—a surprise or short-notice attack with little or no engagement with American military

forces. The ability to prevent an opponent from presenting the United States with a *fait accompli*—that is, from striking quickly and achieving victory before substantial U.S. (and perhaps coalition) forces can be deployed to the theater—is a central component of modern conventional deterrence.

Long, Austin and Dinshaw Mistry. Response to Sugden's paper: "Going Nowhere Fast Assessing Concerns about Long-Range Conventional Ballistic Missiles." *International Security*, Volume 34, Number 4, Spring 2010, pp. 166-184.

Summary: This article is a response to the article by Bruce M. Sugden, "Speed Kills: Analyzing the Deployment of Conventional Ballistic Missiles" (summarized below).

Austin Long responds: Long argues the challenge of having actionable intelligence to use CPGS is much greater than Sugden suggests. Furthermore, he believes that if U.S. forces are present, conventional ballistic missiles will not be needed. If U.S. forces are not present, there is little prospect of obtaining actionable intelligence on these targets from satellites. Even collection on the ground from human and signals intelligence may not produce actionable intelligence and would likely require cooperation with the host nation, which could simply arrest the target, as in the case of Abu Zubaydah. Analysts should therefore look past the technical specifications of the weapon and closely examine the prospect that a target for which a conventional ballistic missile would be appropriate and necessary can actually be located. The conclusion must be that conventional ballistic missiles are an excellent solution to a problem that does not exist.

Dinshaw Mistry responds: Mistry argues that Sugden ignores some of the arguments against CPGS including the undermining of the existing norm against the spread of ballistic missiles by deploying a new type of long-range conventional ballistic missile. He also makes an argument that a large number of conventional ballistic missiles would also undercut deterrence stability when the United States and Russia move to nuclear levels below those of the START follow-on treaty.

Bruce Sugden reply to Long: On actionable intelligence, Sugden responds by saying that anecdotal evidence from U.S. military operations conducted over the past two decades supports his view that a variety of collection sources occasionally produce actionable intelligence sufficient for conventional ballistic missile strikes, and that senior decision-makers have the time to order such strikes. On location

and deployment of U.S. forces, Sugden believes that Long falsely assumes that U.S. assets collecting intelligence are always properly equipped to defeat key targets.

Bruce Sugden reply to Mistry: Sugden believes the idea of a norm against conventional ballistic missiles is spurious considering the growth of such systems in Asia by China, India, and Pakistan. Sugden believes that Mistry's concern over new or reconfigured U.S. conventional ballistic missiles complicating nuclear arms reductions is overstated. The United States and Russia have deployed dual-capable delivery systems for decades, yet they have agreed to nuclear weapons reductions. The key enabler was an intrusive verification regime.

Sugden, Bruce M. "Speed Kills: Analyzing the Deployment of Conventional Ballistic Missiles," *International Security*, Volume 34, Number 1, Summer 2009, pp. 113-146.

Summary: This article presents an argument for the United States to deploy near-term conventional ballistic missiles in support of the PGS mission to mitigate the risk of misperception and an inadvertent nuclear response. The author believes that the "U.S. Navy's CTM is a cost-effective, near-term, niche PGS option that would mitigate the concerns of [conventional ballistic missile] opponents." The author also underlines the importance of policymakers' consideration to PGS alternatives against a variety of strategic issues, such as the risk of misreading of ballistic missile launches and "shaping potential adversaries' military investments, not just first-order tactical effects."

Woolf, Amy F. "Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues," *Congressional Research Service*, March 1, 2011. http://assets.opencrs.com/rpts/R41464_20110301.pdf

Summary: This article provides a comprehensive overview of the subject matter. It states that the current lead design for Conventional Prompt Global Strike (CPGS) is the conventional strike missile (CSM). The CSM is a land-based system that uses boost-glide technologies to deliver conventional payloads on target within minutes to hours of launch to nearly any point on the globe. The CSM would follow a depressed trajectory rather than the standard ballistic trajectory of nuclear-armed ballistic missiles. This capability, along with the ability of the payload to maneuver to avoid overflight of third-party countries, may overcome some of the nuclear ambiguity concerns of CPGS critics. CPGS supporters assert that the system expands U.S. conventional

options and reduces the likelihood of nuclear weapon usage in the absence of a conventional alternative. As a "niche" capability, the United States might only need a very small number of these weapons for use against critical, high-value targets in rare circumstances. The 2010 Nuclear Posture Review extended this logic to regional deterrence and the assurance of U.S. allies. It states that CPGS increases the credibility of the U.S. deterrent by providing the United States with a wider range of conventional weapons that it could turn to when defending its allies and forces overseas.

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APPENDIX G: LIST OF RESEARCH INTERVIEWS

Col David Baylor	AF Air Combat Command
Dr Brad Beck	Los Alamos National Laboratory
Dr Bruce Bennett	RAND
Mr Paul Bernstein	National Defense University
Dr Jim Blackwell	HAF/A10
Mr John Bowers	AF Global Strike Command
Dr Wayne Brasure	AF Nuclear Weapons Center
Lt Col Jason Briggs	HAF/A5XP
Amb Linton Brooks	Center for Strategic & International Studies
Ms Elaine Bunn	National Defense University
Brig Gen Mike Carey	Joint Chiefs of Staff
Col Melvin Deaile	AF Global Strike Command
Dr Peppi DeBiaso	OSD (Policy)
Dr Frank Dellermann	OSD (Policy)
Mr Paul Dodge	OSD (Policy)
Dr Tom Ehrhard	AF/CC-SA
Mr Chris Farris	OSD (AT&L)
Dr Peter Feaver	Duke University
Mr Michael Gerson	Center for Naval Analyses
Mr Bob Gibney	EUCOM
Mr Kurt Guthe	National Institute for Public Policy
Col Paul Hamilton	AF Air Education and Training Command
Mr Brandon Hanchett	HAF/A5XP
Maj Gen (ret) Charles "Ron" Henderson	HAF/A10
Mr Wayne Hudson	OSD (AT&L)
Dr Mim John	Sandia National Lab
Dr Kerry Kartchner	Defense Threat Reduction Agency
Dr Hans Kristensen	Federation of Atomic Scientists
Dr Ron Lehman	Lawrence Livermore National Laboratory
Dr Keir Lieber	Georgetown University
Mr Mike McDowell	HAF/A5XP
Mr Pat McKenna	STRATCOM
Maj Gen (ret) Tim McMahon	USAF
Mr Mike McVicker	STRATCOM
Mr Ralph Miller	HAF/A5XP

Mr Darphaus Mitchell	HAF/A10
Maj Gen (ret) Tom Neary	USAF
LCDR Spencer Nordgran	PACOM J-5 (Navy)
Mr James (Rusty) O'Brien	Missile Defense Agency
Dr Keith Payne	National Institute for Public Policy
Mr Josh Pollack	SAIC
Dr Daryl Press	Dartmouth College
DASD Brad Roberts	OSD (Policy)
Dr Scott Sagan	Stanford University
Dr Gary Sanders	Office of the Under Secretary of the Air Force
Mr Tom Scheber	National Institute for Public Policy
Mr Mike Shoults	HAF/A10
Mr Bill Siegert	SAIC
Maj Gen (ret) Robert Smolen	Lawrence Livermore National Laboratory
Mr David Stein	OSD (Policy)
Mr Bob Tilson	HAF/A10P
Lt Col Greg Tobin	HAF/A10P
Mr Jonathan Trexel	STRATCOM
Mr Tom Troyano	OSD (AT&L)
Dr Forrest Waller	National Defense University
Dr Ted Warner	OSD (Policy)
Gen (ret) Larry Welch	Institute for Defense Analyses
Mr Mike Wheeler	Institute for Defense Analyses
Dr James Wirtz	Naval Postgraduate School
Ms Amy Woolf	Congressional Research Service
Mr Michael Yaguchi	OSD (Policy)
Mr Mike Yap	SAIC
Dr David Yost	Naval Postgraduate School

APPENDIX H: ATTENDEES, SUBJECT MATTER EXPERT WORKSHOPS

H.1 Attendees, 20 January 2011 Workshop

Dr Justin Anderson	SAIC
Mr Richard Benson	HAF/A5XP
Mr Paul Bernstein	National Defense University
Ms Darci Bloyer	SAIC
Dr Clay Bowen	HAF/A9AN
Lt Col Jason Briggs	HAF/A5XP
Mr Mark Curley	SAIC
Col Jed Davis	HAF/A5XP
Mr Thomas Devine	SAIC
Mr Kevin Denninger	HAF/A10
Mr Chris Farris	OSD (AT&L)
Ms Rebecca Gibbons	SAIC
Mr Greg Giles	SAIC
Ms Polly Holdorf	Institute for National Security Studies
Dr Kerry Kartchner	Defense Threat Reduction Agency
Dr Jeffrey Larsen	SAIC
Dr Keir Lieber	Georgetown University
Maj Robert Moschella	HAF/A5XP
Mr Michael Shoults	HAF/A10
Dr Jim Smith	Institute for National Security Studies
Mr David Stein	OSD (Policy)
Ms Tami Stukey	SAIC
Mr Bob Tilson	HAF/A10
Mr Jim Toles	SAIC
Ms Christina Vaughan	SAIC
Mr Forrest Waller	National Defense University
Mr Andrew Walsh	SAIC
Mr Jeffrey Wood	HAF/A5RC
Ms Amy Woolf	CRS
Mr Mike Yaguchi	OSD/P

H.2 Attendees, 15 April 2011 Workshop

Dr Justin Anderson	SAIC
Mr Richard Benson	HAF/A5XP
Dr Brad Beck	Los Alamos National Laboratory
Mr Paul Bernstein	National Defense University
Lt Col Jason Briggs	HAF/A5XP
Amb Linton Brooks	Center for Strategic and International Studies
Mr Mark Curley	SAIC
Col Mel Deaile	Air Force Global Strike Command
Dr Peppi DeBiaso	OSD (Policy)
Mr Thomas Devine	SAIC
Mr Mark Domzalski	Los Alamos National Laboratory
Mr Mike Elliott	Joint Staff
Ms Rebecca Gibbons	SAIC
Ms Polly Holdorf	Institute for National Security Studies
Mr Greg Hulcher	OSD/AT&L
Mr Hunter Hustus	HAF/A10
Dr Kerry Kartchner	Defense Threat Reduction Agency
Dr Jeffrey Larsen	SAIC
Dr Keir Lieber	Georgetown University
Mr Bob Sampson	OSD/P
Mr Tom Scheber	National Institute for Public Policy
Mr Michael Shoults	HAF/A10
Dr Jim Smith	Institute for National Security Studies
Mr David Stein	OSD (Policy)
Ms Tami Stukey	SAIC
Mr Bob Tilson	HAF/A10
Lt Col Greg Tobin	HAF/A10
Mr Andrew Walsh	SAIC
Ms Amy Woolf	Congressional Research Service
Col Norm Worthen	HAF/A10

NOTES

[1] New START mandates three numerical limits for each State Party's nuclear forces: 1) no more than 700 deployed intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and heavy bombers; 2) No more than 800 total deployed and non-deployed ICBM launchers, SLBM launchers, and heavy bombers; and 3) no more than 1550 deployed strategic warheads. New START's counting rules count the actual number of warheads on each deployed ICBM and SLBM, but only assign one warhead to each deployed heavy bomber, regardless of how many bombs or cruise missiles the bomber carries when deployed. New START, Art. II.

[2] "Central Warhead and Delivery Vehicle Limits," State Department Bureau of Verification, Compliance, and Verification, 8 April 2010.

[3] "Remarks by President Barack Obama," White House Press Office, 5 April 2009.

[4] Ibid.

[5] Department of Defense (DoD), *Nuclear Posture Review Report* (NPR), April 2010, p. i.

[6] NPR, pp. 31-32.

[7] NPR pp. viii-ix, 16-17.

[8] NPR, p. 20. The NPR also describes a reduced, but nonetheless important, role for U.S. nuclear forces in deterring a number of non-nuclear threats, to include attacks by conventional or unconventional (biological or chemical) weapons against the United States or its allies. NPR, pp. 16-17.

[9] NPR, p. 33.

[10] NPR, pp. 16-17.

[11] See Appendix D: Qualitative Characteristics of Nuclear Forces and Maintaining Strategic Stability.

[12] During the negotiation of New START, a number of analysts attempted to answer the question of what minimum number of delivery systems and/or nuclear warheads could maintain strategic stability between the United States and Russia, and meet other force requirements. See Bruce Blair et al., "Smaller and Safer Arsenals," *Foreign Affairs*, Sept/Oct 2010, pp. 9-15 and James Wood Forsyth, Jr., B. Chance Saltzman, and Gary Schaub, Jr., "Remembrance of Things Past," *Strategic Studies Quarterly*, Spring 2010, pp. 74-89.

[13] General Kevin P Chilton, address, AFA Air and Space Conference, Washington D.C., 13 September 2010.

[14] For each level of forces: 2 scenarios (deter, prevail) x 4 categories of adversaries, + 1 scenario for assure allies = 9 scenarios.

[15] This research project considered the possible impact of missile defenses and CPGS on individual qualitative characteristics of nuclear forces, rather than the systemic effect of these capabilities on force structure or nuclear operations.

[16] See Appendix G for a full listing of individuals interviewed for this study.

[17] *Nuclear Matters: A Practical Guide* is a publication of the Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters that provides "an overview of the U.S. Nuclear Weapons Program and a description of how the United States maintains an effective nuclear deterrent." Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters, *Nuclear Matters: A Practical Guide* (Washington D.C.: 2008).

[18] Subject matter expert interview data and workshop critiques provided valuable background information for the project's research and served to validate the team's analytic framework. The findings reported in this paper, however, reflect the team's analysis; the paper's conclusions do not necessarily reflect the views of outside individuals or institutions that participated in the research project.

[19] Also sometimes referred to as "delivery vehicles" or "platforms"; this research project will use the term "delivery system."

[20] More broadly, this qualitative characteristic refers to means, methods, and capabilities that provide control, management, or limitation of the possible consequences of executing a nuclear attack. A prominent example of these means and methods is the ability to select a variety of yield options. The research project uses the term *variety of yield options* as a proxy for managing the consequences of a nuclear strike.

[21] The limit of no more than three characteristics in each Tier was a rule created by the research team to prompt an evaluation of the relative value of each characteristic in comparison to the other qualitative characteristics, and to make it easier to identify changes in priorities at lower numbers.

[22] For the purposes of this analysis, warheads will be defined as either "deployed" or "non-deployed" warheads. Deployed warheads are mated with delivery systems or kept relatively close to delivery systems; in short, the term applies to warheads that are not in storage. Non-deployed warheads (sometimes referred to as "hedge warheads") are kept in storage depots or other facilities; they are generally kept at a low state of readiness. Their deployment requires days, weeks, or even months.

[24] The NPR further recognizes that as the role of nuclear weapons is reduced in U.S. strategy, non-nuclear and defensive forces will assume greater responsibility for regional deterrence and regional security architectures. NPR, pp. 32-33. See also Section VII below.

[25] Although it may receive arms, money, or other resources from a state government, and/or may be hosted within the territory of a state, an ANSA is not a state proxy and represents an independent geopolitical actor.

[26] At present there are no known nuclear-armed ANSAs. This type of adversary is included in this analysis because the United States may face a nuclear-armed ANSA at some time in the future. Within open source literature, for example, Aum Shinrokyo and al Qaeda are ANSAs discussed as having displayed an interest in acquiring nuclear weapons or the nuclear materials required for developing a nuclear weapon. Jessica Stern, "Terrorist Motivations and Unconventional Weapons," p. 207 in Peter Lavoy et al., eds. *Planning the Unthinkable* (Ithaca, N.Y.: Cornell Univ. Press, 2000); Matthew Bunn, "The Risk of Nuclear Terrorism," testimony, Committee on Homeland Security and Government Affairs, U.S. Senate, 2 April 2008; Robert S. Mueller, testimony, Committee on Appropriations, Subcommittee on Commerce, Justice, Science and Related Agencies, U.S. Senate, 15 April 2010.

[27] Although production of nuclear weapons currently remains beyond the reach of ANSAs, Aum Shinrikyo successfully developed chemical weapons. The sarin used in the group's 1995 attack on the Tokyo subway system was independently produced in an Aum Shinrikyo laboratory. Richard Danzig et al., "Aum Shinrokyo: Insights Into how Terrorists Develop Biological and Chemical Weapons," Center for New American Security report, July 2011, pp. 27-28.

[28] "IAEA Director General Highlights Risks," IAEA press release, 27 January 2011.

[29] The NPR describes the United States' extended deterrence relationships with "allies and partners" as follows:

> "In Europe, forward-deployed U.S. nuclear weapons have been reduced dramatically since the end of the Cold War, but a small number of U.S. nuclear weapons remain. Although the risk of nuclear attack against North Atlantic Treaty Organization (NATO) members is at an historic low, the presence of U.S. nuclear weapons – combined with NATO's unique nuclear sharing arrangements under which non-nuclear members participate in nuclear planning and possess specially configured aircraft capable of delivering nuclear weapons – contribute to Alliance cohesion and provide reassurance to allies and partners who feel exposed to regional threats …. In Asia and the Middle East –

> where there are no multilateral alliance structures analogous to NATO – the United States has mainly extended deterrence through bilateral alliances and security relationships and through its forward military presence and security guarantees …. The Administration is pursuing strategic dialogues with its allies and partners in East Asia and the Middle East to determine how best to cooperatively strengthen regional security architectures to enhance peace and security, and reassure them that U.S. extended deterrence is credible and effective." NPR, p. 32.

[30] The top and bottom matrixes of Figure 5.1 (each one row, three boxes wide) display the results of the assessment of the relative importance of each of the eight variable characteristics in regard to deterring a peer adversary at New START numbers (top) and at lower numbers following force reductions (bottom). The middle matrix highlights the qualitative characteristics that change in relative importance as numbers decline, and notes their "movement" to a different Tier.

[31] Some subject matter experts preferred the research team capture *ability to signal* as a Tier 1 characteristic for deterring regional powers, rather than *promptness*. The team recognizes the importance of signaling, which is represented in Tier 2. However, relative to other qualitative characteristics, the research team concluded that the threat of a rapid and destructive strike at the crux of a regime's power has greater deterrent value than visibly enhancing alert levels or repositioning forces.

[32] For deterring a regional power adversary, the distribution of qualitative characteristics across Tiers 1, 2, and 3 remains unchanged as numbers of nuclear forces decline.

[33] NPR, vii.

[34] As numbers of nuclear forces decline, the key qualitative characteristics for deterring an ANSA adversary remain unchanged. As a result, there is no movement across Tiers from New START numbers to lower numbers.

[35] NPR, pp. viii-ix, 16-17.

[36] NPR, p. 33.

[37] For further discussion regarding the placement of these characteristics and changes from New START to lower numbers, see Appendix A, Section A.3, pp. 86-90.

[38] As numbers of nuclear forces decline, the distribution of qualitative characteristics across Tiers 1, 2, and 3 for prevailing over a regional power adversary does not change from New START numbers to lower numbers.

[39] As numbers of nuclear forces decline, the distribution of qualitative characteristics across Tiers 1, 2, and 3 for prevailing over an ANSA does not change from New START numbers to lower numbers.

[40] Different organizations and governments use different terms when distinguishing the range of missiles. For the purposes of this analysis, the range of intermediate-range ballistic missiles is provided by the Intermediate-Range Nuclear Forces (INF) Treaty, which defined intermediate-range systems as 1,000-5,500 km (INF Treaty, Art II, 5) and shorter-range systems as 500-1,000 km. Both intermediate and "shorter-range" systems were eliminated by the treaty's two state parties, the United States and Soviet Union (now Russian Federation). Intercontinental ballistic missiles (ICBMs) are defined as missiles with ranges "in excess of 5500km" by New START.

[41] DoD, *Ballistic Missile Defense Review* (BMDR), 2010, p. 15.

[42] "United States European Phased Adaptive Approach," State Department, 3 May 2011; "The Phased Adaptive Approach," Missile Defense Agency, 17 Sept 2009.

[43] Some states have expressed concerns that future U.S. missile defenses will possess the capability to intercept advanced, long-range missiles, allowing it to negate the nuclear deterrent forces of major nuclear powers. U.S. officials have stated that U.S. missile defenses are "capable of countering small numbers of launches of modest sophistication" and will not be capable of countering the "numbers and advanced technology" of forces fielded by major nuclear powers. Ellen Tauscher, "Transatlantic Missile Defense," address, Atlantic Council, Washington D.C., 12 Oct 2011.

[44] Should an ANSA come into possession of a ballistic missile system (or a small number of systems) capable of delivering a nuclear payload, the relationship between missile defenses and nuclear forces in terms of deterring or prevailing over this ANSA would be the same as for a similarly-equipped regional power.

[45] As stated by DASD Brad Roberts in April 2011 Congressional testimony, current U.S. homeland missile defenses can protect against ICBMs "that are few in number, relatively slow, and lack sophisticated countermeasures." Brad Roberts, "Hearing to Receive Testimony on Ballistic Missile Defense Programs", Senate testimony**,** 13 April 2011.

[46] As noted by the 2010 BMDR, "the role of U.S. nuclear weapons in … regional defense architectures can be reduced by increasing the role of missile defenses and other capabilities." BMDR, p. 23.

[47] NATO states repeatedly posed this question to the United States during the Cold War: "At the time of the establishment of the French nuclear forces in the mid-1960s de Gaulle coined the phrase that the Americans would not be willing

to trade New York for Hamburg in a nuclear war with the Soviet Union." Robbin Laird, "The French Strategic Dilemma," *CNA Professional Paper 407*, p. 2.

[48] NPR, p. 46; DoD, *2010 Quadrennial Defense Review*, p. 32.

[49] "Pentagon Revises Prompt Global Strike Effort," *GSN*, 7 April 2011.

[50] Dave Majumdar, "Panetta Backs Prompt Global Strike Capability," *DefenseNews*, 14 June 2011.

[51] U.S. Senate Committee on Armed Services, "Hearing to Receive Testimony on the Nuclear Posture Review," 22 April 2010, p. 24 and Amy Woolf, *Conventional Prompt Global Strike and Long Range Ballistic Missiles: Background and Issues*, Congressional Research Service, June 2011, p. 25.

[52] In October 2008, then-Secretary of Defense Robert Gates stated, "The goal of the new triad is to reduce our emphasis on nuclear weapons for deterrence and provide the president more non-nuclear deterrence options and responses to potential crises." Robert Gates, "Nuclear Weapons and Deterrence in the 21st Century," event transcript, 28 Oct 2008.

[53] Joshua Pollack, "Evaluating Conventional Prompt Global Strike," *Bulletin of the Atomic Scientists* (Jan/Feb 2009), pp. 13-20.

[54] The May 2011 raid on Osama bin Laden's compound, for example, illustrated a case when the intelligence and operational requirements associated with a high-value target resulted in President Obama rejecting options using bombs or missiles to destroy the compound. The president instead selected an option where Navy SEALs could both conduct a raid on the compound and, if successful, return with photographic and forensic evidence.

[55] NPR, p. 28.

[56] Michael Gerson, "Conventional Deterrence in the Second Nuclear Age," *Parameters* (Autumn 2009), pp. 32-48.

[57] NPR, p. 34.

[58] NPR, p. 46.

[59] See Appendix C, "Impact of Arms Control on Individual Qualitative Characteristics," for additional analysis on the relationship between arms control measures and each of the eight variable qualitative characteristics of nuclear forces discussed within this report.

[60] The *ability to retarget* does not appear in Tier 1 within any of the scenarios considered by this analysis, but it does appear several times in Tier 2. See Appendix A, Figures A.19 and A.20.

[61] The first deliveries of operational F-35s to Air Force bases began during the summer of 2011. "With Two Ship Arrival, Eglin F-35 Number Increases to Four," Eglin AFB press release, 1 Sept 2011" and "First Air Force JSF Landing for DoD Training," F-35 Lightning II Program press release, 15 July 2011.

[62] The top and bottom matrixes of Figure 5.1 (each one row, three boxes wide) display the results of the assessment of the relative importance of each of the eight variable characteristics in regard to deterring a peer adversary at New START numbers (top) and at lower numbers following force reductions (bottom). The middle matrix highlights the qualitative characteristics that change in relative importance as numbers decline, and notes their "movement" to a different Tier.

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[68] As numbers of nuclear forces decline, the distribution of qualitative characteristics across Tiers 1, 2, and 3 for prevailing over a regional power adversary does not change from New START numbers to lower numbers.

[69] Dr. James N. Miller, Testimony before the House Committee on Armed Services Subcommittee on Strategic Forces, 2 March 2011.

[70] Congressional Budget Office, *Counterforce Issues for the U.S. Strategic Nuclear Forces*, January 1978, pp. 9-10.

[71] "Boeing LGM-30G Minuteman III," National Museum of the U.S. Air Force Fact Sheet, 28 September 2009.

[72] Ibid.

[73] Ibid.

[74] NPR, p. 23.

[75] "Boeing LGM-30G Minuteman III," National Museum of the U.S. Air Force Fact Sheet, 28 September 2009.

[76] U.S. Senate, Committee on Armed Services, "Implementation of the New Strategic Arms Reduction Treaty," 20 July 2010, Washington, DC. See Dr. Miller's response to question #82.

[77] NPR, p. 27.

[78] NPR p. 23. These warheads were formerly carried by Peacekeeper ICBMs. The last Peacekeeper was retired in September 2005.

[79] *Nuclear Matters*, p. 37.

[80] Miller, House Testimony, 2 March 2011.

[81] "*Trident* Fleet Ballistic Missile," Navy Fact File, 17 January 2009.

[82] "Fleet Ballistic Missile Submarines – SSBN," Navy Fact File, 10 September 2010.

[83] Congressional Budget Office, *Re-thinking the Trident Force*, July 1993, p. 5.

[84] U.S. Navy, "Trident Fleet Ballistic Missile," Navy Fact File, 17 January 2009.

[85] Committee on Foreign Relations, "The New START Treaty Hearings Before the Committee on Foreign Relations, U.S. Senate (Treaty Doc. 111-5)," p. 87.

[86] See Protocol III of the New START text.

[87] NPR, p. 22.

[88] Ibid.

[89] For facts on SSBNs, see "Fleet Ballistic Missile Submarines – SSBN," Navy Fact File, 10 September 2010. Also see the Congressional Budget Office's *Crew Rotation in the Navy: The Long-Term Effect on Forward Presence*, October 2007.

[90] NPR, p. 22.

[91] This does not include the non-operational B-52Gs and B-52Hs located at Davis-Mothan AFB that are accountable under the New START Treaty.

[92] "CONECT: B-52H Receiving a Communications Upgrade," *Defense Industry Daily*, 11 October 2010.

[93] U.S. Air Force, "B-52 Stratofortress," Air Force Fact Sheet, 23 April 2010.

[94] U.S. Air Force, "Northrop B-2A," National Museum of the Air Force Fact Sheet, 20 August 2010.

[95] NPR, p. 24.

[96] "CONECT," *Defense Industry Daily*, 11 October 2010.

[97] *Nuclear Matters*, p. 37. *Nuclear Matters* distinguishes between "tactical" and "strategic" variants of the B-61.

[98] The AGM-129A is the nuclear-capable cruise missile carried by the B-52H. "AGM-129 Advanced Cruise Missile," Air Force Fact Sheet, 17 January 2011.

[99] "B-2 Spirit," Air Force Fact Sheet, 23 April 2010.

[100] Sometimes referred to as "fighter bombers."

[101] NPR, pp. *viii*, 28.

[102] The first deliveries of operational F-35s to Air Force bases began during the summer of 2011. "With Two Ship Arrival, Eglin F-35 Number Increases to Four," Eglin AFB press release, 1 Sept 2011" and "First Air Force JSF Landing for DoD Training," F-35 Lightning II Program press release, 15 July 2011.

[103] *Nuclear Matters*, p. 37.

[104] NPR, p. 27.

[105] NPR, p. 39.

[106] "LANTIRN", Air Force Fact Sheet, 30 October 2009.

[107] NATO, "NATO's Nuclear Forces in the New Security Environment," NATO Fact Sheet, 24 January 2001.

[108] GAO, "DoD and NNSA Need to Better Manage Scope of Refurbishments," May 2011, p. 6.

[109] The New START Protocol, for example, describes the following process for permanently eliminating a "heavy bomber:" "The elimination of a heavy bomber shall be carried out by cutting a wing or tail section from the fuselage at locations obviously not assembly joints, or by cutting the fuselage into two parts at a location obviously not an assembly joint" (New START Protocol, Part 3, Section V.1)

[110] Currently the only treaty to limit numbers of DCA aircraft is the Conventional Forces in Europe Treaty, which limited "combat aircraft" (a category that includes both dual capable aircraft and bombers) to 6,800 within the NATO alliance. CFE, Article IIK, IVD. New START places limits on bombers. START I placed limits on heavy bombers but expired in 2009.

[111] Although not arms control agreements, some states have diplomatic arrangements or national legislation prohibiting nuclear-armed delivery systems from using their territory. If these measures are in place for a U.S. ally, or a state seeking U.S. support in a nuclear crisis, they would prevent the visible

presence of U.S. nuclear forces on their sovereign territory signaling the U.S. intent to defend them from nuclear attack (bombers being deployed to air bases, or submarines deployed to ports, for example).

[112] During part of the Cold War, for example, the Air Force's *Operation Chrome Dome* maintained several bombers (up to one dozen) on airborne alert at all times. This was in addition to hundreds of bombers and tankers on quick-reaction ground alert at their home stations. Bombers were considered "on alert" if they were airborne and "carried nuclear weapons with all the codes and procedures for arming and releasing the bombs." Rebecca Grant, "The Perils of Chrome Dome," *Air Force Magazine*, August 2011, p. 55.

[113] If, for example, a state's central or only warhead type unexpectedly fails.

[114] An arsenal that lacks diversity in terms of warheads may impose significant constraints regarding strategy; for example, a state only fielding warheads of one yield may discover there are certain targets it cannot destroy (if the yield is too low) or that it is self-deterred from employing nuclear forces because it will cause unacceptable collateral damage (if the yield is too high).