

STIMSON

Resolving Ambiguity:
Costing Nuclear Weapons

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Executive Summary

As the defense budget comes under increasing pressure, many have suggested nuclear weapons as an area for savings. But estimates of what the United States spends on nuclear weapons widely vary.

This report provides an estimate of US spending on nuclear weapons that resolves most of the ambiguity created by that variance. It makes two key contributions to the debate about nuclear weapons spending and nuclear weapons policy. First, it clarifies there are few disagreements about the costs of particular components of the nuclear enterprise—which are usually based on official accounts. Instead, most of the ambiguity stems from disagreements about what should be included as nuclear costs under the broad umbrella of costs associated with or related to nuclear weapons. This report reviews official estimates and independent studies, and then arrays these in a like manner to demonstrate most disagreement is definitional.

Second, this report takes a new approach to estimate the costs of the most uncertain part of the nuclear enterprise. It provides a new estimate where disagreement is real and not just definitional. Although many costs might be reasonably included as part of the broader nuclear enterprise, the costs associated with strategic nuclear offensive forces are most contested and yet also most relevant to on-going policy debates. Although the Departments of Defense and Energy each have an account dedicated to these costs, there are costs that support strategic nuclear offensive forces outside of these accounts as well. For the Department of Energy, these costs introduce relatively small swings in estimates; conversely, the size of the Department of Defense budget allows for very large swings in estimates. This report uses an inductive, bottom-up method to estimate the costs within the Defense Department more exactly than previous studies, which have relied on deductive, top-down methods.

Using this methodology, this report estimates that the Department of Defense spends \$23 billion in support of strategic nuclear offensive forces. Of these costs, \$12 billion are found in the account dedicated to strategic forces, while \$11 billion support strategic nuclear offensive forces, but lay outside of the account dedicated to strategic nuclear offensive forces. Despite the greater granularity of this methodology, some uncertainty remains for two primary reasons: the difficulty in assigning costs of aerial refueling tankers that support strategic nuclear offensive forces, and the theoretical difficulty in clearly delineating what is strategic nuclear offensive forces.

This report estimates an annual total of \$31 billion is spent on nuclear weapons when costs dedicated to strategic nuclear offensive forces found in the National Nuclear Security Administration of the Department of Energy are included. Although this report focuses on a single-year estimate, it also extrapolates these costs over a 10-year period of time. It then adds in the additional modernization costs resulting from development programs to replace ballistic missile submarines and strategic bombers. In total, this report estimates that the United States will spend between \$352 and \$392 billion on strategic nuclear offensive forces over the next 10 years. As with the single-year estimate, these sums do not include modernization programs like the next-generation aerial refueling tankers, which could significantly alter the 10-year estimate. This estimate does not represent all of US government spending on nuclear weapons—the broader nuclear enterprise—but only an estimate of the spending on a single subset: strategic nuclear offensive forces.

At the very least, this study should clarify that official estimates relying on a narrow definition of the nuclear enterprise, or even of strategic nuclear offensive forces, understate the actual costs the United States spends on nuclear weapons without settling once and for all what is the single right cost of the nuclear enterprise.

Underlying debates about nuclear weapons spending is the policy debate about nuclear weapons themselves. Too often this more important debate is confused by the debate about costs. This report resolves the ambiguity that has long persisted in the costs of nuclear weapons in order to return the debate to the basic policy questions.

I. Introduction

The defense budget likely will be under great pressure in the coming years. The defense budget for the next nine years is to stay under spending caps set by Congress last fall, and the fiscal situation that prompted those caps still remains. In response, the Department of Defense (DoD) and other observers are considering ways to save money, not least of which by looking to missions or capabilities that may no longer be needed, at least at their current levels. First among these capabilities is nuclear weapons. DoD's own strategic guidance acknowledges the possibility that our future nuclear mission could be accomplished by fewer nuclear weapons: "It is possible that our deterrence goals can be achieved with a smaller nuclear force, which would reduce the number of nuclear weapons in our inventory as well as their role in US national security strategy."¹

A smaller nuclear weapons force presumably means less spending, but no one can say how much lower, in part because there is no definitive estimate of their cost.²

Current estimates vary widely. The administration has said the United States will spend about \$214 billion on nuclear weapons in the next 10 years, or an average of \$21.4 billion a year.³ In contrast, independent studies of nuclear weapons costs have put annual expenditures at well over \$50 billion a year.⁴ Although these estimates appear wildly divergent, most of the difference is due to how each study defines what counts toward nuclear spending. The administration narrowly defines nuclear weapons spending as the costs to operate and maintain nuclear delivery systems and nuclear warheads. In contrast, independent studies define nuclear weapons spending very broadly, counting missile defense costs and the costs to clean up sites previously used for nuclear research, among others.

But even when costs are properly assigned to commonly defined aspects of the nuclear enterprise and compared correctly, ambiguity remains. Most of this ambiguity resides in a specific part of nuclear weapons spending: the funding within DoD for capabilities that support strategic nuclear offensive forces, but are not nuclear delivery systems. For example, the personnel who operate the delivery systems are included in DoD's costs, but the personnel and infrastructure necessary to recruit and train them are not. As an even more pointed example, the delivery systems are included in the administration's figure, but not the command and control systems that allow the President to direct the delivery systems. Although some may feel that the broader definitions include too

1 Department of Defense, "Sustaining US Global Leadership: Priorities for 21st Century Defense," January 2012.

2 For a review of a recent controversy over spending on nuclear weapons see Kingston Reif, "The Nuclear Weapons Budget, Contd," *Nuke of Hazard Blog*, December 12, 2011. As noted in the acknowledgements, this report and the research underlying it was supported by a grant from the Ploughshares Fund.

3 James N. Miller, Testimony before the House Armed Services Subcommittee on Strategic Forces, November 2, 2011.

4 The most recent study is Stephen Schwartz and Deepti Choubey, "Nuclear Security Spending: Assessing Costs, Examining Priorities," *Carnegie Endowment Report*, January 2009, which put 2008 spending at \$52 billion. This and other reports will be discussed further later in the report.

much, direct supporting costs seem critical to our nuclear weapons spending, since those costs are necessary to operate our nuclear weapons.

The Pentagon does not include these funds in its cost estimates because its budgeting systems do not assign these costs to the nuclear mission. DoD budgeting systems do not assign these costs to the nuclear mission for a very understandable reason: these costs are not unique to the nuclear mission. The infrastructure that recruits and trains our nuclear operators also recruits and trains operators of non-nuclear—or conventional—capabilities. The command and control systems that direct our nuclear systems also direct our conventional systems. If the Pentagon's accounting systems assigned these costs solely to the nuclear mission, it would then significantly underestimate the costs of the conventional missions. The Pentagon, reasonably, solves this problem by not assigning the costs to either the nuclear or conventional missions. The costs are accounted for in its annual budget justification and historical displays, but since they are not specifically assigned to particular capabilities, nuclear support costs cannot be easily disaggregated from conventional support costs. In the end, this difficulty means there is no official account of the total costs of the nuclear mission—even narrowly defined.

Independent studies have recognized this official underestimate and tried to account for these additional costs. But independent studies face their own difficulties. First, they face the same theoretical difficulties that confound the Pentagon. Second, independent analysts do not have access to the actual funding data or Pentagon databases that may have the information necessary to disaggregate nuclear from conventional costs. Third, they also face security issues. Nuclear weapons are possibly the most classified defense program. Funding data, and even operational concepts, may not be available in the public sphere, limiting the comprehensiveness of independent studies. Most independent studies have addressed these difficulties by employing a deductive approach by assuming that a percentage of total DoD costs is allocated to the nuclear mission. Although producing a reasonable estimate, this method is inherently imprecise since it assumes uniform costs across a very large defense establishment. Just as the Pentagon's method is too narrow to be definitive, the independent studies' methods are too broad to be definitive, leaving considerable ambiguity despite agreement on both definitions and costs.

This report better resolves that ambiguity. Like the independent studies, it recognizes that the Pentagon's methodology understates total costs, but unlike the independent studies, it takes an inductive approach to estimating the costs of those supporting capabilities—especially within the Pentagon's budget—necessary to operate strategic nuclear offensive forces. The report scrubs public budget data to create a bottom-up compilation of costs, thus significantly narrowing the assumptions made by previous independent studies. This report still faces all of the previously outlined problems limiting previous studies. It overcame some of those problems through a more detailed costing of individual parts. However, this report, in the end, is not definitive. No report or estimate—even an official estimate—can be definitive because of the fundamental and legitimate theoretical and definitional uncertainty.

Nevertheless, this report presents a bottom-up compilation of costs laid out in a transparent manner. The process should resolve the continuing controversy over how much we spend on nuclear weapons. Reasonable disagreement will still remain about what should or should not be counted, and even what a capability does or does not cost. But by providing an annotated list,

this report provides a clear basis for comparing assumptions. By doing so, this report narrows the ambiguity inherent in costing our nuclear enterprise and clarifies the policy issues at play.

The cost of the nuclear enterprise, and the debate over the cost of nuclear weapons, is central to several critical policy issues. If nothing else, at the center of the debate lies the issue of how the United States should handle nuclear weapons. Reasonable people can disagree about this basic issue, and most certainly reasonable people can disagree in the debate over steps that should be taken from where we are today. However, the debate has been clouded recently by too great a focus on what is counted and what it costs, especially when that debate degenerates into assumption against assumption. Accounting more exactly for the cost of our strategic nuclear offensive forces should clarify the debate.

To do so, this report is laid out in the following sections. First, it reviews previous estimates—of both official estimates and independent studies—in greater detail, including what parts of the nuclear enterprise are included, and clarifies why ambiguity remains in the debate about the costs of our nuclear enterprise. Second and most importantly, it generates a single-year figure for the costs necessary to support strategic nuclear offensive forces, especially those costs contained in DoD's budget, but not regularly included by DoD in its estimates, which are the most uncertain costs of the nuclear enterprise. This section is the key contribution, and it breaks down supporting capabilities into specific parts, explains the methodology used to cost each part, and then describes the total costs. Third, the report extrapolates the single-year number into a 10-year cost of strategic nuclear offensive forces, including examining and estimating how current modernization efforts will affect spending levels. Finally, the report lays out how these estimated costs better resolve the ambiguity found in the debate about the costs of the nuclear enterprise, and how this resolution clarifies the debate.

Nuclear weapons are the gravest weapons in the US arsenal. We should always be examining their value and purpose. That is even truer today as DoD faces very real spending constraints, and the world continues to change away from the world we first built nuclear weapons for. This report clarifies the debate about those issues by better resolving ambiguity inherent in our current discussion of nuclear weapons.

II. The Context of Estimating the Nuclear Enterprise

In 1946, President Harry Truman signed the act creating the Atomic Energy Commission, which transferred responsibility for the control of nuclear weapons from military to civilian hands. This division made costing the nuclear enterprise difficult. Although nuclear warheads and their development went to a civilian agency, the delivery systems—and their development—that would carry the warheads stayed with what became the DoD, thus creating two different organizations responsible for two different budgets and forever splintering estimates of the costs of the nuclear enterprise.⁵

This bifurcated context creates the first difficulty when costing nuclear weapons: what should be defined as nuclear weapons. Because this definitional problem is central to the difficulty of costing nuclear weapons, the words and terms used are very important. To address this difficulty, this report creates three levels grouping nuclear weapons costs, and uses two specific terms to refer to two of these groupings. The report does not use a specific term to refer to the third grouping, because a strict definition would infringe on the second grouping. Instead, we use a practical definition.

At the broadest level this report uses the term “nuclear enterprise” to mean the widest possible definition. The report does not exactly define this grouping, or even what capabilities belong in this grouping. Other studies have argued that environmental clean-up, non-proliferation, and missile defenses, among others should all be considered part of the nuclear enterprise. This report reviews what capabilities other studies have included, but recognizes there is not a definitive set of capabilities all agree are associated with and related to nuclear weapons. Instead this report acknowledges this shifting definition, and uses the term “nuclear enterprise” only to refer to this broadest level.

This report uses the term “strategic nuclear offensive forces” to mean specifically that part of the nuclear enterprise maintained to strike an adversary with nuclear weapons. As just described, many costs can reasonably be associated with nuclear weapons. Costs to clean up areas where nuclear weapons were developed would not exist if nuclear weapons had not been developed. Costs to mitigate the threat of proliferation of nuclear weapons would not exist if nuclear weapons had not been developed. Costs to defend against nuclear-armed missiles would not be necessary if nuclear weapons did not exist. Nevertheless, when most people think of nuclear weapons, they think about the strategic offensive forces that enable the United States to launch nuclear weapons at an adversary, like missiles leaving siloes, or bombs falling from aircraft. To be blunt, when people use the phrase nuclear weapons, they mean to describe that which the United States may use to kill people.

⁵ Stephen Schwartz in his book *Atomic Audit* discusses the early difficulties of assigning costs, drawing on the work of Lee Bowen and Robert Little “A History of the Air Force Atomic Energy Program,” 1943-1953, vol. 3: *Building an Atomic Air Force*, 1943-1953 (Washington, D.C.: U.S. Air Force Historical Division, 1959), pp.471-472.

Within that broad definition, this study makes a specific exception—the costs within DoD to support non-strategic nuclear weapons.⁶ Non-strategic nuclear weapons, also known as tactical or theater nuclear weapons, represent a specific subset of nuclear weapons. The cost for these weapons are captured in the budget documentation provided by the Department of Energy (DoE), but the costs of these weapons are not delineated in DoD budget documents. In order to ensure this study’s methodology is repeatable, it has omitted these weapons and their costs from the analysis of DoD’s budget, even though most observers would agree they are legitimate costs not only of the nuclear enterprise broadly, but also of this smaller subset of striking nuclear weapons.

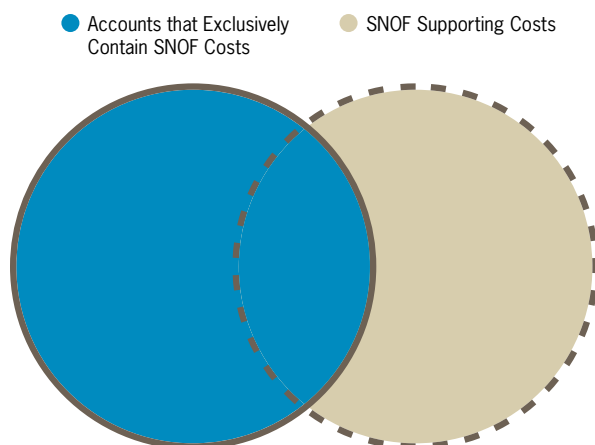
This grouping of “strategic nuclear offensive forces” is also analytically useful. Just as the costs to clean up areas where nuclear weapons were developed would not exist if nuclear weapons had not been developed, those costs would still exist even if the United States instantly disarmed and eliminated its nuclear arsenal. Similarly, costs of non-proliferation and missile defenses would not be reduced by the decision to disarm, and could even be increased. Presuming there is no way to undo the existence of nuclear weapons, and accepting the United States’ limited ability to affect other nations’ nuclear weapons, the United States has the most policy discretion over its own strategic nuclear offensive forces.

This report estimates the costs of “strategic nuclear offensive forces” and in doing so defines the set of capabilities that comprise strategic nuclear offensive forces. At a high level, strategic nuclear offensive forces include the missiles, bombers, submarines, warheads, command and control systems, targeting systems, labs that maintain the warheads, all of the people associated with all of these activities, and all of the supporting activities and their people necessary to operate and maintain these forces. DoD and DoE each have a budget account that exclusively contains costs of strategic nuclear offensive forces, and those accounts form the basis for this report’s estimate of the costs of strategic nuclear offensive forces.⁷ These accounts have official cost estimates no one contests, so therefore are the least interesting aspects of this report. But those accounts do not comprehensively cover all costs of strategic nuclear offensive forces and so this report uses the term to mean more than those accounts. Section III will cover what other capabilities and costs this report included as part of strategic nuclear offensive forces, and so define the universe of strategic nuclear offensive forces practically rather than by a theoretically exact definition.

At a third level, this report creates and costs a subset of strategic nuclear offensive forces: the other supporting costs—primarily within DoD—necessary to operate and maintain strategic nuclear offensive forces but outside of those accounts dedicated to strategic nuclear offensive forces. This report does not use a single term to refer to these other supporting costs because a strict definition would include costs already contained within the dedicated accounts. The dedicated accounts include not just the primary aspects of nuclear weapons, such as the warheads themselves and the delivery vehicles that carry the warheads, but some capabilities and costs that support operating and maintaining these primary aspects. A strict definition of support costs would include some portion of these accounts.

⁶ See page 40 for a greater discussion of the methodological difficulties of non-strategic nuclear weapons.

⁷ Weapons Activities for DoE and MFP-1 for DoD; MFP-1 has a small number of exceptions to its exclusive coverage of strategic nuclear offensive forces. These accounts, the exceptions, and their implications are covered more fully in Section II.

Figure 1: Strategic Nuclear Offensive Forces

This third definitional grouping is meant to capture only those costs outside of these accounts. Outside of these accounts are a number of capabilities and costs that are necessary to support strategic nuclear offensive forces. It is these costs—those that support strategic nuclear offensive forces but are outside of the exclusively strategic nuclear offensive forces accounts—that are the most uncertain costs of the nuclear enterprise, and therefore the key contribution of this report and what this third level of grouping is to capture. Figure 1 provides a visual display of these relationships; the

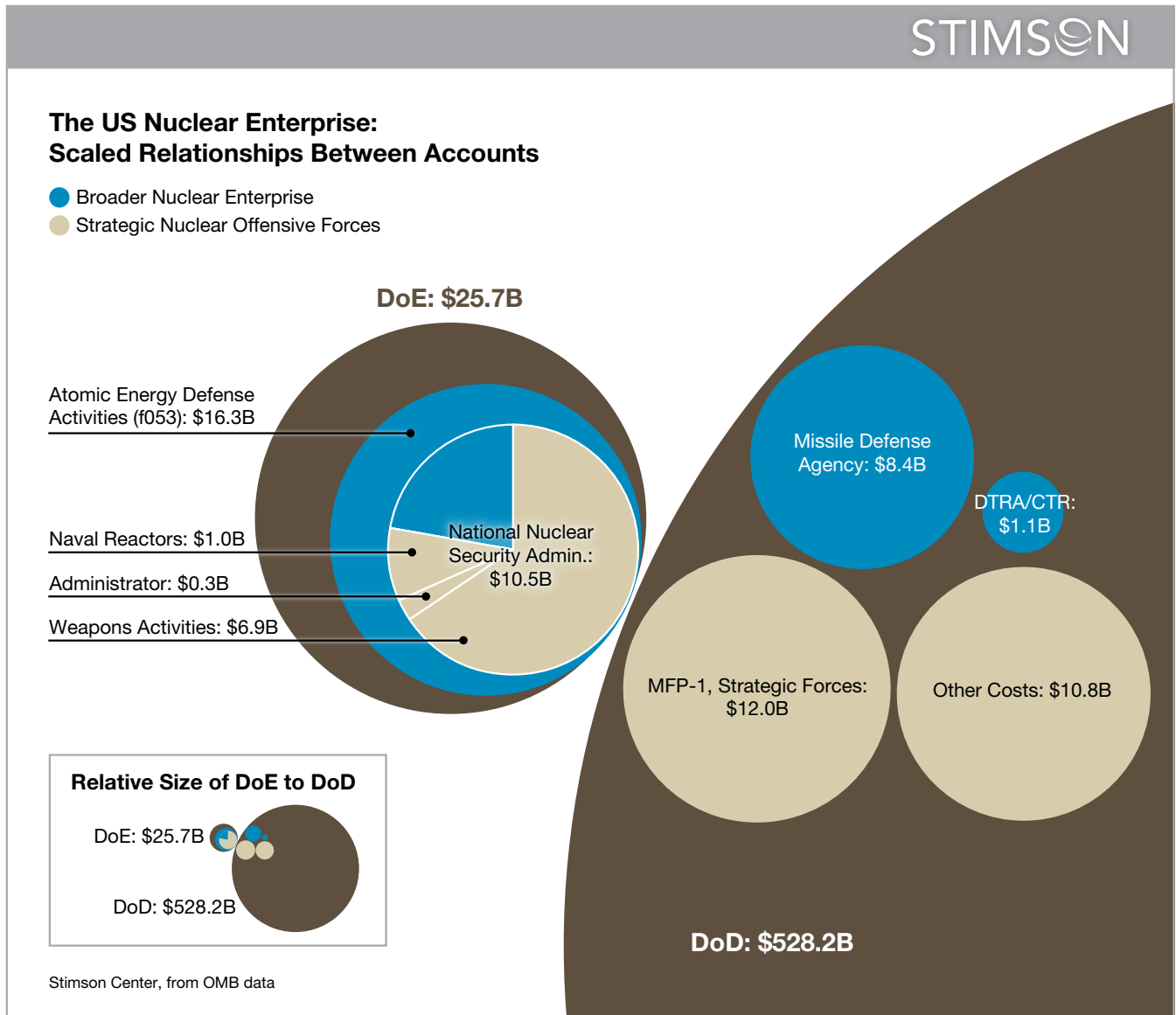
beige area is what this third level grouping describes. Section III defines and costs this grouping. Because of the ambiguity inherent in describing this grouping, when referring to it this report stresses the modifier “other,” and takes the space to more completely define what is being discussed as these costs are presented. While not as elegant as assigning a specific term to describe these costs, this method is more precise.

Finally, this report also uses the phrase “nuclear weapons” as a general descriptor when it is not necessary or appropriate to more exactly define what is being referred to. In this report, nuclear weapons does not have a technical definition. When discussing more specific capabilities than the three groupings and two terms described above, this report uses the appropriate technical terms with a description—but not definition—of what those terms represent to aid the layperson’s understanding. And last, this report uses the term “nuclear mission” to loosely capture the purposes of US nuclear weapons. What these purposes are is a matter of some debate itself, and a matter outside of this report’s scope.⁸ To avoid this debate, this report therefore uses the term nuclear mission to represent all the possible purposes without assuming any preference.

Figure 2 provides a visual summary of how various parts of the nuclear enterprise relate to each other, with specific attention to ascribing strategic nuclear offensive forces. Most importantly, the chart is scaled to illustrate funding levels. The nuclear enterprise is represented by all components colored blue or beige. Neither this chart nor this report provide an estimate for the nuclear enterprise. In this chart, formal budget accounts are used to represent aspects others have previously designated as part of the nuclear enterprise: DoD’s Missile Defense Agency represents missile defense costs; Cooperative Threat Reduction (CTR) and the Defense Threat Reduction Agency (DTRA) represent DoD non-proliferation efforts. Within DoE, Atomic Energy Defense Activities represents the costs of defense environmental clean-up as well as other nuclear-related costs. Some may define the nuclear enterprise differently, but this chart illustrates the universe and scale of what could be considered the nuclear enterprise without attempting to be definitive.

⁸ For a summary of the debate see Christopher F. Chyba and J. D. Crouch, “Understanding the U.S. Nuclear Weapons Policy Debate,” *The Washington Quarterly*, Vol. 32:3, July 2009, pp. 21-36.

Figure 2: Strategic Nuclear Offensive Forces



Strategic nuclear offensive forces are represented by all components colored beige. The costs displayed represent the findings of this report. The components are described in greater detail in Section III.

These three levels of groupings enable this report to serve two key purposes. First, it clarifies there is a “nuclear enterprise,” although there is reasonable disagreement about what should be included as part of it. Most importantly, it emphasizes that these disagreements are not really about the costs of these components—which are based on formal accounts—but about what should be included. Second, it clarifies and costs the most uncertain aspect of the nuclear enterprise—those costs that support strategic nuclear offensive forces, but are not included in the accounts exclusively dedicated to them.

Using these terms to provide clarity, the following section explicates previous estimates to estimate the costs of the nuclear enterprise in more detail.

The Official Estimates

Today, two agencies represent the split of nuclear weapons' costs created 65 years ago.⁹ The National Nuclear Security Administration (NNSA) at DoE is the descendant of the Atomic Energy Commission and DoD is the heir to the World War II military that first oversaw nuclear weapons. Although neither agency satisfies its critics, both agencies understand the gravity of their mission in overseeing nuclear weapons and both regularly produce their own estimates of what they spend on nuclear weapons.

Atomic Energy Defense Activities

President Truman is also responsible for how the US Government budget is currently displayed. In 1948, he and his Budget Bureau proposed a classification scheme for the budget that aggregated programs into functions—broad categories of like spending.¹⁰ One of these functions was National Defense. In 1955, the subfunction dealing with atomic energy was moved under National Defense because of the reliance on atomic energy in defense. It finally became subfunction 053, “Atomic Energy Defense Activities,” in 1976 dealing only with the military applications of nuclear power; the civilian applications being covered in the Energy function. Today, budget subfunction 053, Atomic Energy Defense Activities, covers all defense-related uses of atomic energy not in DoD.

However, for some this category captures too many costs. Specifically, 35% of the \$16.3 billion spent on Atomic Energy Defense Activities in 2011 was spent on cleaning up sites used to develop or make nuclear weapons, primarily sites used in the original work of the Manhattan Project. While these costs are clearly part of the costs of nuclear weapons—the US Government would not need to clean up nuclear residue if a nuclear bomb had never been developed—these costs are not directly tied to our current or future nuclear weapons or nuclear weapons policy. Current sites supporting the nuclear enterprise are maintained at a high standard that has little environmental impact.

National Nuclear Security Administration

Because of the broader scope of the budget subfunction, Atomic Energy Defense Activities, some would cite the NNSA as the correct budget line to capture the costs of the civilian side of the nuclear enterprise. When President Ford signed the Energy Reorganization Act in 1974, the Atomic Energy Commission was dissolved due to substantial regulatory and environmental concerns arising

9 Other US government agencies could reasonably be considered part of the nuclear enterprise, and thus part of the cost of nuclear weapons. For instance, the Department of State runs certain non-proliferation efforts and the Department of Homeland Security is responsible, at least partly, for responding should a nuclear weapon be used on US territory. Because this report does not seek to cost the broader nuclear enterprise, it examines only the Departments of Defense and Energy, who are solely responsible for the costs of strategic nuclear offensive forces.

10 US General Accounting Office, “Budget Function Classifications: Origins, Trends, and Implications for Current Uses,” GAO/AIMD-98-67, February 1998. Interestingly, President Truman’s 1948 budget did not actually include Atomic Energy Related Activities under National Defense. Instead, it included the Atomic Energy Commission under the function Natural Resources, to emphasize his administration’s plan and desire to harness atomic energy for peaceful purposes. The Budget of the United States Government for the Fiscal Year Ending June 30, 1948, United States Government Printing Office (Washington, D.C., 1947), p. 1353.

from the Atomic Energy Commission's conflicting roles as the developer of nuclear weapons and regulator of civilian nuclear power.¹¹ The act transferred the national nuclear laboratories to the Energy Research and Development Administration within DoE.¹² Then in 1999 in the aftermath of allegations that lax oversight and security had culminated in the loss of nuclear secrets to China, NNSA was created and assumed responsibility for the national security responsibilities of DoE.¹³ The bulk of its activities are devoted to the development and stewardship of nuclear warheads, most of which are for strategic purposes, however, also include non-strategic, or tactical, nuclear weapons as well. And these activities are clearly budgeted under the line "Weapons Activities" within the annual budget justification submitted to Congress and available publicly. These activities account for almost—but not quite—all of the agency's efforts to maintain the stockpile of nuclear warheads, including the work at the national laboratories. For 2011, Weapons Activities received \$6.9 billion.

However, NNSA is responsible for more than just weapons activities. It is also responsible for nonproliferation efforts to prevent the spread of nuclear weapons materiel and even knowledge beyond the currently acknowledged nuclear powers and, most importantly in today's age, to terrorists or other non-state actors. It received \$2.3 billion to fund these activities in FY11.

Furthermore, NNSA also budgets separately for the Office of the Administrator, capturing the centralized management and oversight costs of all of its activities including both weapons activities and nonproliferation activities. Here, then, is the first complication in assigning costs to the subset of the nuclear enterprise, strategic nuclear offensive forces. The weapons activities could not be carried out without the staff, support, and funding of the Office of the Administrator, or some of those costs and efforts would have to be dispersed to the various activities if those activities were to function independently of the Office of the Administrator. How to divide these costs is a thorny problem that even the NNSA administrator would have a difficult time solving.

Assigning costs only gets more complicated from there. NNSA also oversees the Naval Nuclear Propulsion Program, which designs and maintains the nuclear reactors that power certain US Navy ships. Only three types of ships in today's fleet are powered by nuclear energy: all of the aircraft carriers, all three classes of attack submarines, and the Ohio-class ballistic submarines. In the past, aircraft carriers did carry tactical nuclear weapons but today do not, and only rely on nuclear energy for propulsion, making it a simple case for whether to bin as a cost of strategic nuclear offensive forces or not.¹⁴ The Ohio-class ballistic submarines are also a simple case. Not only powered by nuclear energy, they carry the Trident missiles that constitute the sea-based leg of US strategic nuclear offensive forces, making their costs clearly part of strategic nuclear offensive forces. The attack submarines are not as clear a case. They do not carry nuclear weapons and rely on nuclear energy only for propulsion. But as will be discussed later, they have a role in undersea warfare, potentially responsible for finding an adversary's ballistic missile submarines. Regardless,

11 Alice Buck, "A History of the Atomic Energy Commission," United States Department of Energy, July 1983, <<http://www.atomictraveler.com/HistoryofAEC.pdf>>.

12 National Nuclear Security Administration, "President Ford Signs the Energy Reorganization Act of 1974," no date, <<http://nnsa.energy.gov/aboutus/ourhistory/timeline/president-ford-signs-energy-reorganization-act-1974>>.

13 James Risen and David Johnston, "U.S. Will Broaden Investigation of China Nuclear Secrets Case," *The New York Times*, September 23, 1999, <<http://www.nytimes.com/1999/09/23/us/us-will-broaden-investigation-of-china-nuclear-secrets-case.html?pagewanted=all>>.

14 Jerry Miller, *Nuclear Weapons and Aircraft Carriers: How the Bomb Saved Naval Aviation*, (Smithsonian Institution Scholarly Press: 2001).

each type of naval vessel has a different relationship to the nuclear enterprise, making it difficult to assign the costs of this program to strategic nuclear offensive forces.

Despite these irregularities, the NNSA and DoE annually provide clear budget documents that capture its part of the nuclear enterprise. The civilian side of the nuclear enterprise may not be all of the NNSA's budget of \$10.6 billion, or it may be slightly more to incorporate other overhead and management costs captured in the broader DoE budget. Or it may best be described by including the broader clean-up costs found elsewhere in the DoE's budget. But the costs are bounded at least by the amount included in the budget subfunction Atomic Energy Defense Activities. DOE nuclear spending is clear and disagreements are minimal compared to DoD nuclear spending.

The Department of Defense

The other side of the split nuclear enterprise is owned by the DoD. Although the nuclear warheads are developed and maintained by the NNSA, they are deployed on delivery systems developed, maintained, and operated by DoD. Moreover, DoD provides other capabilities that could reasonably be considered part of the nuclear enterprise. But DoD's story is very different from NNSA's. DoD was created in 1947 to consolidate the War and Navy Departments and house the newly created Air Force.¹⁵ In so doing, it became the home of hundreds of years of traditions and missions, rather than being created solely for the nuclear mission like the NNSA and its predecessors. Maybe more importantly, those missions and traditions—post 1950—are funded on a scale 60 times the size of the NNSA budget, and 25 times the size of the entire DoE budget. That scale creates a significantly wider range of possible costs of DoD's side of the nuclear enterprise.

Despite the traditions and missions compounding the possible range of costs, in the 1950s DoD's primary mission was nuclear deterrence.¹⁶ Behind President Eisenhower's strategy of "massive retaliation," the Air Force received on average 44% of each year's defense budget from 1954-1960, and the Strategic Air Command—the lead organization for conducting nuclear deterrence—dominated the Air Force's budget.¹⁷ Because of this focus, the other military services attempted to characterize their programs as key to the nuclear mission, blurring the division between strategic and non-strategic forces.¹⁸ In the 1960s, Secretary of Defense Robert McNamara set out to more closely account for forces by mission area and therefore compare them better. To do so, he and his team divided the defense budget into nine major programs, including a program dedicated to Strategic Retaliatory Forces and Continental Defense Forces, thus creating a formal tally of DoD's nuclear spending.¹⁹

15 Technically the National Security Act of 1947 created the National Military Establishment, which became the Department of Defense in 1949.

16 Herman S. Wolk, "The 'New Look'," *Air Force Magazine*, v. 65, no. 8, August 2003.

17 Mike Worden, *Rise of the Fighter Generals: The Problem of Air Force Leadership, 1945-1982*, (Air University Press:1998), p. 221 and FY12 Department of Defense Greenbook, Table 6-10.

18 Paul Y. Hammond, "Super Carriers and B-36 Bombers: Appropriations, Strategy, and Politics." In *American Civil-Military Decisions: A Book of Case Studies*, 484-554. (University of Alabama Press: 1963) and Andrew Bacevich, *The Pentomic Era: the US Army Between Korea and Vietnam*, (National Defense University Press: 1986).

19 Charles J. Hitch, *Decision-Making in Defense*, (University of California Press: 1965). The role of the Major Force Programs will be discussed further later in this report.

As a vestige of that effort, DoD has provided an annual cost of the systems it operates and maintains to support the nuclear mission. These systems are grouped together in what is called Major Force Program 1 (MFP), Strategic Forces, one of 11 major force programs that together display the entire defense budget by like categories. More than 40 percent (including war costs) of the defense budget is found in a single MFP—general purpose forces, which are the combat forces that conduct conventional, or non-nuclear, operations. In contrast, MFP-1 accounts for only two percent of the total defense budget. The rest of the budget is spread out over the other nine major force programs.

MFP-1 covers most of what is usually considered strategic nuclear offensive forces. It includes the Air Force's bombers, the Air Force's missiles, and the Navy's ballistic submarines. It includes the people and infrastructure that support those weapons systems. It includes the costs to operate and maintain those weapons systems.

But MFP-1 today does not approximate DoD's costs of the nuclear enterprise. DoD also includes capabilities and their costs that could reasonably be included as costs of the broader nuclear enterprise. Specifically, DoD pays for basically all of the costs for missile defense and some of the costs for non-proliferation efforts.

DoD has always held responsibility within the US government for missile defense.²⁰ Since 2002, the Missile Defense Agency has been the primary organization responsible for missile defense within DoD and within the US government. None of the costs of the Missile Defense Agency are captured by MFP-1. In FY11, the Missile Defense Agency itself received \$8.5 billion, and other funds went to support other programs run by the military services as well.²¹

After the fall of the Soviet Union, what became known as non-proliferation efforts were housed at DoD. As the difficulties of fissile material became more central, the DoE took on more of a role, captured in the NNSA non-proliferation programs above.²² Today, DoD still receives about \$500 million a year in support of cooperative threat reduction as part of government-wide non-proliferation efforts, and another \$500 million for the Defense Threat Reduction Agency's research and development programs.²³ However, other parts of DoD also perform non-proliferation tasks and may need to be accounted for as well to establish a comprehensive take to assess DoD costs for non-proliferation. Non-proliferation efforts can also be found in agencies other than DoD and DoE.²⁴ Besides these examples, other costs within DoD could also be reasonably considered part of the nuclear enterprise.

More importantly for this report's purposes, MFP-1 does not correspond directly even to the costs of strategic nuclear offensive forces.²⁵ The major force programs have not been used regularly to

20 For a simple history of US missile defense, see the Missile Defense Agency's "Missile Defense: The First Sixty Years," August 15, 2008.

21 FY13 President's Budget Submission, Missile Defense Agency, Volume 2a, p. xxiv.

22 "Nonproliferation Programs Need Better Integration," Government Accountability Office, January 2005, GAO-05-157.

23 FY13 Budget estimates, Cooperative Threat Reduction Program, Defense Threat Reduction Agency, February 2012. DoD FY13 President's Budget Submission, Defense Threat Reduction Agency, RDT&E, February 2012.

24 Specifically, the State Department's Non-proliferation, Anti-Terrorism, and Demining program provides about \$300 million a year for non-proliferation activities. FY13 Executive Budget Summary, Function 150 and other International Programs, Department of State, p. 112.

25 The Secretary of Defense Task Force on DoD Nuclear Weapons Management acknowledged in its Phase II report that not all costs within DoD associated with strategic nuclear offensive forces were captured in MFP-1. Secretary of Defense Task Force on DoD Nuclear Weapons Management, "Phase II: Review of the DoD Nuclear Mission," December 2008, p. 22.

manage or even budget the DoD since McNamara. As such, the elements that make up the major force programs have not been managed to ensure the MFPs reflect an accurate and comprehensive accounting of the categories they were originally intended to represent. Three specific examples illustrate the deficiencies of MFP-1: the B-1 bomber, submarine research and development, and command and control satellites.

As noted earlier, MFP-1 contains the cost to operate the Air Force's bombers, but those costs include the operation of the B-1 bomber.²⁶ The B-1 was originally developed as a low-flying, fast jet to evade Soviet air defenses and deliver nuclear bombs.²⁷ But it wasn't fielded until the 1980s, and by that time, secret efforts to develop stealth technology were rendering the B-1's obsolete.²⁸ Moreover the signing of the START treaty limited the number of nuclear delivery vehicles, making the B-1's nuclear capability a liability rather than an asset. By 1995, the B-1 fleet had been converted to an exclusively conventional role, and none of the aircraft are now capable of carrying nuclear weapons.²⁹ However, since the B-1 was initially nuclear-capable, its costs are still included in MFP-1. As this example illustrates, MFP-1 does not exclusively cover DoD's costs of strategic nuclear offensive forces.

The MFPs were designed to capture the full lifecycle costs of a weapons system. But even when the MFPs were first created, the DoD funded basic research that was not specific to any weapon system. For this reason, a separate MFP—Research and Development—was created to hold these costs. Originally, as research and technology developed enough to assign it to a specific weapons system, its funding was to be moved to the relevant MFP. But, as the use of the MFPs as a management tool atrophied, these moves ceased. That is the current case with the Navy's next-generation ballistic missile submarine. The Navy maintains certain research lines designed to further the capabilities of submarine development. At a certain point, these research lines represented an intentional effort to design a system to replace the Ohio-class submarines, which currently carry the sea-based leg of the nuclear arsenal. However, these research lines are still carried in the research and development MFP, and have not been shifted to MFP-1, as originally intended. As this example illustrates, MFP-1 does not comprehensively cover DoD's costs of strategic nuclear offensive forces.

Similarly, MFP-1 does not include most of the costs to maintain the command and control of strategic nuclear offensive forces. Since the MFPs were first created and used in the 1960s, command and control has increasingly relied on satellite-based communication systems. These communication systems are not just used to direct nuclear forces, but all US military forces. As with NNSA's Office of the Administrator and Naval Reactor program, assigning the costs of these systems accurately to the nuclear or conventional missions is difficult. Nevertheless, command and control is so critical to the operation of US nuclear forces, it is even more difficult to argue these costs should not be accounted for in some way. As this example illustrates, a full accounting of DoD's costs of strategic nuclear offensive forces must include funding outside of MFP-1.

26 Department of Defense, "Future Years Defense Program (FYDP Structure), April 2004, <<http://www.dtic.mil/whs/directives/corres/pdf/704507h.pdf>>.

27 Congressional Budget Office, "The B-1B Bomber and Options for Enhancements," August 1988, <<http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/62xx/doc6257/doc07b-entire.pdf>>, p. xi-x.

28 Roger Bezdek, "B-1: a history," *Bulletin of the Atomic Scientists*, Volume 40, number 9 (November 1984), p.13.

29 Federation of American Scientists, "B-1B Lancer," no date, <<http://www.fas.org/programs/ssp/man/uswpns/air/bombers/b1b.html>>.

Even if MFP-1 was an exclusive and comprehensive account of defense spending support nuclear delivery systems, definitional challenges would still undermine the definitiveness of the estimate. For example, B-52 and B-2 bombers serve both nuclear and conventional missions and if the United States eliminated the nuclear mission, it might retain every B-52 or B-2 bomber. If the United States eliminated the conventional mission for these bombers, the US would continue to maintain some portion of the bomber fleet. If the Defense Department assigned all B-2 and B-52 costs to the nuclear mission, it would significantly undercount spending in support of the conventional mission, and vice versa.

In 2011, MFP-1 cost \$12 billion, and represents the single-biggest piece of both the nuclear enterprise generally, and strategic nuclear offensive forces specifically, on either the civilian or military side.³⁰ This data underlies most estimates—official or unofficial—of spending on the nuclear enterprise. However, as this section has demonstrated, MFP-1 is neither exclusive nor comprehensive and so is not an accurate or definitive estimate of costs of either the nuclear enterprise or even strategic nuclear offensive forces.

The DoD has responsibility for a wide-range of nuclear enterprise-related activities, all of which have fairly comprehensive and public budget justifications. But nowhere does DoD compile the cost of these programs. Because of the scale and definitional questions about what DoD capabilities to include, a great deal of uncertainty continues over how much DoD spends to support the nuclear enterprise. This uncertainty is especially acute over the parts of DoD's budget outside of MFP-1 that support strategic nuclear offensive forces.

The 1251 Report

As debate heated up about the New START treaty, which was ratified in December 2010, Congress asked the administration for a more specific estimate of current and future spending on the nuclear mission.³¹ Called the 1251 Report after the section in the bill that ordered it, a classified report was produced by the administration in April 2010. Since then, unclassified summaries and updates have been released, providing the best official estimate yet of US spending on nuclear weapons.³² These estimates address the difficulty created by the first splintering of the nuclear enterprise, since the 1251 Report includes both NNSA and DoD's costs.

30 MFPs are presented in terms of total obligational authority (TOA), which is an accounting method unique to DoD that sums the cumulative budget authority in any given year. Budget authority, the more traditional and commonly-used accounting method, describes only the funding authorized by Congress in that year. But the authorizations may be good for several years, or be decremented by later acts of Congress creating variation over time. DoD's TOA aims to more accurately reflect the budget resources available that year. However, most budget justifications—including DoD's—are provided in Budget Authority, not TOA. As MFP-1 is the only example of reporting in TOA, this report ignores the distinction between TOA and Budget Authority. Although it is neither accurate nor precise to compare these two different accountings, they are not wildly different than each other because of the relatively steady level of funding over time to most accounts—especially the nuclear accounts. By appropriation title, the FY12 Greenbook shows the difference between TOA and BA to be: .968 for MILPERS; .997 for O&M; .992 for Procurement; and 1.001 for RDT&E. With MILPERS showing the greatest variance, the DoD average is .994. This report simply ignores the distinction.

31 Eli Jacobs, "Problematizing the Section 1251 Report," *PONIBloggers's Blog*, January 16, 2012, <<http://csis.org/blog/problematizing-section-1251-report>>.

32 This report refers to the 1251 Report, but as it is a classified document, these references refer not to the original report, but the aggregate of the reporting and unclassified summaries. The subject '1251 Report' is shorthand.

The 1251 Report estimated the costs of operating, maintaining, and modernizing nuclear weapons and delivery systems—both DoD and NNSA—at \$214 billion over the 10 years from FY11 to FY20. For NNSA’s weapons activities, it provided an estimate of \$88.5 billion over 10 years. The November update included additional costs as determined by the administration, raising the 10-year cost to a range from \$91.8 to \$92.6 billion.³³ For DoD, the report listed costs of \$125.8 billion.

Section 1251 called for a report on the plan and budget requirements for three specific items: the safety, security, and reliability of the nuclear weapons stockpile, modernization of the nuclear weapons complex, and maintenance of the delivery platforms for nuclear weapons.³⁴ Despite the limited nature of these requirements, a DoD official testified that: “*the Section 1251 Report that was submitted by the administration included our best estimate of the total costs [of] the amount of a nuclear enterprise and the delivery systems from FY12 through FY21.*”³⁵

But best official estimate does not mean it is a definitive estimate. The 1251 Report is not comprehensive and suffers from many of the same shortcomings already described for other estimates of strategic nuclear offensive forces, let alone the nuclear enterprise more broadly. The NNSA number explicitly cites only weapons activities, and does not broach the subject of what costs of the Office of the Administrator or the Naval Nuclear Propulsion Program should be included in a complete accounting of strategic nuclear offensive forces.

The Report is even less comprehensive on the DoD side. First, although no exact accounting has surfaced of what costs the report included for DoD, it seems to underestimate the funding for DoD. In the FY11 future year’s defense plan, MFP-1 was listed at \$11.2 billion and \$62 billion over five years. Simply doubling this figure to cover all 10 years would provide funding equal to the 1251 Report’s estimate of DoD’s funding. Yet the report also claimed to include modernization efforts for all three legs of the nuclear triad. Currently the Air Force has plans to modernize the bomber leg of the triad and the Navy the submarine leg of the triad. These modernization programs are large-cost programs.³⁶ As already discussed, some of these costs are not included in MFP-1, and more importantly the costs involved are likely much greater in later years than current years. The Navy in successive years (FY11 and FY12) estimated it would cost \$9.0 to \$11.6 billion in FY10 dollars to procure the first next-generation ballistic missile submarine, which was to be procured in 2019.³⁷ This spike—a roughly \$10 billion spike in costs associated with modernization and nuclear enterprise spending—suggests that either the 1251 Report is not counting all of the operations captured in MFP-1 or is not counting all of the modernization costs. However, without an unclassified version of the report and its assumptions, it is impossible to determine what elements of DoD nuclear spending are included or excluded by the 1251 Report.

33 November 2010 Update to the National Defense Authorization Act of FY2010, Section 1251 Report, New START Treaty Framework and Nuclear Force Structure Plans. The original report reportedly included only \$88.5 billion in funding for weapons activities for 10 years. See note 39 on page 20 for a description of what led to the change in funding levels.

34 National Defense Authorization Act for Fiscal Year 2010, Section 1251. The report could have successfully addressed all three items, and not provided an authoritative estimate of the costs of strategic nuclear offensive forces. For instance, in describing what it takes to maintain the delivery platforms, the report may not discuss what it takes to operate those platforms.

35 James N. Miller, Testimony before the Subcommittee on Strategic Forces, House Armed Services Committee, November 2, 2011. Note he does not appear to be using the term “nuclear enterprise” as defined in this report.

36 For greater discussion, see Section IV: 10 year Extrapolations and Modernization.

37 “An Analysis of the Navy’s Fiscal Year 2012 Shipbuilding Plan,” Congressional Budget Office, June 2011, p. 16.

Further clouding the issue, in fall of 2011 Secretary Panetta released a letter outlining the effects of sequester on DoD.³⁸ As one of the effects listed, Secretary Panetta's letter stated \$18 billion would be saved if the next-generation bomber program was cancelled and not restarted until the 2020s—outside the window covered by the 1251 Report. The five year costs for the bomber were listed in the FY11 budget request at only \$1.7 billion, placing the bulk of the \$18 billion in costs in the latter five years of the 1251 Report's budget window. Even in the FY13 request that was submitted a few months after Secretary Panetta's letter on the effects of sequestration, the five year costs—now FY13-FY17—were listed as \$6.3 billion, suggesting the bulk of the funding would still come in later years—although possibly years outside of the 1251 Report's original 10-year window. Still and again, if the latter half of the window includes significantly greater costs, the 1251 Report's total for DoD would not cover the stated costs of MFP-1 in the first five years of the window.

The 1251 Report is also now out of date. Actually, the report went out of date before the New START treaty was even ratified. The 1251 Report became tied to requests from advocates of greater spending on nuclear weapons facilities, specifically prominent Senate Republicans who connected that spending to their support of the New START treaty.³⁹ However, federal spending for FY11, which was considered in fall of 2010, was provided only in a continuing resolution. A continuing resolution is a legislative vehicle to extend the funding levels provided the year before when the new fiscal year arrives but agreement has not been reached on its funding levels. To address these concerns, the House of Representatives included an exception for weapons activities, funding it at the President's requested funding in the first continuing resolution after the Obama administration announced it would pursue ratification of the New START treaty in December of 2010.⁴⁰ The Senate version also included the President's requested level of funding for weapons activities.⁴¹ However the agreed upon final version of the bill—signed into law on December 22, 2010, the same day the treaty was ratified by the Senate—did not include the increased funding, instead leaving the weapons activities at FY10 levels. That version was forced by Senate Republicans refusing to vote for the earlier Senate version, even though it included the increased weapons activities funding.⁴² This conclusion was repeated when the House passed HR 1, which put weapons activities at \$300 million less than originally requested, and finalized five months later, when the now-Republican controlled House and Democrat-controlled Senate agreed to fund weapons activities at \$7 billion—10 percent more than FY10 levels but less than the President's FY11 request, and therefore presumably less than noted in the 1251 Report.⁴³

38 Letter to Senators John McCain and Lindsey Graham, and fact sheet "Effects of Sequestration on the Department of Defense," Leon Panetta, November 14, 2011.

39 Memorandum from Senators Jon Kyl and Bob Corker to Republican Members, "Progress in Defining Nuclear Modernization Requirements," November 24, 2010. For more context, see Josh Rogin, "Path for vote on New START this year goes through Kyl," *The Cable: Foreign Policy blog*, October 27, 2010.

40 House Amendment to Senate Amendment to HR 3082, Full-Year Continuing Appropriations Act, 2011, passed December 8, 2010, 111th Congress, Roll number 622.

41 Substitute Amendment to HR 3082, Consolidated Appropriations Act, 2011, December 8, 2010.

42 Gail Russell Chaddock, "Stopgap spending bill clears Congress. What happens next?," *Christian Science Monitor*, December 21, 2010.

43 HR1, Full-Year Continuing Appropriations Act, 2011, as Engrossed in House, February 19, 2011, Sec. 1445 and Public Law 112-010, Department of Defense and Full-Year Continuing Appropriations Act, 2011, April 15, 2011.

Budget pressures have continued to erode the fidelity of the 1251 Report. In FY12, Congress again passed less funding than the Obama administration had envisioned in the 1251 Report.⁴⁴ In this year, the dynamic is most apparent in the FY13 request for the next-generation ballistic missile submarine, which delayed procurement of the next-generation ballistic submarine by two years.⁴⁵ DoD stated that the program was being delayed not for any policy decision, but because greater cost efficiencies could be achieved by delaying. That delay likely has some effect on future costs. In the FY12 request, \$6.1 billion was allocated over the five years from FY12 to FY16 to develop the submarine. In the FY13 request, reflecting the two-year delay, the same time period requested only \$5.1 billion, or 17 percent less. The budget documents only show estimates for five years, so the cost over the 10 year window of the 1251 Report may not change, as costs are deferred to later in the window. However, it seems reasonable to note that the estimates are not fixed and decisions—both policy and otherwise—will change the estimates included in the 1251 Report.

The 1251 Report represents the best estimate of the costs of strategic nuclear offensive forces yet provided by any administration. Yet it is still not a definitive estimate because of the limited type of costs it includes, and Congressional action that made the cost estimates wrong almost immediately. Because of continuing budget pressures, the 1251 Report is becoming even less accurate as time passes.⁴⁶

Presidential administrations—and in particular, the current administration, prompted to assuage critics of the New START treaty—have understood the importance of our nuclear arsenal and tried to make good-faith estimates of the costs. But administrations have also faced fundamental questions that prevent them from offering an exact accounting of strategic nuclear offensive forces, let alone our nuclear enterprise. The two government agencies—the Departments of Defense and Energy—even more so understand the importance of strategic nuclear offensive forces, but also have other responsibilities. These agencies provide correct and thorough justifications of their budgets every year. Nevertheless, these justifications do not provide a visible accounting of the costs of the nuclear enterprise or even of just strategic nuclear offensive forces. The systems in place cannot answer the fundamental questions about what to include—especially given the agencies’ need to care for other responsibilities as well—in the costs of the nuclear enterprise. Therefore, official estimates have continued to prove less than definitive.

44 Department of Energy FY13 budget request summary table by appropriation.

45 Secretary of Defense Leon Panetta, “Statement of Major Budget Decisions,” January 26, 2012.

46 The President directed the Secretaries of Defense and Energy to update the 1251 Report annually, and provide it to Congress along with the budget submission. These reports are classified and have not been released. As stated in note 31, this study uses the shorthand subject ‘1251 Report’ to refer to the public accounts of the 2010 report and update, as it is commonly referred to in public. The formal, annual submission updated to existing budget numbers obviously will be accurate at its publication, but to be accurate will also be different from the original 2010 report. Barack Obama, “Annual Update to the Report Specified in Section 1251 of the National Defense Authorization Act for Fiscal Year 2010 (Public Law 111-84),” Memorandum for the Secretary of Defense [and] the Secretary of Energy, Federal Register Document citation 76 FR 7477, February 9, 2011.

Unofficial Estimates

To address these inherent deficiencies of official estimates, outside experts have attempted to estimate the cost of the nuclear enterprise. The three most notable recent studies are Stephen Schwartz' seminal work, the *Atomic Audit*, from 1998, which set out to account for all costs of strategic nuclear offensive forces since the original Manhattan Project, Steve Kosiak's 2006 study, which looked only at contemporary spending, and Stephen Schwartz and Deepti Choubey's 2009 study, which updated Schwartz's historical work with estimates of contemporary spending; these studies will be respectively referred to as Schwartz '98, Kosiak '06, and Schwartz and Choubey '09.⁴⁷ All of these studies took a broad definition of the nuclear enterprise to compensate for the splintered government accounting of strategic nuclear offensive forces.⁴⁸ All three studies use roughly the same bins and methodologies. These studies divide spending on the nuclear enterprise into six distinct categories: offensive strategic forces at DoD; tactical nuclear weapons; missile and air defenses; weapons activities; other DoE nuclear activities; and non-proliferation and arms control costs.

Table 1 displays the categories each of the three studies employed to determine costs of the nuclear enterprise, divided into the general bins described above. None of the studies used the exact same categories as the others, and each study rolled together different categories. Many of these categories are uncontroversial in themselves, and many of their costs are readily accessible from primary source government documents, thus removing most of the debate about their cost.⁴⁹

Yet these studies have been met with skepticism about how well they capture the costs of strategic nuclear offensive forces primarily for two reasons.

First, for some observers, these bins are too comprehensive. While the costs to clean-up sites used to develop nuclear weapons would never have occurred without the existence of nuclear weapons, those costs would still be incurred even if the United States immediately disarmed. Similarly, even were the United States to end its nuclear weapons program, it would likely want to continue to fund non-proliferation efforts to prevent states or non-state actors from developing or acquiring nuclear weapons. The same argument may apply to missile defenses as well. These different components of

47 Stephen I. Schwartz, *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940*, (Brookings Institution Press: 1998), Steven M. Kosiak, "Spending on US Strategic Nuclear Forces: Plans & Options for the 21st Century," Center for Strategic and Budgetary Assessments, 2006, and Stephen I. Schwartz and Deepti Choubey, "Nuclear Security Spending: Assessing Costs, Examining Priorities," Carnegie Endowment for International Peace, January 2009.

48 Not included in this review, but of particular interest and value was a CBO study conducted in 1998. This study estimated the savings in the nuclear enterprise at three alternative levels. To estimate these savings, the study set out a total baseline of nuclear enterprise costs of \$22 billion in 1998. Most importantly, those costs include more than MFP-1, but follow a fairly narrow definition of the nuclear enterprise. It binned the enterprise as strategic offensive forces, DoE programs, C3 and surveillance, treaty verification and other related programs, and CBO's own estimate of modernization costs in addition to DoD's estimate necessary to achieve DoD's plans. CBO occupies a special place in the defense community in that it is independent of DoD, but has access to some databases and classified information. Because of these advantages, the CBO estimate is an inductive, bottom-up approach, and likely the best assessment of the costs of the nuclear enterprise. Unfortunately, the policy and programs underlying the nuclear enterprise have changed in the intervening 14 years, suggesting the estimate is no longer completely valid. Nevertheless, for comparison's sake, the FY11 value of the CBO estimate would be \$33 billion. Letter to the Honorable Thomas Daschle, encl. "Estimated Budgetary Impacts of Alternate Levels of Strategic Forces," Congressional Budget Office, March 18, 1998.

49 For example, David Mosher in 2001 compiled a simple table comparing "US nuclear budgets" from 1990 and 2000. Although he relied on outside studies, most of his data was pulled from government documents. Table 5.1, David Mosher, "The Hunt for Small Potatoes: Savings in Nuclear Deterrence Forces," in Cindy Williams, ed. *Holding the Line: US Defense Alternatives for the Early 21st Century*, (MIT Press: 2001), p. 120.

Table 1: Comparing Costs of the Nuclear Enterprise: Independent Studies

<i>In billions of then year dollars</i>	Schwartz '98	Kosiak '06	Schwartz/Choubey '09
Nuclear Strategic Forces			
Nuclear Strategic Forces	\$7.50		
Overhead and Support	\$4.00	\$15.50	\$22.50
RDT&E	\$0.70		
Command and Control	\$6.00	\$9.50	
<i>Subtotal</i>	<i>\$18.20</i>	<i>\$25.00</i>	<i>\$22.50</i>
Nuclear Offensive Theater Forces			
<i>Nuclear Offensive Theater Forces</i>	<i>\$1.00</i>	<i>\$0.40</i>	
Strategic Defenses			
Ballistic Missile Defense		\$8.70	\$9.18
Air Defenses	\$3.80	\$1.50	
<i>Subtotal</i>	<i>\$3.80</i>	<i>\$10.20</i>	<i>\$9.18</i>
Nonproliferation Initiatives			
Nonproliferation Initiatives	\$1.41	\$1.60	\$5.15
Agencies (ACDA/IAEA)	\$0.11		
<i>Subtotal</i>	<i>\$1.51</i>	<i>\$1.60</i>	<i>\$5.15</i>
Department of Energy			
Nuclear Warheads (DOE)	\$4.66		\$6.56
Deferred environmental and health costs	\$5.93	\$17.00	\$8.29
Nuclear incident management			\$0.70
<i>Subtotal</i>	<i>\$10.59</i>	<i>\$17.00</i>	<i>\$15.55</i>
Total	\$35.10	\$54.20	\$52.38

Note: May not total due to rounding

the nuclear enterprise stem from fairly distinct and separate policy decisions. How the United States handles its strategic nuclear offensive forces has only a tangential relationship to environmental clean-up and non-proliferation efforts.

Of course, even within a stricter definition of what comprises the nuclear enterprise, the different components stem from fairly distinct and separate policy decisions. The decisions to pursue the

different legs of the triad—though serving the same mission—were rarely made in reference to each other. Nevertheless, as the unofficial estimates illustrate, the different components of the nuclear enterprise can be binned into fairly broad and intuitively satisfying categories. Offensive nuclear weapons are distinct from missile defenses, which are distinct from non-proliferation efforts.

This argument about what to include in an accounting of the nuclear enterprise nevertheless confuses the debate as parties compare numbers that include different components of the nuclear enterprise. Comparing an annual figure of \$55 billion, like the 2006 Kosiak number, against MFP-1's \$12 billion creates a false sense of uncertainty. There is not a 500 percent range of uncertainty between those two numbers. Rather, there are fundamentally different components being costed. These differences can be easily identified and once the components are agreed to, the costs in question can be agreed to within a limited range.

Second, even when components are agreed to and compared in a like manner, one area does suffer from a large range of uncertainty in costs: the costs of supporting and associated items and activities within DoD, but outside of MFP-1.⁵⁰ As has already been described, official estimates tend to simply ignore these costs because of the difficulty in defining what should be included. At best, official estimates take MFP-1 and add in the triad systems' development costs outside of MFP-1. In this regard, unofficial estimates have an advantage over official estimates because the author and researcher of a study can make a judgment call about what to include or exclude. Provided the study clearly delineates what is included, most judgment calls can be justified and intellectually defended. Outside researchers nevertheless face a separate problem. Although they can more easily decide what to include, they do not have access to the databases and information that can provide a granular level of detail of each program the researcher may like to associate with nuclear weapons. Without that account level of detail, an outside researcher is left to make informed estimates to disaggregate costs. Further complicating the matter, some aspects of nuclear weapons and their operations are classified, clouding what costs should be included or excluded in a comprehensive estimate of what capabilities and costs support the cost of strategic nuclear offensive forces, but are outside of MFP-1.

The three studies all resolved these difficulties by using a deductive approach. Each attempted to estimate some costs directly from budget documentation, but in the end estimated costs across wide swaths of the DoD budget by pro-rating costs across multiple categories.

In Schwartz 1998, the study first binned the defense budget by MFP into two categories: Combat (including MFP-1), and other operations and support. Schwartz '98 then took the ratio of MFP-1 to total Combat costs (2%), and applied that ratio to the costs of other operations and support to derive a figure of \$4 billion. The study then added in specific costs for RDT&E (\$0.7 billion) and Command and Control (\$6 billion). By adding this total figure to MFP-1, the study derived its estimate of all costs for strategic forces within DoD at \$18.2 billion in 1996 dollars.

50 In 1973, a study assessing the costs of strategic nuclear offensive forces discussed the difficulty of costing the indirect costs. This study—unlike the other studies considered here—used a proportion of the direct costs rather than a proportion of the rest of the defense budget. Some of this assumption was the authors' need to assign indirect costs to specific systems of strategic nuclear offensive forces—something neither this study nor the other studies considered to do. Nevertheless, the indirect costs of the strategic nuclear offensive forces have never been authoritatively determined. Alton Quanbeck and Barry Blechman, "Strategic Forces: Issues for the Mid-Seventies," (Brookings institution: 1973), Appendix E, p. 94.

Kosiak '06 provides a narrative description of how costs were estimated, but provides only a single summary table showing year costs then, so his methodology is opaque. Unlike the two Schwartz studies, Kosiak '06 does not appear to have relied on MFP-1. Instead in Appendix A, he states the direct costs of the three legs of the triad were estimated, implying they were estimated from a bottom-up perspective. Procurement and Research and Development are also suggested to be estimated from a bottom-up methodology. The study also estimates Command, Control, Communications and Intelligence (C3I) costs and displays them separately (\$9.5 billion). However, none of the methodologies for estimating these bottom-up costs are provided.

Finally, the study includes an estimate of indirect operations and support costs. These costs, like the Schwartz studies, are calculated deductively by taking “a proportional share of indirect and overhead O&S costs were allocated to each” of the legs of the triad.⁵¹ Added to the direct costs described above, Kosiak '06 found a figure of \$15.5 billion for “nuclear offensive strategic forces” plus the \$9.5 billion for C3I, for a total DoD cost of \$25 billion in 2006 dollars.

Schwartz and Choubey '09 recognized the shortcomings of even these limited efforts to annotate costs in a bottom-up way, and relied on a nearly wholly deductive approach. The study limited combat forces to MFPs-1, 2, and 11; strategic, general purpose, and special operations forces, respectively. It then took the remainder of the defense budget—all remaining MFPs, and applied the ratio of MFP-1 to the Combat Forces total. In this regard, the Schwartz and Choubey '09 method differs slightly from the method used in Schwartz '98, where MFP-4 and 5, dedicated to mobility and reserve forces respectively, were included in combat forces. Using this broad-based methodology, the study found a cost of \$10.9 billion for all nuclear enterprise costs outside of MFP-1. To augment this deductive approach, Schwartz and Choubey '09 added \$1.4 billion of specific items on top of their deductively derived estimate.⁵² However, these items were also included in the proportional costs already included in the \$10.9 billion figure. Nevertheless, Schwartz and Choubey '09 added these figures together for a total of \$12.7 billion.

Interestingly, Schwartz and Choubey '09 ended up with a lower number from Schwartz '98 when adjusted for inflation over time. This difference stems largely from how they estimated C2 costs. In Schwartz '98, the study identified a specific C2 cost, but in Schwartz and Choubey '09 C2 costs were figured proportionately along with all other components of the budget, producing a much smaller C2 figure (\$9 billion for Schwartz '98 versus \$4 billion for Schwartz and Choubey '09). Some of this difference stems from C2 R&D costs being captured in MFP-6, R&D, rather than MFP-1 or 3, although one can reasonably assign C2 R&D costs to the category C2. As will be shown later, the Schwartz and Choubey '09 deductive approach yields a figure close to what this study's inductive approach found, although if the methodology is used to examine costs by major force program,

51 Kosiak '06, p. 74.

52 Schwartz and Choubey '09 added the following Nuclear Weapons Support, Space-Based Infrared System High EMD, E-4B National Airborne Operations Center Modernization, Vandenberg AFB launch base support, Space-Based Infrared System High Advance Procurement, E-4B (National Airborne Operations Center) modifications, Construction at Minot Air Force Base, Nuclear Accession Bonus, Nuclear Material Consumption, Escort vessels for Trident SSBNs, SURTASS, Strategic Missile Systems Equipment (Trident II/D5 life extension), Strategic Submarine and Weapon System Support, Enhanced Special Weapons, Fleet Communications (includes positive control and EAM dissemination to SSBNs). See Schwartz and Choubey '09, Table 8, pages 49-57.

the distribution is much different.⁵³ Nevertheless, this wrinkle between Schwartz '98 and Schwartz and Choubey '09 demonstrate how much these deductive assumptions can vary the total estimates.

Table 2a displays the costs estimated by the three studies boiled down to MFP-1 and other DoD costs.⁵⁴ Table 2b further displays the costs in constant FY11 dollars. Note, however, this adjustment does not make these figures completely comparable. In this more than decade-long time-span, policy decisions were made, different things were bought, and the environment changed. For instance, from FY96 to FY06, the total defense budget increased 56 percent in real terms. In other words, the estimates could reflect costs of fundamentally different things. To illustrate this point, DoD provides an estimate for MFP-1 in FY11 in FY11 dollars: \$11.1 billion. All of the studies' use of MFP-1—itsself an estimate derived from their calculations solely for this report—underestimate the costs reported by DoD in FY11. Most of these discrepancies are likely explained by MFP-1 costing more because it is buying more than it did in FY06 or in FY96. Certainly, the increased defense budget and larger defense establishment would suggest that is the case.

Still, these comparisons are valuable, although valuable in that they show two conflicting perspectives. From one perspective, nuclear spending has been fairly steady since the post-Cold War drawdown. All three studies estimate MFP-1 costs from \$10.3 billion to \$10.8 billion, and other DoD costs from \$12.8 billion to \$17.7 billion.⁵⁵

This perspective is supported by the stability displayed by MFP-1. Spending on the programs within MFP-1 changes every year, but MFP-1 captures both programmatic and cost changes, and so is comparable over time. From FY96 to FY10, MFP-1 averaged at \$10.4 billion, with a standard deviation of 7.2 percent. That compares to a standard deviation for the entire defense budget of 25 percent. Qualitatively, this conclusion should not be terribly surprising, as war funding introduced truly dramatic swings and scale, though the base defense budget increased a great deal as well. Strategic forces for the most part were not involved in the day to day operations of the wars in Iraq and Afghanistan—although bomber operations, which have been a critical capability in the wars, are a notable exception. Moreover, the force structure underpinning MFP-1 has not dramatically changed in this time period, although again there have been changes—including a modernization of the Minuteman III missile system and upgrades to the bomber fleets. There have been changes and this stability is relative, but nevertheless the closeness of the estimates in like terms suggests that there is stability in the nuclear budget.

From a second perspective, the three studies' estimates reflect how much uncertainty there remains about the support costs for strategic nuclear offensive forces within DoD. Where the MFP-1 estimates vary by 10 percent, the 'other costs' estimates vary by a third. The wide range between \$12.8 billion and \$17.9 billion itself implies uncertainty. But unlike the MFP-1 estimates, the 'other costs' fluctuate without apparent correlation to the broader defense budget trends. The lowest estimate of other costs is the latest, despite a much increased defense budget over time.

53 For further discussion see Figure 6 on page 50.

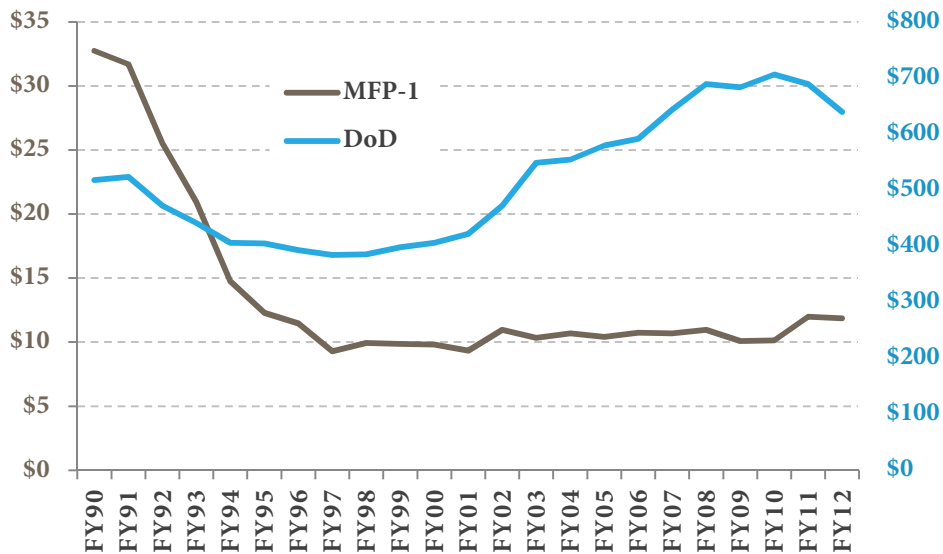
54 These figures were derived by taking MFP-1 costs from the FY12 Greenbook and then subtracting that figure from the total costs provided by each study for DoD within the bin offensive strategic forces costs at DoD. Please refer to note 30 on page 18 to note a methodological shortcut that matters here and makes the numbers only generally correct.

55 Again note the artificialness of these inflated estimates.

Table 2a: Nuclear Offensive Strategic Forces Estimates			
<i>study's estimates billions of dollars</i>	Schwartz '98	Kosiak '06	Schwartz and Choubey '09
MFP-1	\$7.4	\$9.7	\$10.1
Other Costs	\$10.8	\$15.3	\$12.4
Total	\$18.2	\$25.0	\$22.5

Table 2b: Nuclear Offensive Strategic Forces Estimates			
<i>in billions of FY11 dollars</i>	Schwartz '98	Kosiak '06	Schwartz and Choubey '09
MFP-1	\$10.8	\$10.7	\$10.3
Other Costs	\$17.7	\$17.3	\$12.8
Total	\$28.5	\$28.0	\$23.1

Figure 3: DoD and MFP-1 Funding: 1990-2012
in billions of constant FY11 dollars



Erring on the side of comprehensiveness, as all three studies do, adds imprecision. Each of the studies derived “Other Operations and Support” by taking pro-rated costs from a very wide swath of the defense budget. Worse, this deductive approach does not provide an accessible list documenting included items, preventing critics from examining the different aspects and then

agreeing or disagreeing about whether any given aspect was rightfully included or excluded. Here then we find true uncertainty and a wide range of plausible costs.

Outside studies surmount the basic flaws of official estimates of the nuclear enterprise; the outside studies aim to be comprehensive to compensate for the narrow estimates provided by the government. However, this comprehensiveness creates controversy for two specific reasons: a debate about what to include, and imprecision in estimating the cost of DoD spending outside of MFP-1.

As discussed above, it is reasonable to debate what should or should not be included, although this debate further inflames uncertainty over the cost of the nuclear enterprise. However, definitional debates need not contribute to uncertainty and rancor. The cost of most components of the nuclear enterprise can be clearly identified in primary government documents. When arrayed next to each other, estimates produce consistently similar costs for similar programs. Most of the uncertainty in what should be included stems from an unwillingness to compare like numbers, not from any true uncertainty.

However, there is genuine uncertainty in efforts to cost the elements of the DoD budget supporting strategic nuclear offensive forces. It is this particular component of strategic nuclear offensive forces—the costs within the DoD budget yet outside of MFP-1 that support and enable strategic offensive forces—that stands behind almost all of the unexplained ambiguity in what the entire nuclear enterprise costs. Critics of these studies can reasonably say that costs are not as great as the deductive approach suggests, and this complaint cannot be dismissed because though the authors of the study can defend their judgments, the judgments ultimately rest on assumptions of what is included in the broad categories of spending included in a comprehensive, deductive approach. In turn, critics of nuclear spending can claim these studies underrepresent the costs of the nuclear enterprise, misleading taxpayers on what they spend to support strategic nuclear offensive forces, and neither can the authors authoritatively rebut these claims.

III. Our Estimate

This study seeks to resolve the lingering ambiguity about the costs of the nuclear enterprise by taking an inductive approach to build a comprehensive assessment of what costs within DoD's budget support strategic nuclear offensive forces but are outside of MFP-1.

This section lays out how this study approached the question as well as the answer. First, it discusses overarching definitional questions. Second, after a summary of the study's findings, it provides a category-by-category discussion of the methodology used to estimate that category and a specific estimate. Third, it discusses other elements that were not included, but could be, and why they were excluded. Fourth, it compares this study's estimate to past official and unofficial estimates. Fifth, and finally, it incorporates the costs found in NNSA. In this way, this study produces a transparent and comprehensive estimate of the costs within DoD's budget that support strategic nuclear offensive forces but are outside of MFP-1, and thus reduces the ambiguity in the debate about the costs of nuclear weapons.

The Theoretical Framework

As stated previously, this study seeks to resolve ambiguities about the cost of the US nuclear enterprise by conducting an inductive analysis of the aspect of the nuclear enterprise with the most uncertainty: the costs within DoD but outside of MFP-1 associated with strategic nuclear offensive forces.

Even so constrained, this description is not enough to start costing these forces. To inductively cost these forces, it is necessary to define the scope of our inquiry more specifically than what is required for deductive analyses. This definition has its own theoretical dilemmas. This study set out to cost the capabilities within DoD necessary to maintain and operate strategic nuclear offensive forces. As another way of putting it, this study seeks to cost what would remain if DoD's only responsibility were to operate and maintain strategic nuclear offensive forces. This approach is inherently broader than an approach that sought to cost support functions dedicated to nuclear weapons, since the existence of many DoD support functions is prerequisite to nuclear operations but also serve non-nuclear forces? That is, presuming the existence of DoD, what is the incremental cost to operate and maintain strategic nuclear offensive forces. In this latter approach, much of the supporting infrastructure—recruiting and training, medical, distribution systems, even most of C2—would already exist and strategic nuclear offensive forces could piggyback off those costs. Frankly, if one prefers the narrower approach, MFP-1 provides a fairly satisfactory answer and so requires little extra work. However as discussed before, this narrow approach has its limitations as well, not least of which are dual use capabilities. Strategic bombers are now frequently and commonly used for conventional operations. On a narrow definition, these bombers would be left outside the set of costs. Yet that is intuitively unsatisfying to most. Therefore, this study pursued the former approach—all costs necessary to maintain and operate strategic nuclear offensive forces.

This approach provides a more comprehensive answer, although the specific methodologies used to arrive at estimates were circumscribed to not overly include costs. The comprehensive approach has other drawbacks, namely that the sum is not purely associated with nuclear weapons and therefore even if all nuclear weapons would disappear tomorrow, some of these costs would remain. Nevertheless, this approach is the most intuitively appealing, as it treats strategic nuclear offensive forces as a stand-alone capability and answers the question of what it costs to operate and maintain such forces.

Costs and Methodology

When considering all the costs that support strategic nuclear offensive forces, much of the defense budget comes into play. Moreover, many of these costs reside in the most opaque parts of the defense budget. The following section sets out the smallest item possible and apportions costs to strategic nuclear offensive forces. This approach results in four distinct bins: Operating Costs; Research, Development, Testing and Evaluation (RDT&E); Command and Control (C2); and Other Operations and Support. Within each bin are different components, for each of which a different methodology is necessary. The following subsections describe each of the methodologies.

Operating Costs: MFP-1

MFP-1 is the base of most costs of strategic nuclear offensive forces. When someone thinks of the costs of strategic nuclear offensive forces, the first presumption is of the day-to-day costs necessary to operate the nation's nuclear deterrent. Those costs are captured by MFP-1 to a large extent. It includes the costs of the weapons systems, maintaining the weapons systems, fueling the weapons systems, arming the weapons systems. It includes the cost of the units that run the weapons systems, the people who man those units, the people who feed those people, and the operations of those units. MFP-1 probably captures even more than someone's initial conception of strategic nuclear offensive forces because it includes the costs to maintain the headquarters to direct those units and weapons systems, the bases those units and weapons systems call home, even the environmental compliance and pollution prevention costs of those bases. MFP-1 is fairly comprehensive as the official definition describes:

“Strategic forces [MFP-1] are those organizations and associated weapon systems whose force missions encompass intercontinental or transoceanic inter-theater responsibilities. Program 1 is further subdivided into strategic offensive forces and strategic defensive forces, including operational management headquarters, logistics, and support organizations identifiable and associated with these major subdivisions.”⁵⁶

The core of the nuclear arsenal is the three legs of the nuclear triad, generally called Strategic Forces. The nuclear triad is the umbrella term to capture the three “legs” that deliver nuclear weapons. First is the land-based intercontinental ballistic missile (ICBM). Today, the only ICBM in use is the Minuteman III ICBM. Each missile can carry a range of nuclear warheads and has its own dedicated silo that serves as its own delivery system as well. The Air Force operates the ICBM leg of the triad. The second leg of the triad is the strategic bombers. The Air Force currently operates two types

56 “Future Years Defense Program Structure,” DoD 7045.7-H, Department of Defense, April 2004.

of strategic bombers: the B-2 and B-52H. The B-2 carries nuclear-armed gravity bombs, while the B-52 carries nuclear-armed cruise missiles. The third leg of the triad is the ballistic missile submarines operated by the Navy. Currently, the Ohio-Class ballistic missile submarine is the only

submarine that carries nuclear warheads; it carries the Trident II D-5 submarine-launched ballistic missile (SLBM). The ICBM and submarine legs are exclusively dedicated to nuclear missions, although any could be converted to deliver conventional weapons.⁵⁷ In contrast, both bombers can and have delivered conventional munitions making any bomber of these types dual-use, unlike the SSBNs and ICBMs.⁵⁸ Although some might argue that the cost of these dual-mission bombers should not be included, they are necessary for the operation of one full leg of the nuclear triad. Alternatively, costs could be assigned proportionally to the nuclear and conventional missions of the bombers. Since, however, the aircraft—as yet—are all capable of nuclear missions and a nuclear mission could not be conducted without a complete aircraft and supporting systems, this study assigned the entirety of the bomber funding as a nuclear cost. The costs of these missile and weapons systems are primarily captured in MFP-1; certainly including direct operational costs.⁵⁹

MFP-1 also includes most of the costs of the headquarters that direct and support strategic nuclear offensive forces. It includes the costs for the unified command responsible for the deployment and operation of all nuclear delivery vehicles and weapons: US Strategic Command (STRATCOM). It also includes the costs of the administrative commands run by the services that oversee the organization, training, and equipping of the nuclear forces. Since 2009, Global Strike Command has overseen both Air Force legs of the nuclear triad: the Minuteman ICBM and strategic bombers. The Navy does not have a central nuclear command, instead maintaining its SSBNs under the two fleets' submarine commands: the Atlantic Fleet Submarine Command (COMSUBLANT) and the Pacific Fleet Submarine Command (COMSUBPAC). Notably, both of these commands also oversee operations of the Navy's non-nuclear armed attack subs and guided missile subs. Funding for these commands, as well as other command platforms like the Global Operations Center and the National Airborne Operations Center (NAOC), is mainly included in MFP-1, although a small subset of spending on nuclear commands is found in MFP-3, 'Command, Control, Communications, Intelligence, and Space.'

MFP-1 could be parsed more finely in determining nuclear costs. Most significantly, the costs of the dual-use bombers could be prorated between the nuclear and conventional missions. Some of the bombers are individually 'combat-coded' for the nuclear mission, while others are not.⁶⁰ This divide is likely to become more concrete in the future as the Obama administration has stated it will

Strategic Forces (MFP-1)

In billions of FY11 dollars

Total	\$11.99
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57 The Ohio-class SSBNs have already had four submarines converted to Guided-Missile Submarines (SSGN), which carry Tomahawk conventional-warhead cruise missiles rather than the nuclear-warhead Trident IIs. As yet, no conventional-warhead ICBM has been fielded, although such a capability, generally called "Prompt Global Strike," has been considered. For SSGNs, see US Navy Fact File, "Guided Missile Submarines—SSGN," updated November 10, 2011. For Prompt Global Strike, see Amy Woolf, "Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues," Congressional Research Service, February 13, 2012, R41464.

58 For a description of how the bombers are used, see James Kitfield, "The Cruise Missile Question," *Air Force Magazine*, February 2010.

59 For an accounting by leg of the triad see Amy Woolf and Stephen Daggett, "Comparative Funding for B-52H, B-2, Minuteman ICBMs, and Trident Submarines and Missiles," Congressional Research Service, May 19, 2009.

60 Amy Woolf, "Modernizing the Triad on a Tight Budget," *Arms Control Today*, January/February 2012.

keep only 60 nuclear-capable bombers under the New START treaty limits on delivery vehicles.⁶¹ However, as of today, there is no physical difference between B-52 and B-2 bombers assigned a nuclear mission and those that are not. Nor is it clear if these codings would hold if the bombers were alerted for or even launched on a nuclear mission. Finally, this study does not make a judgment on the suitability of the current—or future—nuclear force structure, instead attempting to refine the estimate of its costs. For these reasons, this study does include all of MFP-1, including the total costs of the entire nuclear-capable strategic bomber fleet.

Additionally, this study includes all of MFP-1 even though MFP-1 also theoretically captures strategic defensive forces, including both defenses against aircraft and missiles. Yet, this study uses MFP-1 as a proxy for strategic *offensive* forces. This study justifies this wholesale inclusion because of how the budget has developed over time, leaving most air and missile defense costs out of MFP-1.

First, continental air defenses focused on aircraft have changed over time. Whereas before continental air defenses involved the complete set of capabilities from detection to interception, since the 1990s the aircraft at the interception end of the chain were shifted to other conventional missions. Following 9-11, the Air Force reestablished alerts of fighters to intercept aircraft, known as air superiority missions.⁶² But these missions are conducted largely by the Air National Guard, which are not funded in MFP-1. MFP-1 still contains early-warning radars, part of the original and still existing air defense network. This study has included early warning as an important component of strategic nuclear offensive forces as these early warning systems inform whether or not to respond with US offensive forces, and so including these costs within MFP-1 accords with how like systems are treated elsewhere.

Second, missile defenses are for the most part not included in MFP-1. National-level ballistic missile defense took on new importance when President Reagan launched the Strategic Defense Initiative, including establishing a new office responsible for overseeing national missile defense. In 2002, the successor to this organization was renamed the Missile Defense Agency (MDA), with the intent to “establish a single program to develop an integrated system under a newly titled Missile Defense Agency.”⁶³ Because of these assignments, MDA represents the bulk of missile defense funding—although not all. As a research and development agency, most of MDA’s funding is channeled through program elements associated with the research and development MFP, not MFP-1. At the end of 2009, the Obama administration reoriented missile defense programs to focus on theater rather than national missile defenses, although the Missile Defense Agency and national missile defense efforts continue.⁶⁴ The theater missile defense systems are primarily run by the military services: the Navy’s AEGIS ship-based system and the Army’s Terminal High Altitude Area Defense (THAAD) and Patriot Advanced Capability-3 (PAC-3). All three of these programs are also not funded in MFP-1, but in research and development program elements. When mature, they are transferred to general purpose forces—not strategic forces.⁶⁵ Though MFP-1 theoretically

61 Amy F. Woolf, “The New START Treaty: Central Limits and Key Provisions,” Congressional Research Service, February 14, 2011.

62 Stephen Trimble, “USAF grapples with air sovereignty alert mission a decade after 9/11,” *Flight International*, September 6, 2011.

63 Donald Rumsfeld, “Missile Defense Program Direction,” Memorandum for Deputy Secretary of Defense et al., January 2, 2002.

64 Tom Collina, “US Missile Defense Programs at a Glance,” Arms Control Association, <http://www.armscontrol.org/factsheets/usmissiledefense>, accessed March 22, 2012.

65 Future Years Defense Structure: Codes and Definitions for All DoD Components, DoD 7045.7-H, Office of the Director, Program Analysis and Evaluation, Department of Defense, April 2004.

includes defensive strategic costs, practically these costs are not included in MFP-1, making it an even better proxy of a narrow definition of strategic nuclear offensive forces.

As described earlier, MFP-1 is not a definitive description of the costs of strategic nuclear offensive forces. But as noted earlier, if a narrow definition of what constitutes the costs of strategic nuclear offensive forces within DoD was applied, MFP-1 would be the best answer.

MFP-1 also represents the single biggest chunk of costs of strategic nuclear offensive forces within DoD. For FY11, DoD provides a cost for MFP-1 of \$12 billion.⁶⁶

Research, Development, Testing, and Evaluation (RDT&E)

RDT&E is the most obvious omission of MFP-1. As described earlier, the original MFP structure held RDT&E separate to capture those research programs that were not mature enough yet to be assigned to a particular weapons systems, and therefore a particular MFP. But as use of MFPs as a managerial tool waned, research projects were left in the research MFP longer. From an appropriations perspective, this arrangement makes sense. The appropriation title RDT&E separates programs into separate budget activities by stage of development, and includes very advanced development stages. For instance, RDT&E includes budget activity 5, System Development and Demonstration, defined as “Characteristics of this budget activity involve mature system development, integration and demonstration to support Milestone C decisions, and conducting live fire test and evaluation and initial operational test and evaluation of production representative articles.”⁶⁷ Further along, budget activity 7, Operational System Development, actually funds development for systems already fielded.⁶⁸ Today budget activity 7 accounts for 38 percent of all RDT&E funding.⁶⁹ If this activity is separated out, budget activity 5 in turn accounts for 31 percent of all remaining RDT&E funding. RDT&E are clearly crucial and substantial costs that must be accounted for.

This conclusion is especially true of strategic nuclear offensive forces, and especially true today. All three legs of the triad currently have modernization programs underway.⁷⁰ Two of those legs, the Navy’s ballistic missile submarine and the Air Force’s bomber, are already defined programs with target dates to procure and field.

In FY11, \$610 million was allocated toward development of the next-generation ballistic submarine (SSBN-X), the replacement for the aging Ohio Class SSBN. Spending on the next-generation long-range bomber was far lower at just \$190 million, but development only began in 2011. According to FYDP projections, RDT&E spending on both SSBN-X and the next-generation bomber will increase substantially over the next five years, and in the case of the bomber, exponentially. These costs will be accounted for in Section III of this report.

66 All numbers included as part of this report’s estimate are FY11 actual as reported in the FY13 budget request. This particular cost of MFP-1 is not quite comparable to the estimates of other components because it is expressed in TOA not BA as described in note 20.

67 DoD 7000.14-R, Volume 2B, Chapter 5 “Research, Development, Test, and Evaluation Appropriations,” December 2010, p. 5-5

68 Ibid, p. 5-6. Budget Activity 6 is RDT&E Management Support, and includes costs not in the development progression, but rather the costs to sustain and modernize the RDT&E facilities themselves, not new systems.

69 Calculated using FY13 R-1 on FY12 base budget estimates.

70 For a discussion about another modernization program, the next-generation aerial refueling tanker, see pages 55 to 56.

Research and Development (RDT&E)	
<i>In billions of FY11 dollars</i>	
SSBN(X)	\$0.61
Next-generation Bomber	\$0.19
Other technologies	\$0.69
Total	\$1.50

Note: May not total due to rounding

Annual spending devoted to researching new technologies relevant to nuclear delivery systems represents the balance of RDT&E spending. Most of these programs, such as “Rocket Propulsion Technology” or “Undersea Warfare Advanced Technology,” are not specifically oriented toward a particular weapons system, but this research likely enhances the capability of existing or future nuclear delivery systems. Since these items might

also support a number of items with no implication for nuclear operations, the sum of research on these basic and applied research items has been multiplied by the fraction of relevant systems dedicated to nuclear operations – for instance, “Undersea Warfare Advanced Technology” is multiplied by the number of ballistic missile submarines divided by all Navy submarines.

In total, RDT&E on weapons systems of strategic nuclear offensive forces within DoD is \$1.50 billion in FY11, which will become more significant in the coming years as discussed in the section on modernization.

Command and Control (C2)

If RDT&E is the most obvious omission of MFP-1, Command and Control satellites are maybe the most notable omission. The nuclear forces operated by DoD would be near worthless without the systems and people who provide what is called command and control: the systems and people who direct and communicate with the actual operators and weapons systems.⁷¹ These costs are especially significant since command and control systems are largely satellite-based, with large and specific costs associated with each system.

Command and Control can be broadly grouped into two categories: the nuclear commands, like STRATCOM, that direct nuclear forces; and the satellite communication links and early warning systems that provide the means for commanders to direct nuclear forces. While the spending for nuclear commands is included in MFP-1, the cost to operate, procure, and develop satellite communication and early warning capabilities is found elsewhere in the defense budget. Because we have included the nuclear commands under MFP-1, as budgeted by DoD, the figure for Command and Control presented here is less than the total spending on Command and Control, since it excludes spending on the nuclear commands.

The costs for satellite communications and early warning systems can be divided into three distinct bins: procurement of the systems, research and development of the systems, and operations and maintenance of the systems.⁷²

For procurement funding for C2 systems, this study accounted for and summed all of the individual system line items provided in the annual budget justifications associated with the

71 Some command and control assets are included in MFP-1, however, these assets are limited to those systems devoted solely to the strategic mission. For instance, MFP-1 maintains a program element for “Minuteman Communications.”

72 The previous section on RDT&E did not include RDT&E costs for Command and Control, which is included in this section.

nuclear mission.⁷³ Using FY13 justifications, the FY11 actual is \$1.35 billion. Although the communication capabilities supporting nuclear command and control, including the Military Strategic and Tactical Relay (MILSTAR) Satellite Communications system, are dual-capable and serve non-nuclear missions, the Congressional Research Service characterized conventional missions as “secondary” for nuclear C2, and they are certainly necessary for nuclear operations.⁷⁴ Similarly, the United States possesses early warning systems (EWS) to detect nuclear ballistic missile launches, including ground-based radar systems and satellites. Early warning system capabilities include an array of long-range radar sites and infrared satellites to detect ICBM launches. Because of the indivisibility of C2 systems and minor incremental cost differences between a C2 system dedicated solely to the conventional vice dual-use missions, this study did not attempt to apportion costs between the nuclear mission and others. This study’s C2 figure includes the total cost of the system. For greater detail of what programs were included, see Appendix A.

C2 costs create budgetary peaks because of the large costs of buying any given system. DoD is attempting to mitigate these budgetary perturbations, but still C2 totals can vary over years.⁷⁵

In the previous five years, the procurement and RDT&E costs of C2 systems ranged in total cost from \$3.4 billion to a high of nearly \$5 billion in FY09. Making FY11’s \$3.4 billion on the low end of historical spending, though projected spending, including the FY13 request, are significantly lower. The dynamics of C2 procurement will be discussed more in the section on modernization. For the single-year estimate, this study relies on the actual FY11 figure, as it is unclear which period is most representative of future C2 spending.

C2 also bears significant RDT&E costs, not least because frequently the first satellites of a program are acquired solely with RDT&E funds before the program transfers to procurement. Most defense programs are bought in large enough quantity, the prototypes and early systems become just test platforms. However, because satellites are bought in such small numbers, the same satellite often serves as both a testing and operational platform. In FY2011, RDT&E spending on C2 projects totaled \$2.03 billion, accounting for nearly 66 percent of nuclear RDT&E spending. The majority of this spending results from efforts to improve satellite communication capabilities, including advanced MILSATCOM and MILSATCOM terminals, although more than one quarter of C2 RDT&E spending was dedicated to improving early warning systems, and particularly the costly SBIRS satellite project.

Command and Control (C2)

In billions of FY11 dollars

Operations and Maintenance	\$1.92
RDT&E	\$2.02
Procurement	\$1.35
Total	\$5.30

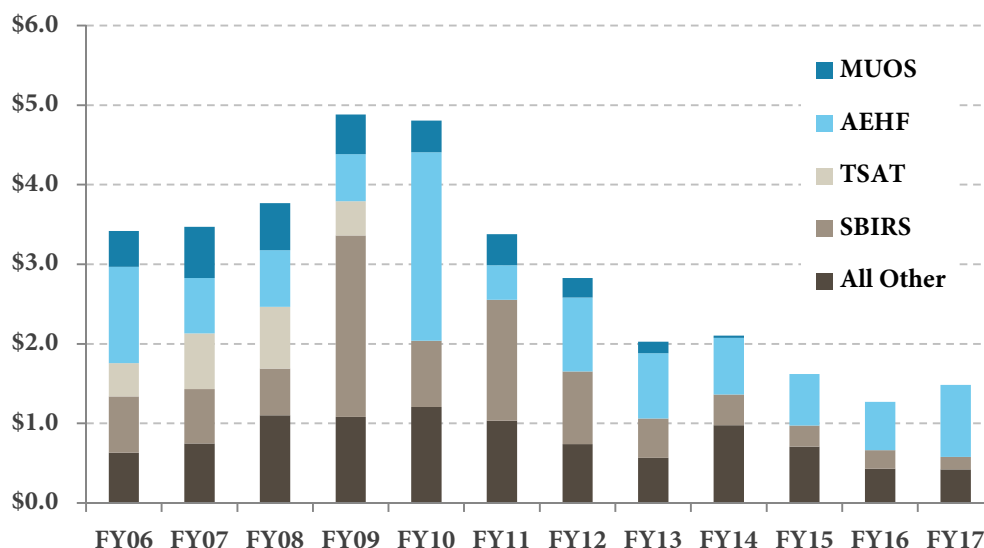
Note: May not total due to rounding

73 This study relied on Robert Critchlow, “Nuclear Command and Control: Current Programs and Issues,” Congressional Research Service, May 3, 2006, <http://www.fas.org/sgp/crs/nuke/RL33408.pdf>, to designate what C2 systems are used by the nuclear mission.

74 Critchlow, “Nuclear Command and Control: Current Programs and Issues.”

75 Statement of Cristina T. Chaplain, Director, Acquisition and Sourcing Management before the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate, “DoD Delivering New Generations of Satellites, but Space System Acquisition Challenges Remain,” Government Accountability Office, GAO-11-590T, May 11, 2011, p. 24-25.

Figure 4: Command Control (C2) Procurement and RDT&E
in billions of FY11 dollars



For operations and maintenance, this study took the two subactivity groups, Global C3I and Early Warning and Space Control Systems, from the Air Force operations and maintenance (O&M) budget justification, as well as two subactivity groups, Combat Communications and Space Systems and Surveillance, from the Navy O&M budget justifications. However, not all of the costs of these subactivities should be associated with strategic nuclear offensive forces. For instance, the Navy’s Combat Communications subactivity includes the program “Mobile Ashore Support Terminal.” This program supports commanders of conventional forces when maneuvering at sea, not nuclear command and control.⁷⁶ Without more granular detail of the O&M costs of each system, this study assigned equal weight to each acknowledged system, creating a proportional share of the total subactivity based on how many of the systems included in each subactivity support strategic nuclear offensive forces. Using FY13 budget justifications, the FY11 actual for C2 O&M is \$1.92 billion. For greater detail of what programs were included, see Appendix A.

Combined, this study identified \$5.30 billion of spending on nuclear C2 outside of MFP-1. This does not include the cost of operating and maintaining the nuclear commands found in MFP-1. A full account of the systems included is listed in Appendix I. C2 makes up the second largest part of DoD’s cost of strategic nuclear offensive forces.

Other Operational Costs and Support

C2 and RDT&E, though not accounted for in MFP-1, can be accounted for within budget documents on a line-by-line, system-by-system basis providing fairly specific costs. Other Operations and Support includes costs that cannot be estimated so precisely. Nevertheless, Other Operations and Support includes very real costs within DoD to operate and maintain strategic nuclear offensive forces, especially given the approach of this study, which presumes all costs necessary if operating

⁷⁶ “Jane’s C4I Systems”, *Jane’s*, June 23, 2011

strategic nuclear offensive forces was the sole mission of DoD. Other Operations and Support in this study includes six specific components: other operational costs; training and recruiting costs; medical costs; family housing; centralized supply and maintenance; and centralized administrative costs.

Other operational costs. As discussed above, MFP-1 captures the vast bulk of the operational costs of strategic nuclear offensive forces including the costs of the weapons themselves and the units that operate those weapons. However, it leaves out one significant capability and cost, aerial refueling tankers, and one small, but important capability and cost, nuclear-specific airlift.

The strategic bombers rely on aerial refueling to extend how far and how long they can fly. The tankers that provide aerial refueling themselves owe their development to the Air Force's focus on strategic bombing during the early Cold War. The KC-135 tanker, the primary tanker in the fleet today, was developed specifically to support the B-52s that were the heart of the Strategic Air Command's (SAC) nuclear deterrent in the mid-1950s.⁷⁷ As long as that nuclear mission existed, it was the tankers main responsibility; "Almost to the day SAC passed out of existence, May 31, 1992, it retained control of the nation's premier aerial refueling force."⁷⁸ However, the end of the Cold War and the transfer of the tankers to the newly formed Air Mobility Command changed the primary focus of the tankers. The foreword to the Air Force's Doctrine Document on Aerial Refueling captures this shift:

"During the Cold War air refueling operations were focused on supporting the bomber force of our nuclear deterrence triad... Today, air refueling is conducted to provide rapid response, increased range, and extended airborne operations for bombers, fighters, airlift, command and control, and intelligence, surveillance, and reconnaissance aircraft from the Air Force, Navy, Marines, and US allies and coalition partners."⁷⁹

That shift manifests itself in the planning and budgeting for tankers. STRATCOM today maintains a task force, Task Force 294, which provides tankers to support STRATCOM's mission.⁸⁰ However, there is no public assignment of what number of tankers or units directly support the nuclear mission. And since the end of the Cold War, the requirements for tankers for conventional missions has only grown. The Pentagon conducts a study every five years to determine the requirements for aerial refueling. The last one, conducted in 2010, found that in two of the three cases it examined—none of which included the nuclear mission—the tanker inventory was not enough to meet these conventional requirements.⁸¹ If the tanker inventory as is does not support just the conventional mission, it is difficult to say what proportion of the tanker fleet supports the nuclear mission.

This difficulty becomes even more acute when the cost figures are included. The Air Force in 2011 had an inventory of 417 KC-135 tankers across the active and reserve components. This number does not include KC-10 tankers, which were developed in response not to the nuclear mission, but to the conventional missions the Air Force required tanker support for. Furthermore, the Air Force

77 Michael Lombardi, "The first KC-135 tanker aircraft rolled out 50 years ago this month," *Boeing Frontiers*, July 2006.

78 Richard K. Smith, *Seventy-Five Years of Inflight Refueling: Highlights, 1923–1998*, Air Force History and Museums Program, 1998, p. 52.

79 Major General Timothy Kinnan, Foreword, *Air Refueling*, Air Force Doctrine Document 2-6.2, July 19, 1999.

80 US Strategic Command, *Task Forces*, http://www.stratcom.mil/task_forces/, accessed March 25, 2012.

81 William Lynn, "Mobility Capabilities and Requirements Study 2016," Department of Defense Memorandum, February 26, 2010.

has embarked on a program to acquire a next-generation tanker, the KC-46A tanker, which will procure 179 new tankers by 2028 for a cost of nearly \$52 billion. In just FY11, the Air Force by our estimate spent \$6 billion on the KC-135 tanker fleet and KC-46A replacement. If all of these aircraft were dedicated to the nuclear mission, their costs would overwhelm all of the other supporting costs of strategic nuclear offensive forces.

To estimate what proportion of tankers and their cost to assign to strategic nuclear offensive forces despite the lack of public material on how tankers support strategic bombers in the nuclear mission, this study made several assumptions and used a crude model to determine what proportion of tanker costs should be included. First, the study assumed that it was Air Force Reserve and Guard tankers that supported the nuclear mission, rather than the active duty tankers. Second, after calculating the B-2 and B-52s fuel capacity, the refueling capacity of the KC-135, and the fuel required to fly from the central United States to central Eurasia, the study assumes a need for 1.5 tankers per bomber, which may underestimate the number of tankers as it works mathematically but in reality—especially for a nuclear mission—some additional margin would likely be included. Finally, the study assumed a peak demand of all the nuclear-capable bombers needing tanker support, which would be 144 tankers and in turn is likely an overestimate as it is unlikely every nuclear-capable bomber would fly at one time. The study then figured costs by prorating the Air Guard and Air Force reserve line item costs for KC-135 by the demanded tankers against the total number of tankers, assuming the proportion of tankers assigned to the nuclear mission between the Guard and Reserve equaled the ratio between the total Guard and Reserve tankers. Additionally, the study calculated the personnel and even supporting military construction costs of the Guard and Reserve in proportion to the demanded tankers. This methodology results in an estimated cost for tankers supporting strategic nuclear offensive forces of \$690 million. Because there are so many assumptions and calculations in this methodology, it is sensitive to each of those assumptions. If tanker support were determined only for bombers combat-coded for nuclear missions, the cost would be only \$440 million. If all bombers were included as peak demand, but they required two tankers each, the cost would be nearly \$919 million. These costs would change even more if active components were included as well. Active duty forces carry significantly higher personnel and operational costs as their budget lines reflect continuously incurred costs while guard and reserve personnel only incur many of those costs when conducting operations.

Tankers, even under this study's methodology, represent the greatest continuing uncertainty in determining the supporting costs of strategic nuclear offensive forces. Because of the limited public discussion of how tankers support strategic bombers, and likely because of the ambiguity inherent in the DoD's planning and force assignment processes, tanker costs can be calculated at widely varying levels in support of strategic nuclear offensive forces. This study relied on a somewhat conservative estimate to ensure the tanker cost alone does not become the primary driver of the supporting costs of strategic nuclear offensive forces, especially because tankers and their costs would almost certainly exist in at least their current form even if the US ended its nuclear program immediately because of their conventional mission.

The Air Force's Air Mobility Command also manages the aircraft and units that provide airlift to the entire US military. Strategic nuclear offensive forces, too, require occasional—and specialized—airlift. This lift is provided by the 62nd Airlift Wing, which consists of 48 C-17 aircraft, and is the Prime Nuclear Airlift Force responsible for transporting nuclear weapons and weapons components

in support of nuclear operations and arms control treaties. The 62nd Airlift Wing is also tasked with a variety of humanitarian and combat airlift missions, but it still delivered more than 32,000 lbs. of nuclear-related cargo in 2010.⁸² Since the FDYP structure does not assign C-17 squadrons to MFP-1, the cost of the 62nd Airlift Wing likely is found elsewhere. This study estimated the cost of the 62nd Airlift Wing by multiplying spending on Air Force Airlift Operations by the fraction of all Airlift planes under the 62nd Airlift Wing. This is certainly a rough estimate, and may overestimate spending necessary for nuclear operations, since fuel and maintenance costs might be lower with a smaller mission. Additionally, this estimate captures significant costs just because it is an active unit, even if the nuclear mission is only a small part of their workload. This method yields an estimated \$598 million in airlift costs.

Together, these two capabilities produce \$1.29 billion in other operational costs.

Training and Recruiting. MFP-1 provides the bulk of personnel costs for strategic nuclear offensive forces as it captures the costs of the personnel serving in units operating and maintaining nuclear weapons. It does not, however, account for the overhead necessary to transport personnel to those units, specifically the costs to recruit and then provide both general and specific training of nuclear personnel. If strategic nuclear offensive forces were all that was to exist of the US military, it would still require some overhead to provide these services. However, since these services are provided on a centralized basis, it is difficult to assign these tasks to a specific mission rather than to DoD as a whole.

The broad costs to recruit and train personnel are broken out separately in the Air Force and Navy budget justifications. To assign specific costs to strategic nuclear offensive forces, this study estimates the spending on services dedicated to nuclear personnel by multiplying spending on personnel services by the fraction of service personnel dedicated to nuclear operations as a share of the relevant number of individuals of the service. In some instances, personnel figures are publically available. Open-source information reveals that 33,000 individuals are assigned to Global Strike Command, STRATCOM, and the 62nd Airlift Wing. These figures likely overstate the number of nuclear personnel, since they include some number of non-nuclear operators, such as cyber-security personnel at STRATCOM. Open-source estimates of naval personnel dedicated to nuclear operations are less clear. One non-authoritative website estimates that 15,000 persons support COMSUBLANT, but no information is available for COMSUBPAC. Further, the Submarine Commands control more attack submarines than nuclear submarines. To estimate naval nuclear

Other Operations and Support

In billions of FY11 dollars

Other Operational Costs	\$1.29
Training and Recruiting	\$0.55
Medical Costs	\$0.80
Family Housing	\$0.09
Centralized Supply and Maintenance	\$0.65
Administration	\$0.54
Total	\$3.92

82 *The Associated Press*, "McChord nuclear airlift wing rated unsatisfactory," November 25, 2011, <http://seattletimes.nwsources.com/html/localnews/2016859240_apwanuclearairlift1stldwritethru.html>.

personnel, we multiplied the number of persons in COMSUBLANT by the percentage of nuclear submarines as a share of all COMSUBLANT submarines. Then, this study multiplied the number of persons per nuclear submarine by the number of nuclear submarines, which yielded 11,000 naval personnel. This might understate total naval nuclear personnel, since it is unlikely that command staff could be reduced in proportion to reductions in submarines. Additionally, this study includes in its calculations its estimates of personnel directly supporting strategic nuclear offensive forces operations, including those operating C2 systems, aerial refueling, and airlift personnel, but not the cost of supporting personnel, including health professionals, trainers and recruiters, and other centralized support personnel. This includes an additional 15,000 people, although some are Guard and Reserve. The costs for training operational personnel are understated because the study does not include their profession-specific training, which is captured elsewhere while the direct nuclear operators advanced training costs are captured in MFP-1.

Using this methodology, this study estimates recruiting and training costs associated with strategic nuclear offensive forces at \$550 million. Here this study begins to use methodologies similar to the other outside estimates discussed above—a proportional assignment of costs in a deductive manner. Given the difficulties of assigning costs for centralized services to only one aspect of the US military mission—which even the Pentagon cannot do with any fidelity, this approach is really the only plausible methodology. Nevertheless, this study has sought to dampen the possible variance in the estimate by relying on as small a budgetary element as possible before taking a proportional representation. In this case, by relying on subactivity groups. For this particular case, the estimate is overstated because it includes proportional costs for personnel who are only tangential to strategic nuclear offensive forces—like cybersecurity personnel at STRATCOM or some headquarters personnel at the Navy’s submarine fleet commands. However, it also underestimates these costs because it does not include the personnel from the centralized supply, maintenance, and administrative functions that support strategic nuclear offensive forces but also support other missions.

Although this report relies on a deductive method for calculating many centralized support costs, our methodology differs slightly from previous studies since this report relies on nuclear personnel as a share of defense personnel, rather than nuclear spending as a share of all spending on offensive forces, to calculate most overhead and support costs. This method is preferable for two reasons. First, in many instances, like health care and training and recruiting, costs are clearly more related to the limited number of persons supporting the nuclear enterprise than the cost of maintaining extremely expensive major weapons systems. Second, while other studies use the nuclear share of all operational forces, this report uses the nuclear share of all defense personnel. The former method tends to slightly overestimate the nuclear share of personnel based support costs, since even the personnel for overhead and support incur their own overhead and support costs. The military personnel dedicated to centralized administrative support at the Pentagon, for instance, still receive training and medical care. It may be the case that operational forces require greater overhead costs. If true, our methodology might tend to understate costs as much as other approaches overstate them. Even so, the defense-wide approach is conceptually consistent with how overhead and supply costs are distributed, even if it’s possible to envision how the other figures may still be relatively accurate. Ultimately, although our metrics are imprecise, relying

on the indices most related to the form of support—persons for recruiting, for example—should prove a more accurate deductive method.

Medical costs. DoD maintains and operates its own medical establishment providing medical services for all active duty personnel and selected reserve personnel, as well as their dependents and military retirees and their dependents—9.7 million beneficiaries in all.⁸³ Not surprisingly, this establishment is robust with a budget of \$52 billion in FY11. Medical costs within DoD have been handled in varying ways over the years. At times, each military service has borne the costs of medical care for its members and dependents. Today, however, these costs are centralized in the Defense Health Program, which helps identify what costs to include but makes it very difficult to provide much granularity on what medical costs are unique to strategic nuclear offensive forces.

To derive the medical costs necessary to sustain the personnel of strategic nuclear offensive forces, this study again relied on a proportional assignment of costs. Using the same personnel figures as for recruiting and training, this ratio was applied against specific budget activities found within the Defense Health Program: In-House Care, Consolidated Health Support, Information Management, Education and Training, Base Operations and Communications, and Facilities Sustainment and Restoration.⁸⁴ This methodology provides a reasonable assignment of costs, although not a perfectly precise one. It does not account for the changing scale of supporting a population of tens of thousands rather than one of millions, nor does it account for the specific medical costs borne by strategic nuclear offensive forces.⁸⁵ Nevertheless, it provides a repeatable method to apportion costs to the nuclear weapons.

For FY11, this study estimates \$801 million in medical costs for strategic nuclear offensive forces.

Family Housing. DoD maintains and operates family housing services for active duty personnel. Funding for operation and maintenance of existing facilities, as well as planning, design, and construction of new and replacement housing units are centrally funded in accounts designated for family housing. In FY11, the Air Force, Navy, and Marines spent a combined \$1.06 billion on Family Housing, the preponderance of which was dedicated to operations and repaying debt, while approximately 18 percent of Family Housing spending was allocated toward construction costs.

To determine the cost of Family Housing units necessary for the personnel of the nuclear enterprise, this study again relied on a proportional assignment of costs, based on the same service-wide personnel figures as for recruiting and training. This ratio was applied against the total service-wide costs of Air Force and Navy Family Housing in FY11, generating a strategic nuclear offensive forces cost of \$93 million.

83 For more information about the Military Health System, see 2012 MHS Stakeholder's Report, Military Health System, Department of Defense.

84 Defense Health Program, Fiscal Year 2013 Budget Estimates, February 2012.

85 Nuclear personnel face more rigorous physical and psychological screening because of the sensitive nature of working with nuclear weapons. This screening is called the Nuclear Weapons Personnel Reliability Program. See "Nuclear Weapons Personnel Reliability Program," DoD 5210.42-R, Department of Defense, June 30, 2006. This methodology also does not account for greater health care costs engendered by combat. Strategic nuclear offensive forces—though standing alert or patrol every day—are not deployed to Iraq and Afghanistan, where combat casualties may cause higher proportional health care costs. This exception has its own exception as some personnel captured in MFP-1 have been deployed, for instance, Air Force Security Forces and individual augmentees. Strategic bombers have been deployed, but there have been no reports of casualties of bomber crews.

Centralized Supply and Maintenance. Once again, specific costs to maintain nuclear weapons and its supporting capabilities are captured in MFP-1. However, these costs do not include the broader supply and maintenance costs that support many missions within DoD and are managed centrally. This broader supply chain consists of the transportation and logistics costs necessary to move materiel around. These costs do not include unique costs to move nuclear materiel. These costs are accounted for budgetarily in a single MFP. These costs may or may not be tied simply to number of personnel because where the personnel are located figures prominently in the costs to supply them. Therefore, this study created a base index in order to assign proportional costs. The base index is relatively crude, intended less to provide an exact accounting, as to ensure some sensitivity in allocating costs. The base index was composed by compiling the number of buildings (to proxy infrastructure) and personnel at bases that where strategic nuclear offensive forces are stationed. Nuclear delivery vehicles are kept at a small number of bases that, for the most part, are dedicated to the nuclear mission (with the caveat that the delivery vehicles themselves are not dedicated to the nuclear mission). Nevertheless, the ballistic missile submarine bases, strategic bomber bases, and ICBM bases are focused almost solely on these missions. Multiplying this base index against all US bases, this study derived an estimate for allocating the centralized supply and maintenance costs to strategic nuclear offensive forces.

For FY11, this study estimates \$651 million in centralized supply and maintenance costs for strategic nuclear offensive forces.

Centralized Administrative Costs. Centralized administrative costs create fundamental methodological issues for allocating costs to strategic nuclear offensive forces. These costs—like centralized supply and maintenance—represent costs necessary to support strategic nuclear offensive forces, but bound up in networks and headquarters that support all military missions, making them very difficult to disaggregate. Like medical costs, these costs also do not scale purely proportional. The Pentagon—until recently the largest office building in the world—is necessary only because of the vast scale of the DoD. If DoD were not as big, if it were only strategic nuclear offensive forces, the Pentagon’s functions would not be as many. Whole layers of management may be unnecessary at a smaller scale.

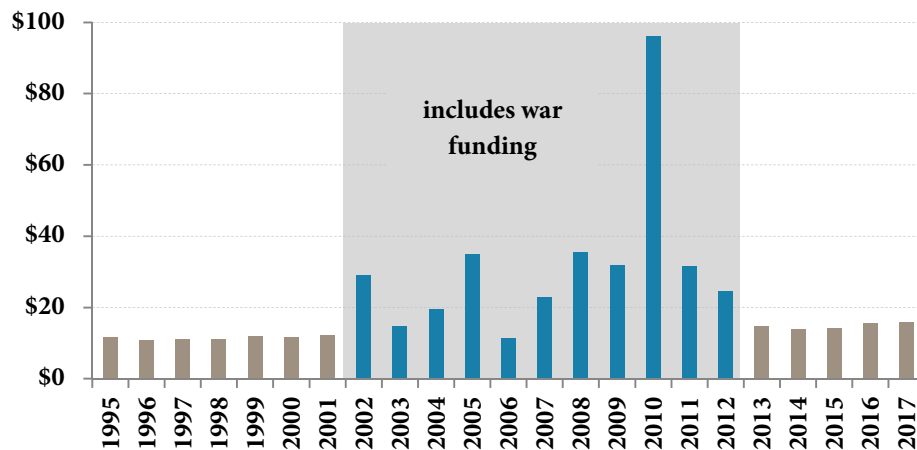
Centralized administrative costs pose an even thornier, though more mundane, budgeting problem. The MFP for centralized administrative costs includes catch-all program elements where funding is parked until it is transferred to the accounts it is actually used in. These budgetary moves are for the most part limited to contingency operations. However, contingency operations include the wars of Iraq and Afghanistan fought in the last decade, creating dramatic skewing in the budget presentation.

One case can serve to illustrate this phenomenon. From 2001-2003, funding was appropriated to DoD in what is called the Defense Emergency Response Fund (DERF), to deal with unforeseen contingencies in Iraq and Afghanistan.⁸⁶ The program element, 0901000D, associated with DERF

⁸⁶ Department of Defense, “Defense Emergency Response Fund,” FY 2004 Operations and Maintenance Overview book, Congressional Budget Justification, p. 61.

is found in the MFP comprising centralized administrative costs.⁸⁷ The anomalous peak of the 2002 appropriation of \$11.3 billion to DERF can be clearly seen in Figure 5 displaying MFP-9 over time. FY10 represents an even greater anomaly, with a peak over \$90 billion—eight times more than the FY96-00 average, and seven times more than the FY13-17 average, and little public explanation for why these accounts are so anomalous.

Figure 5: MFP-9: Administration and Associated Costs
in billions of FY11 dollars



To compensate for this variability, this study does not use the FY11 actual provided in the FY13 budget justification for MFP-9, as is used for other estimates, but rather averages funding for MFP-9 in real terms from FY-13-17, as projected by the FY13 FYDP, when MFP-9 projections stabilize at more representative levels to pre-war funding levels. This figure is then pro-rated with the same personnel-based methodology used above. This methodology inherently creates some imprecision as it moves away from primary budget documentation, however, such a methodology better accounts for the variability found in the budgeting practices of contingency operations.

This study derives a one-year cost of centralized administration and management for strategic nuclear offensive forces at \$538 million.

Although covering a large part of the rest of the defense budget and including multiple categories, Other Operations and Support is still less expensive than C2. Summing over the six bins presented above, this study estimates Other Operations and Support costs at \$3.92 billion.

Having broken the defense budget into as small a parts as possible and attempted to allocate costs to strategic nuclear offensive forces, this report has taken a bottom-up and inductive approach to determining the costs of strategic nuclear offensive forces. Using the methodology presented above for each category, the total cost for strategic nuclear offensive forces not including MFP-1 is \$10.8 billion in a single year.

⁸⁷ For more information about the DERF spike, see Government Accountability Office, “Tracking of Emergency Response Funds for the War on Terrorism,” Report to the Subcommittee on Defense, Committee on Appropriations, US Senate, April 2003, GAO-03-346.

DoD Costs for Strategic Nuclear Offensive Forces

In billions of FY11 dollars

MFP-1	\$11.99
Costs Outside of MFP-1	
Command and Control	\$5.30
RDT&E	\$1.50
Overhead and Support	\$3.92
Total	\$22.71

This figured can be added to MFP-1 to create a total in FY11 for DoD's costs of strategic nuclear offensive forces of \$22.7 billion.

Aspects Not Included

Above is a single-year estimate of the costs of strategic nuclear offensive forces within DoD. However, that cost represents only those components described above. Other components could also plausibly be included. This section reviews components not included and the methodological or theoretical justification for leaving those components out.

Intelligence. As already discussed throughout this study, command and control, early warning and intelligence are critical and substantial parts of strategic nuclear offensive forces. Besides and including DoD, US intelligence agencies also bear responsibility for these missions. However, intelligence funding is intentionally kept classified and is not presented in any attributable manner. Therefore, though these capabilities and costs are critical, this study did not attempt to estimate them. This approach aligns with others' past approaches and the general debate, which acknowledges the existence of intelligence capabilities but does not specifically include them.

Tactical Nuclear Weapons. This study does not account for the costs of tactical nuclear weapons outside of NNSA's weapons activities. The United States does still possess some tactical nuclear weapons, which are deployed to European countries, theoretically for their use if US conventional forces are defeated in Europe.⁸⁸ There are costs to maintaining those weapons, including special storage requirements.⁸⁹ But there is no public documentation of the costs of tactical nuclear weapons in Europe.⁹⁰ Kosiak '06 estimated the cost of these weapons at \$400 million in FY06 dollars but this study does not validate that estimate or provide any alternative estimate in the interest of only providing a repeatable estimate. Tactical nuclear weapons also pose a theoretical challenge of the type discussed below. They are delivered using aircraft whose dominant mission is conventional, which opens a question of what line should be drawn between nuclear and conventional costs.

88 Oliver Meier, "An End to U.S. Tactical Nuclear Weapons in Europe?" *Arms Control Today*, July/August 2006.

89 For a discussion of what costs pay for—although not the costs themselves—including a quote from a senior leader resenting the costs of tactical nuclear weapons, see "Phase II: Review of the DoD Nuclear Mission," Report of the Secretary of Defense Task Force on DoD Nuclear Weapons Management, December 2008, p. 59-63.

90 Hans Kristensen, "US Nuclear Weapons in Europe: A Review of Post-Cold War Policy, Force Levels, and War Planning," Natural Resources Defense Council, February 2005, p. 18.

Basic and Applied Research. This study did not account for funding for basic or applied research. DoD spends roughly \$8 billion a year on Basic and Applied Research. Basic research is defined as “systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards process or products in mind.”⁹¹ That is, basic research funds activities that may eventually support the mission of strategic offensive nuclear forces, but are not directly intended to. Applied research is defined as “necessary to determine the means by which a recognized and specific need may be met.”⁹² Although aimed at specific needs, applied research still occurs at a very general level. For instance, the Air Force’s applied research is binned in categories like “Aerospace Vehicle Technologies” and “Space Technology.”⁹³ Similarly, Navy R&D includes “Power Projection Applied Research” and “Future Naval Capabilities Applied Research.”⁹⁴ These capabilities may very well benefit strategic nuclear offensive forces, but are general enough that it is very difficult to assess whether and how such funding supports strategic nuclear offensive forces. Therefore, this study has omitted any costs from these areas.

Other operational support. Intelligence and tactical nuclear weapons funding were excluded for methodological reasons, but there are other operational costs that were excluded for more theoretical reasons. As discussed earlier, this study seeks to cost strategic nuclear offensive forces as if it were the sole mission of the DoD—what would DoD cost if all it did were operate strategic nuclear offensive forces? While this goal provides a conceptual framework that has helped determine what to include or exclude, in practice, it breaks down, if for no other reason than through the application of recursive logic. For instance, to maintain strategic nuclear offensive forces, DoD must ensure the security of the United States and therefore all the costs of DoD support strategic nuclear offensive forces. Obviously, this example takes the recursive logic to an extreme. However, as discussed earlier, the first step on this recursive path is taken as soon as strategic bombers are included in the costs of strategic nuclear offensive forces. Since the bombers conduct both nuclear and conventional missions, their costs can only be completely included if the share of their purpose that is the nuclear mission qualifies them as a nuclear cost. But if this logic holds, every component of DoD that no matter how distantly supports the nuclear mission (as in the recursive example above), could theoretically be included. To help illustrate this dilemma, this section looks at two capabilities that were not included: attack submarines and high-altitude unmanned aerial vehicles.

Attack submarines do not carry nuclear weapons, and are not part of the triad. However, attack submarines are a key defensive part of the nuclear deterrent—or at least were in the Cold War. As a CBO report from 2002 states: “The principal purpose of U.S. attack submarines during the Cold War was to conduct antisubmarine warfare in the open ocean. Their job was to locate and trail Soviet submarines, especially ones carrying ballistic missiles, so those subs could be destroyed in

91 For a greater discussion on DoD Basic Research, see “Assessment of Department of Defense Basic Research,” Committee on Department of Defense Basic Research, National Research Council, (National Academies Press: 2005).

92 See Appendix B: Government-wide and DoD Definitions of R&D in Donna Fossum, Lawrence S. Painter, Valerie L. Williams, Allison Yezril, and Elaine M. Newton, *Discovery and Innovation: Federal Research and Development Activities in the Fifty States, District of Columbia, and Puerto Rico*, (RAND: 2000).

93 Department of the Air Force, FY13 President’s Budget Submission, RDT&E vol 1, p. xxxii-xxxiii.

94 Department of the Navy, FY13 President’s Budget Submission, RDT&E vol 1, p. xxxii-xxxiii.

the event of war.”⁹⁵ Russian SSBNs have not patrolled as regularly as Soviet ones did during the Cold War, but it is possible that US attack submarines still conduct such a mission.⁹⁶ If they do, should their costs be included in the costs of strategic nuclear offensive forces? If they were included, the costs of the 54 attack submarines in the fleet would dramatically change the totals of the study. In FY11, the procurement of two Virginia-class submarines cost \$5 billion, or nearly 50 percent of this study’s estimate of non-MFP-1 DoD nuclear costs.⁹⁷ For this study, attack submarines as a defensive part of the nuclear deterrent are fairly easy to rule out since this study is considering only those capabilities necessary to execute offensive operations, and so has already excluded costs for ballistic missile defense. In this aspect, attack submarines fall fairly cleanly outside of this study’s cost scope.

However, the games of undersea warfare are not so easily defined as offensive and defensive. If an attack submarine is not hunting an adversary’s ballistic missile submarines, but rather hunting an adversary’s attack submarines who are in turn hunting US ballistic missile submarines, the US attack submarine would be supporting the offensive side of nuclear deterrence, and would reopen the debate closed above. But attack submarines also conduct missions beyond just anti-submarine warfare. The Navy’s own Submarine Warfare Division lists the following missions: intelligence-gathering, striking land-based targets through the use of cruise missiles, insertion of special operations forces, and mine warfare.⁹⁸ Thus attack submarines represent a cusp case that shows how much larger an estimate could be of what DoD costs support strategic nuclear offensive forces. This study has attempted to define strategic nuclear offensive forces broadly enough to capture necessary supporting capabilities like C2, but strictly enough to exclude more complimentary capabilities, like attack submarines. However, even this necessary versus complimentary distinction breaks down if taken too far.

A second example of a cusp capability is unmanned aerial drones used for intelligence, surveillance, and reconnaissance. One of the methods used to make land-based ballistic missiles more survivable is to make them mobile. Mounted on vehicles called Transporter-Erector-Launchers, or TELs, these missiles can move locations so their location cannot be fixed, and therefore targeted.⁹⁹ While satellite-based surveillance can help locate these missiles, the missiles can also move faster than satellites can track them, complicating targeting. Unmanned drones may be able to better fix a mobile missile location by providing constant—and mobile—surveillance of a TEL.¹⁰⁰ Unlike attack submarines, drones’ ability to locate and fix mobile-missiles is more clearly offensive in nature as it helps target US offensive missiles, and similar to the early warning systems this study has included

95 “Increasing the Mission Capability of the Attack Submarine Force,” Congressional Budget Office, March 2002, p. 5. For popular accounts of Cold War submarine missions, also see Peter Sasgen, *Stalking the Red Bear: The True Story of a U.S. Cold War Submarine’s Covert Operations Against the Soviet Union*, (MacMillan: 2010), and Sherry Sontag, Christopher Drew, and Annette Lawrence Drew, *Blind Man’s Bluff: The Untold Story of American Submarine*, (HarperCollins: 2000).

96 Russian Navy Commander-in-Chief Admiral Vladimir Vysotsky reportedly said Russia would resume permanent patrols of SSBNs in international waters this summer, although the article also notes that Russia has dropped its number of patrols to less than 10 a year in recent years. “Russian SSBNs to Resume Patrols in International Waters in June 2012,” *NavalToday.com*, February 7, 2012.

97 FY13 US Navy Shipbuilding and Conversion Budget Justification, p. N-3.

98 “Submarine Themes,” Chief of Naval Operations Submarine Warfare Division, <http://www.navy.mil/navydata/cno/n87/themes/denied.html>, accessed March 20, 2012.

99 “Ballistic and Cruise Missile Threat,” National Air and Space Intelligence Center, NASIC-1031-0985-09, April 2009, p. 6.

100 Barry R. Schneider, “Counterforce Targeting Capabilities and Challenges,” Air University, August 2004. Note that the cited paper argues for how drones might be used and does not provide any examples of drones having been used for such a mission. Neither does this study present any evidence that drones have been used that way, concerning itself more with the theoretical question of what could be included in the costs of offensive nuclear operations.

in its cost estimates. However, like attack submarines, drones also conduct multiple missions unrelated to offensive nuclear targeting. The Global Hawk—a high-altitude drone with the kinds of capability most suited to a fixing mission—has been used in Iraq, Afghanistan, Libya, Haiti, Japan, and elsewhere all on missions not focused on nuclear targeting, and including providing support for humanitarian operations.¹⁰¹ Drones also come in a range of capabilities from small, hand-held drones to the Global Hawk just described. Certainly even the smallest unmanned drones could be valuable for this mission in certain circumstances, although those circumstances become pretty demanding—like a team of people inserted in to overwatch a TEL. Thus, this capability starts down the recursive logic chain and becomes more comprehensive than useful. This study has not included the costs of unmanned drones because of the broad missions they perform, and the small role they may be able to play in nuclear operations. Nevertheless, drones represent a capability that carries a fairly direct rationale for including in the costs of strategic nuclear offensive forces, highlighting how difficult it is to designate costs to include and exclude.

This section acknowledges that there is no theoretical way to create a sharp break between nuclear costs and other costs. Nevertheless, in reality, most observers will have an intuitive sense of what they would bin in each category. This section has sought to illustrate where the break was chosen in this study, and point to what capabilities would most likely next be included if the definition was expanded slightly.

As already described in multiple places, a completely definitive costing of strategic nuclear offensive forces is not possible because of the different ways one could define strategic nuclear offensive forces. Nevertheless, this section has added transparency to that debate by acknowledging what this study included and what it did not, including the methodological or theoretical justifications.

Including NNSA

Having assembled a cost estimate for strategic nuclear offensive forces within DoD and explained what was not included, the next step is to include costs not in DoD. This study has focused on those additional costs funded in DoD's budget, and has prioritized the research of those costs. However, NNSA also carries basic costs necessary to operate and maintain strategic nuclear offensive forces. As described in section II, almost all of these costs are captured in NNSA's weapons activities account. However, section II also laid out two other components of NNSA that include costs that fairly directly support strategic nuclear offensive forces: the Office of the Administrator and Naval Nuclear Propulsion.

NNSA's Weapons Activities was appropriated \$6.9 billion in FY11, covering “the research, development, secure transportation, and production activities necessary to support the US nuclear weapons stockpile.”¹⁰² The US nuclear weapons stockpile represents all of the US nuclear warheads, as the United States discontinued production of new nuclear warheads following the Cold War.¹⁰³ As mentioned before, this account also includes the costs of maintaining the remaining non-strategic

101 For examples see Christopher Drew, “Costly Drone is Poised to Replace U-2 Spy Plane,” *New York Times*, August 2, 2011 and Nathan Hodge, “U.S. Diverts Spy Drone from Afghanistan to Haiti,” Danger Room Blog, *Wired Magazine*, January 15, 2010.

102 “Our Programs: Defense Programs,” National Nuclear Security Administration, <http://nnsa.energy.gov/aboutus/ourprograms/defenseprograms>, accessed March 22, 2012.

103 Ibid.

NNSA Costs for Strategic Nuclear Offensive Forces

In billions of FY11 dollars

Weapons Activities	\$6.92
Office of the Administrator	\$0.34
Naval Reactors	\$.99
Total	\$8.25

nuclear warheads, a capability not costed in the DoD sections. Weapons activities encompasses all the costs of those warheads.

The Office of the Administrator primarily consists of those people administering the nuclear programs of NNSA. Therefore this study allocated the Office's funding by full-time equivalents (FTEs).¹⁰⁴ This study assumed that Office of the Administrator spending allocated toward NNSA Weapons Activities and Naval Nuclear Reactors was in proportion to the number

of FTE's supporting those tasks with respect to the Office of the Administrator as a whole. In FY11, 252 FTEs supported defense nuclear nonproliferation programs and 1538 FTE's supported NNSA Weapons Activities and Naval Nuclear Reactors, and consequently this report allocated 86 percent of Office of the Administrator Funding toward the nuclear mission.

For FY11, this figure is \$343 million.

The Naval Nuclear Propulsion Program—usually called Naval Reactors—represents a more technical question of the assignment of costs than the centralized administrative costs of the Office of the Administrator. Some of the Naval Reactors costs are supporting overhead and basic research, while other costs support specific reactor designs for specific boats. The office provides reactors and their support for three classes of Navy ships: aircraft carriers, ballistic missile submarines, and attack submarines, all of which are nuclear powered. However, only one of these classes is part of strategic nuclear offensive forces: the ballistic missile submarine. Despite the three types of ships Naval Reactors supports, most of their work would require much of the same infrastructure, minimizing the incremental costs created for the separate ship types. So as was done with Command and Control, this study has included all budgeted costs for Naval Reactors as part of strategic nuclear offensive forces. For FY11, Naval Reactors was provided \$987 million.

Strategic Nuclear Offensive Forces

In billions of FY11 dollars

DoD	\$22.71
NNSA	\$8.25
Total	\$30.96

Adding together these three components of NNSA's budget, this study estimates NNSA's part of strategic nuclear offensive forces to be \$8.3 billion.

Adding this sum to DoD's part of strategic nuclear offensive forces, this study estimates a one-year cost of strategic nuclear offensive forces at \$31 billion.

104 FTEs is a technical term to account for the varying work weeks individual people may work. The Bureau Of Economic Analysis defines FTEs as "Full-time equivalent employees equal the number of employees on full-time schedules plus the number of employees on part-time schedules converted to a full-time basis. The number of full-time equivalent employees in each industry is the product of the total number of employees and the ratio of average weekly hours per employee for all employees to average weekly hours per employee on full-time schedules." http://bea.gov/faq/index.cfm?faq_id=368&searchQuery=&start=200&cat_id=0.

Compared to Other Estimates

This study has sought to clarify the debate about the costs of nuclear weapons by focusing on the most uncertain aspect of costs of the nuclear enterprise: the costs within DoD but outside of MFP-1 for strategic nuclear offensive forces. Previous independent estimates have taken a broader approach and looked to cost multiple aspects of the nuclear enterprise. These other studies did estimate costs within DoD but outside of MFP-1 for strategic nuclear offensive forces. These studies did not conduct nor provide as granular analysis as this study has, largely because of the broader focus of the previous studies. Nevertheless, this study generally validates the earlier studies' estimates of the costs of strategic nuclear offensive forces within DoD.

Table 3 compares this study's estimate to the three previous studies' estimates for strategic nuclear offensive forces in like terms. The estimates are presented in FY11 dollars. However, because of the wide span of time, these estimates could be costing fundamentally different programs. The forces being costed could have changed over the 10-year span. Moreover, the methodologies are all different making strict comparisons impossible. Nevertheless, the inductive approach arrives at a similar—if slightly lower—estimate to the previous estimates.

Table 3: Nuclear Offensive Strategic Forces Estimates				
<i>in billions of FY11 dollars</i>	Schwartz '98	Kosiak '06	Schwartz and Choubey '09	Stimson '12
MFP-1	\$10.8	\$10.7	\$10.3	\$12.0
other Costs	\$17.7	\$17.3	\$12.8	\$10.8
Total	\$28.5	\$28.0	\$23.1	\$22.7

Note: May not total due to rounding

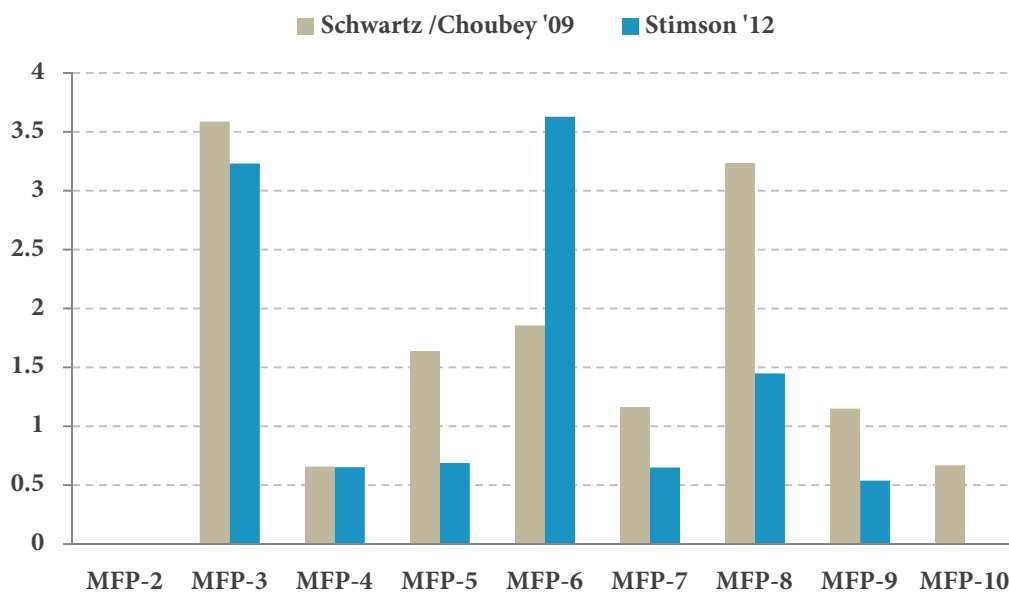
Schwartz '98 presents a significantly greater cost outside of MFP-1. The largest contributor to this divergence is C2, which Schwartz '98 estimated at \$6 billion in 1996 dollars, or \$9 billion in FY2011 dollars. Although it is unclear exactly how the study arrived at that estimate, it clearly exceeds the \$5.3 billion in C2 costs outside of MFP-1 identified by this study. It is possible that the C2 estimate may have assumed – in contrast to this study's assumptions—that all command and control costs are tabulated outside of MFP-1. Indeed, it is quite possible that the sum of all C2 costs, including those found in MFP-1, reaches \$9 billion in FY2011.

Kosiak '06 provides less detail over fewer categories making comparisons difficult. But Kosiak '06 also appears to be high, most likely because that study includes more of the DoD budget, although it is unclear what specific capabilities were included. Again, it is worth noting that their estimate includes \$10 billion in C2 costs, again suggesting that the discrepancy lies in this category.

Schwartz and Choubey '09 study corresponds very well with this study's estimate, despite dramatically different methodologies. Figure 4 compares Schwartz and Choubey's '09 estimate against this study's estimate by major force program to illustrate how differently the two studies reach a similar

total estimate. Schwartz and Choubey '09 use a very deductive approach, which pulls costs without reference from each MFP. Our study, in contrast, took an inductive approach that tailored the methodology to the costs being estimated. In general, our study found lower Other Operations and Support costs, since their methodology relies on the nuclear share of operational costs, while our study relied on the nuclear share of all defense personnel. As explained earlier, the nuclear share of all defense personnel is smaller than the nuclear share of operational spending, since nuclear weapons platforms are costly to maintain but require relatively few persons, especially compared to the Army and Marines. On the other hand, our study finds many more RDT&E costs, since a high proportion of nuclear capabilities—two-thirds of the triad and many communications links—are undergoing modernization programs. Further, the nuclear enterprise is dependent on costly major weapons and satellite platforms, which are more likely to incur relatively higher research and development costs than the rest of the US military. Finally, while Schwartz and Choubey deduce central administrative costs based on the whole of MFP-9, which is inflated by war costs during this period, we rely on an average of central administrative costs after war funding subsidies, which results in a somewhat lower number.

Figure 6: Comparison by MFP: Schwartz and Choubey '09 vs. Stimson '12



For the NNSA components, comparison is difficult because the previous studies in pursuing a comprehensive estimate of the nuclear enterprise included most DoE nuclear spending, and were less concerned about distinguishing what costs were directly related to strategic nuclear offensive forces. The three studies seemed to set aside NNSA's weapons activities, capturing the other costs in other bins. Because of this, the nuclear warhead categories are slightly understated compared to this study's NNSA estimate. However, this understatement is more than compensated for by the inclusion of much broader costs.

Although it is difficult to create strict comparisons, comparing the various estimates demonstrate that narrow definitions of the nuclear enterprise and even strategic nuclear offensive forces understate how much funding goes to the nuclear enterprise. This study—by taking a different approach—has validated that there are greater costs supporting strategic nuclear offensive forces within DoD. Although this study cannot be any more definitive than the previous independent estimates, it does corroborate the more general conclusion about the scale and scope of costs within DoD that support strategic nuclear offensive forces.

IV. Modernization and 10-Year Extrapolations

So far, this study has considered only single-year costs. But strategic nuclear offensive forces have more than just single year costs. They have costs for each year they exist. However, projecting future costs carries inherent difficulties as it requires costing circumstances that have not yet occurred and decisions that have not yet been made. Nevertheless, to provide some scale, this study will offer not just single year costs but a 10-year cost, although each successive year loses fidelity. This 10-year estimate comprises two parts: an extrapolation of single year costs and an estimate of possible modernization costs.

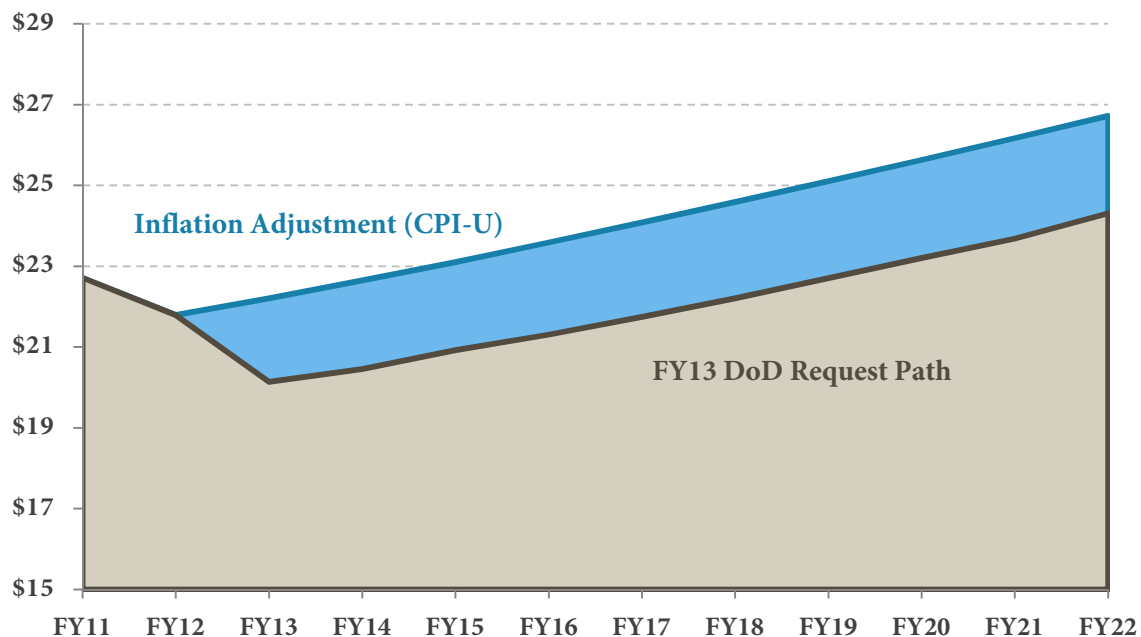
Extrapolation

To extrapolate the base costs out 10 years, this study applies two different rates of growth over the next 10 years. First, it applies the traditional extrapolation of costs: an inflation adjustment from the last budgeted year (FY12).¹⁰⁵ Doing so keeps the real level of funding steady by providing nominal increases that compensate for the weakening buying power caused by inflation. While this method is the traditional way to extrapolate outyear costs, it assumes no change in policy. Such an assumption seems reasonable, given the stability in MFP-1 over the previous 10 years (See Figure 7 on page 54). But such an assumption also clearly can be faulty—especially in times like today, where fiscal pressures are all too real.

Therefore, the study estimates a lower path by extrapolating out the single-year estimate not by an inflation adjustment, but by applying the spending path the President has proposed for the entire defense budget over the next 10 years. Most significantly, this path accepts the funding level requested for FY13, which is \$2.6 billion lower than our FY11 estimate, in contrast to the inflation assumption, which assumes FY13 will be inflated from the FY12 enacted levels. In line with the Budget Control Act of 2011, the defense spending path does not keep pace with inflation—slightly eroding the spending on the defense budget over 10 years under OMB’s inflation assumptions. Figure 6 displays the 10-year path under each of these approaches. Over 10 years, this study’s single-year estimate for costs within DOD would translate into \$221 billion under the lower approach and \$244 billion under the higher approach for the budget window FY13-22.

Defense budgets have historically both risen and fallen faster than inflation in a somewhat regular cycle. In the last 10 years, defense budgets have cycled up faster than inflation, but seem to have peaked out in FY10, with FY11 and FY12 being lower in real terms. If the historical cycle were to hold, defense budgets would fall greater than even the President’s proposed path. Such a scenario means even the lower estimate provided above could very well be higher than actual spending in the coming decade.

¹⁰⁵ For a discussion of inflation adjustments, see Jerry McCaffery and LR Jones, *Budgeting and Financial Management in the Federal Government*, (Information Age Publishing: 2001), p. 105.

Figure 7: 10-Year Extrapolation of Costs of Strategic Nuclear Offensive Forces

Despite the broader context of the overall defense budget, nuclear spending may very well be disconnected from those trends. Nuclear spending particularly fell faster in the 1990s during the last build-down, but did not rise when the defense budget overall increased in the 2000s. The past two decades and even the years since World War II then may not be indicative of nuclear spending in the future.

Nevertheless, the two paths extrapolated here provide a reasonable range of possible futures.

Modernization

The second part of the 10-year estimate is to capture the increased costs the modernization programs, especially the two large programs, the new bomber and new sub, could mean for nuclear spending.

The section above reviewed why costs could be lower than simple extrapolations suggest. But the costs could also be higher. Even before considering the modernization programs, other forces could drive costs up. As CBO has covered annually, each proposed defense budget would require more funds than planned to actually execute in later years.¹⁰⁶ Health care costs and personnel compensation being one of the largest drivers of growing costs, costs which would certainly affect the cost of our strategic nuclear offensive forces. These potential costs rarely become actual costs as the next year's budget changes the plan enough to meet that year's fiscal constraints. Still if the force structure was held steady, strategic nuclear offensive forces could cost more than the extrapolations above.

¹⁰⁶ For FY12, CBO projected DoD would need \$208 billion more, or 8 percent more, over the next five years just to execute its plans. Long-Term Implications of the 2012 Future Years Defense Program, Congressional Budget Office, June 2011.

More dramatically, the US military is set to embark on an ambitious modernization scheme of two legs of the Triad simultaneously.¹⁰⁷ The Navy is well along on replacing the current Ohio-class ballistic missile submarines with what is referred to as SSBN(X). The Navy estimates that the SSBN(X) program will cost a total of \$75 billion, including almost \$12 billion for the first boat and almost \$6 billion for the remaining 11 to be purchased.¹⁰⁸ In the FY13 budget request, DoD delayed the purchase of the first SSBN(X) by two years, saving \$500 million in FY13 and \$4 billion over five years.¹⁰⁹ These savings only come in that time window, and the costs likely would still be incurred if the program remains the same, although some observers do not expect the program to remain as it is currently planned.¹¹⁰ The first is currently planned to be procured in 2021 and enter service now in the early 2030s.

The Air Force is less far along in developing a next-generation bomber to replace the B-52s currently in the fleet. The program was restarted in the FY12 budget and prioritized in the FY13 budget. The Air Force currently expects to buy 80-100 bombers at \$550 million each for a program in the range of \$44 to \$55 billion.¹¹¹ The aircraft is expected to enter service in the mid-2020s, making it concurrent with the development and fielding of the SSBN(X).

The third leg of the Triad—land-based ICBMs—is also supposed to get a replacement program. The FY13 budget request includes \$11.7 million for an analysis of what that program should be.¹¹² The program could create significant costs, although it is at such an early stage, this study does not include specific ICBM modernization costs beyond the extrapolations of existing ICBM costs.

As noted in the section on other operational costs, aerial refueling is also set to embark on a significant modernization program. The Air Force let a contract for the KC-46A next-generation tanker in February 2011 as the first step in this modernization.¹¹³ As currently planned, this program will replace two-fifths of the existing KC-135 fleet. The modernization program is also very large, with a projected cost of nearly \$52 billion. In FY11, the Air Force received \$540 million for development of the KC-46A, which is included in this study's single-year estimate of other operational costs. From FY12 to FY17, the Air Force projects to spend an additional \$6.3 billion on development costs, including an average of \$1.5 billion a year from FY13 to FY16. Within the FYDP, the Air Force also projects to spend an additional \$8.7 billion on procurement and military construction costs, with annual costs just ramping up in FY17 suggesting significantly greater sums over the remaining years of the 10-year modernization window included here. However, the uncertainty over what part of the tanker fleet directly makes assigning these costs to strategic nuclear offensive forces difficult. Even after the KC-46A is fielded, the Air Force intends to maintain over 300 KC-135s in its inventory. If the nuclear mission is primarily supported by the remaining KC-135s, most of the

107 The FY13 budget includes study funds to explore potential modernization of the third leg of the Triad, land-based ICBMs, but no specific program has been initiated yet.

108 "An Analysis of the Navy's Fiscal Year 2012 Shipbuilding Plan," Congressional Budget Office, p. 16.

109 Kingston Reif, "Some Thoughts on the SSBN(X) Delay: Could 12 be the new 10? Or 8?," Nukes of Hazard Blog: A Project of the Center for Arms Control and Non-Proliferation, March 26, 2012.

110 Ibid.

111 Jeff Schogol, "Schwartz Defends Cost of Next-Gen Bomber," *Air Force Times*, February 29, 2012.

112 DOD News Briefing by Maj. Gen. Bolton and Marilyn Thomas from the Pentagon on the Fiscal 2013 Budget Proposal, February 13, 2012.

113 This section draws heavily from Government Accountability Office, "KC-46 Tanker Aircraft: Acquisition Plans Have Good Features but Contain Schedule Risk," GAO-12-366, March 2012. FYDP costs are taken from the US Air Force R-2 display for PE 0605221F: KC-46, Next Generation Aerial Refueling Aircraft, February 2012.

modernization costs of the KC-46A would not directly apply to strategic nuclear offensive forces. However, it is simplistic to assume that tanker modernization will have no impact on the costs of strategic nuclear offensive forces, especially as tankers are essentially a fungible resource that can be redirected to different missions very rapidly; the KC-46A will be able to and is very likely to refuel strategic bombers. Nevertheless, because of this uncertainty, this study has not explicitly assigned in total or proportionately the costs of tanker modernization. However, it has included the \$540 million provided in FY11 in other operational costs, and that sum is extrapolated out in both the high and low range providing some placeholder for tanker costs attributable to strategic nuclear offensive forces. As with the single-year estimate, though for different reasons, tanker modernization remains the most uncertain aspect of the costs of strategic nuclear offensive forces.

Modernization poses a particular interest for non-strategic nuclear weapons. The F-35 fighter currently being developed is intended to replace the F-16 and F-15 fighters that currently would carry non-strategic nuclear weapons. One estimate of the marginal cost to make the F-35 nuclear-capable is \$339 million, although it is not clear whether those costs would fall in the time window of this study.¹¹⁴ The F-35 is the largest procurement program in DoD and a certain logic could be used to include some of its costs in the modernization costs of the nuclear forces. But in keeping with the treatment of non-strategic nuclear costs within DoD elsewhere in this paper, these numbers are not included here either.

Almost all of these costs are on top of the costs this study identified for the strategic nuclear offensive forces. The Navy always planned to retire some Ohio-class submarines before the SSBN(X)s enter service because patrol schedules mean though there are less submarines in the fleet, there would still be the same number of submarines at sea. In contrast, the Air Force has not announced plans to retire any bombers prior to fielding of the next-generation bomber.¹¹⁵ Nevertheless, both services today plan to maintain the bulk of their current inventory—meaning the costs of those systems would continue as well—while it develops the next-generation systems.¹¹⁶ The costs of those existing systems may not be linear as they are all aging, which may create greater costs even just to maintain existing levels and capability.

Most of the costs discussed here fall outside of the 10-year window extrapolated above. But even within the 10-year window, these costs are significantly greater than shown in just an extrapolation of FY11's funding for these programs. This study attempted to capture these costs by, first, accepting the figures presented in the FY13 DoD budget request, which provides development and procurement costs out to FY17. And by, second, extending those costs to meet total program costs over the 10-year window.¹¹⁷

114 Rebecca Grant, "Nukes for NATO," *Air Force Magazine*, July 2010.

115 The Air Force has announced plans to retire B-1 bombers, but these no longer perform a nuclear mission.

116 For a discussion of the alternative approaches to generational procurement, see Russell Rumbaugh, "*What We Bought: Defense Procurement FY01-FY11*," Stimson Center, October 28, 2011.

117 For the bomber, these total programs costs in the 10-year window were \$18 billion taken from Secretary of Defense Leon Panetta, Letter to Senators John McCain and Lindsey Graham and fact sheet "Effects of Sequestration on the Department of Defense," November 14, 2011. For the submarine, these costs in the window were \$29.4 billion taken from the 1251 report; the 1251 report provides the total for the window FY11-20. Given the delay of two years in the FY13 request, this study simply moves those costs forward to the FY13-22 window.

The costs of these planned paths can be laid on top of the 10-year extrapolations to provide a 10-year estimate that accounts for the modernization plans already announced.¹¹⁸ Over 10-years, the planned paths would create modernization costs of \$48 billion.¹¹⁹

Yet these costs likely are underestimated because DoD notoriously suffers from cost-growth in its major weapons programs.¹²⁰ In 1962, two Harvard professors examined 12 weapons programs and found an average cost growth of 3.2 times the original cost estimates.¹²¹ Fifty years later, cost-growth remains endemic in weapons development and procurement. The Government Accountability Office (GAO) conducts an annual assessment of DoD weapons systems acquisitions because GAO identifies it as a high-risk area. The FY11 study found an average of 9 percent cost growth since 2008 in DoD's portfolio of major defense acquisition programs.¹²²

Research by RAND also identifies systemic cost-growth for weapons programs. A 2006 RAND study, which examined 46 major defense acquisition programs, found that estimates of development costs were consistently under estimated and, in particular, aircraft development costs were too low by 35 percent.¹²³ To provide a simplistic accounting for cost growth, increasing the DoD-based cost projection of the bomber over this time period by 35 percent yields a 10-year estimate of \$26.8 billion. This conclusion is consistent with the Congressional Budget Office's findings. A 2006 CBO report on the cost of potential Long-Range Ground-Attack Systems, including a new long-range, subsonic bomber, also adjusted for cost-growth based on, among others, the RAND and GAO studies.¹²⁴ The CBO report estimated total RDT&E costs for a long-range subsonic bomber at \$31 billion.

A proxy for SSBN(X) cost growth can be calculated in a similar manner. Historically, there is less cost-growth in Navy programs than Air Force programs. A 1993 RAND study considered 14 ship projects, and only found 10 percent cost growth.¹²⁵ Applying a cost-growth adjustment thus only increases expected 10-year SSBN(X) spending to \$31 billion.

These figures could be conservative. According to the RAND study, cost-growth is typically highest early in a program and the 35 percent and 10 percent adjustments represents the historic mean for aircraft and ship cost-growth, suggesting a significant chance that cost-growth at these early stages exceeds these means. Beyond systemic underestimation, changes in technical requirements could considerably increase costs. Some argue for a supersonic bomber and, if DoD eventually reaches the same conclusion, the CBO estimates this would increase RDT&E costs by 122 percent. On

118 To lay them on top, the initial program costs and their extrapolations must be backed out of either the base costs or the modernization costs. Otherwise the sums will double-count certain costs.

119 \$48 billion is not additive to the 10-year extrapolations of the base estimate because the base estimate already includes modernization costs extrapolated from the FY11 funding.

120 For a persuasive explanation of why cost-growth is endemic in DoD weapons programs, see Thomas J. McNaugher, "New Weapons, Old Politics:" (Brookings: 1989).

121 Merton J. Peck and Frederic M. Scherer, "The Weapons Acquisition Process: An Economic Analysis," (Harvard Graduate School of Business Administration: 1962), Table 16.1, p. 429.

122 "Assessments of Selected Weapon Programs,:" Government Accountability Office, March 2011, GAO-11-233SP

123 Mark V. Arena, Robert S. Leonard, Sheila E. Murray, Obaid Younossi, "Historical Cost Growth of Completed Weapon System Programs."

124 "Alternatives for Long-Range Ground-Attack Systems," Congressional Budget Office, March 2006.

125 Jeffrey A. Drezner, Jeanne M. Jarvaise, Ron Hess, Daniel M. Norton, and Paul G. Hough, "An Analysis of Weapon System Cost Growth," (RAND: 1993).

the other hand, there is a possibility that excessive cost-growth forces DoD to cancel the program creating much less costs.

This study does not include a specific projection of C2 modernization spending as it does for the bomber and SSBN(X). There is no official estimate of total costs for C2 programs over the next 10 years that would allow an extrapolation of projected costs beyond the FYDP. Additionally, FYDP projections indicate considerable uncertainty about future C2 modernization costs. In FY11, DoD spent nearly \$3.4 billion on C2 RDT&E and procurement projects. By FY13, funding for these programs falls to just over \$2 billion, and just \$1.5 billion by FY17. Some of these changes could be the result of the development cycle, as funding for certain programs, like MILSATCOM terminals, inevitably fades as the project reaches completion. Similarly, out years may not include future programs, since DoD could initiate new development programs not assumed by the FY13 FYDP. Indeed, the two additional AEHF satellites fielded to compensate for the cancellation of the Transformational Satellite Communication System (TSAT) program were only intended as an interim replacement, and DoD may well try and develop a communication satellite to fulfill the requirements which prompted the initial development of TSAT. However, reduced C2 RDT&E and procurement spending might instead reflect a long term policy decision. Further complicating modernization projections is cost-growth, which represents a powerful countervailing factor against the projected FYDP declines, since few weapons systems are more affected by rampant development cost growth than communications satellites. A 2007 RAND study estimated 46 percent cost growth for completed satellite major defense acquisition programs.¹²⁶ The RAND study excluded on-going satellite programs, such as the AEHF satellite, which has experienced 77 percent programmatic cost-growth, including 51.7 percent in RDT&E and 289 percent in procurement costs, according to a 2011 GAO study.¹²⁷ Indeed, the TSAT program was canceled due to excessive cost growth, a demonstration of how exceptional cost-growth can ultimately lower eventual costs. Due to the absence of an authoritative 10-year estimate on expected C2 modernization costs, and the wide range of possible spending on C2 development supported by available data, this study assumes that FY11 C2 modernization costs represent typical, base spending on C2 modernization, much as is assumed for most other programs included in this study.

Totaled together the estimates of bomber and submarine cost growth supply a 10-year figure of \$58 billion. These two estimates provide a plausible range of modernization costs over the next 10 years.

The President's budget provided a 10-year path for NNSA. Under that path, the strategic nuclear offensive forces costs within NNSA would total \$92 billion from FY13-22. Pointedly, these costs also include the projected cost to extend the life of B-61 gravity bombs, including the non-strategic variants of the bomb. To provide an alternative range, this study applied the inflation extrapolation it used for DoD's costs, which increases the estimate to \$99 billion over ten-years.

Each of these components follows different budgeting dynamics and will respond to the coming pressures differently. But for illustrative purposes, the paths—with an allowance for modernization

126 RAND Corporation, "Improving the Cost Estimation of Space Systems," 2008, http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG690.pdf.

127 United States Government Accountability Office, "Defense Acquisitions: Assessments of Selected Weapons Programs," GAO-11-233SP, March 2011, <http://www.gao.gov/assets/320/317081.pdf>.

costs already captured by the base extrapolation—can be summed together to provide a total 10-year cost for strategic nuclear offensive forces. Assuming each component follows the low estimate, the total would be \$352 billion. If each component instead followed its respective high path, the total would be \$392 billion, a swing of almost 20 percent from the low estimate. Table 4 displays these possible paths.

Table 4: 10-Year Estimates and Modernization Costs for Strategic Nuclear Offensive Forces

<i>in billions of dollars</i>	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY13-22
DoD Extrap. (Low)¹	\$22.71	\$21.79	\$20.14	\$20.45	\$20.92	\$21.31	\$21.75	\$22.21	\$22.71	\$23.21	\$23.68	\$24.31	\$220.68
DoD Extrap. (High)²	\$22.71	\$21.79	\$22.21	\$22.65	\$23.10	\$23.59	\$24.08	\$24.59	\$25.11	\$25.63	\$26.17	\$26.72	\$243.86
Mod. Costs (Low)³	\$0.80	\$1.40	\$0.90	\$1.60	\$2.30	\$3.20	\$4.40	\$4.80	\$5.20	\$5.70	\$14.40	\$5.70	\$48.10
Mod. Costs (High)⁴	\$0.80	\$1.60	\$1.00	\$1.90	\$2.80	\$3.90	\$5.60	\$5.90	\$6.40	\$6.90	\$16.50	\$6.90	\$57.90
NNSA 10-Yr (Low)⁵	\$8.20	\$8.60	\$9.00	\$8.50	\$8.60	\$8.80	\$9.00	\$9.20	\$9.30	\$9.60	\$9.70	\$10.10	\$91.80
NNSA Extrap. (High)⁶	\$8.20	\$8.60	\$9.00	\$9.20	\$9.40	\$9.60	\$9.80	\$10.00	\$10.20	\$10.40	\$10.60	\$10.90	\$99.20
Low Estimate	\$30.96	\$30.99	\$29.23	\$29.76	\$31.00	\$32.44	\$34.28	\$35.30	\$36.34	\$37.53	\$46.89	\$39.07	\$351.85
High Estimate	\$30.96	\$31.18	\$31.42	\$32.95	\$34.39	\$36.23	\$38.54	\$39.61	\$40.76	\$42.01	\$52.36	\$43.50	\$391.77

Notes:

¹ DoD Extrapolation (Low) is our methodology for FY11, FY12 enacted, and FY13 request. FY14-21 extrapolated using PB13 DoD path.

² DoD Extrapolation (High) is our methodology for FY11 and FY12 enacted. FY13-22 is assumed to grow at inflation.

³ Modernization Costs (Low) is DoD's FYDP data for sub and bomber through FY17, and projections from FY18-FY22 to match state 10 year modernization costs for each system. Note these costs are not additive to the DoD extrapolations because the DoD extrapolations already include modernization costs extrapolated as figured above.

⁴ Modernization Costs (High) is DoD's FYDP data and projections, increased by cost growth estimates for each type of system. Note these costs are not additive to the DoD extrapolations because the DoD extrapolations already include modernization costs extrapolated as figured above.

⁵ NNSA 10-Year figure (Low) is taken from PB13 S-12.

⁶ NNSA Extrapolation (High) is PB12 for FY11-13, then increased by inflation through FY22.

V. Implications and Conclusion

This report serves two key purposes. First, by arraying official and unofficial estimates against each other, it has demonstrated there is less disagreement about what the United States spends on its nuclear enterprise than suggested by the continuing controversy around these estimates. Second, it helps to reduce the ambiguity in the estimates even further by providing an inductive, bottom-up approach to the most uncertain part of strategic nuclear offensive forces—the other costs within DoD that support strategic nuclear offensive forces, but outside MFP-1—and transparently displaying the methodology for figuring these costs to encourage debate. Since this study’s estimate corresponds with previous estimates, it is reasonable to presume the actual costs lay somewhere around these figures.

At the very least, this study should clarify that official estimates relying on a narrow definition of the nuclear enterprise, or even of strategic nuclear offensive forces, understate the actual costs the United States spends on nuclear weapons without settling once and for all what is the single right cost of the nuclear enterprise.

Even with a more accurate tally of how much strategic nuclear offensive forces cost, this study does not lay out specific savings to be achieved. Beyond the question of specific options to be considered, this study has clarified the costs supporting the broader nuclear enterprise, but it cannot assign specific savings because many of the costs support not only the nuclear mission but other missions. These overlapping capabilities create significant complexity in assigning costs, and even greater complexity in calculating savings.¹²⁸ The C2 overhead necessary to support a single nuclear delivery system is likely the same as the overhead necessary to support 700 nuclear delivery systems. Moreover, the C2 overhead supporting those nuclear delivery systems also supports most conventional missions. C2 is an extreme example, although not the only capability considered here where savings would not proceed in a direct relationship to weapons reductions. Many other capabilities included in this study scale with the number of nuclear weapons maintained, even if not on a one-to-one basis. Additionally, this study has not considered costs that would be incurred by reducing weapons and force structure: demilitarization, base closings, environmental restoration, and many others would create costs before savings would be achieved. Still, not being able to estimate savings beforehand is not the same as realizing savings after the process has been run.

This study has focused on the aspect of greatest ambiguity concerning the costs of the nuclear enterprise. By using an inductive methodology, this study has provided a new, repeatable, and defensible estimate of the costs of strategic nuclear offensive forces. In doing so, it has mitigated the shortcomings of previous independent estimates and official estimates, even as it still falls short of a definitive estimate of the nuclear enterprise or even strategic nuclear offensive forces.

¹²⁸ For a cogent description of the difficulty in assessing savings, see David Mosher, “The Hunt for Small Potatoes: Savings in Nuclear Deterrence Forces,” in Cindy Williams, ed. *Holding the Line: US Defense Alternatives for the Early 21st Century*, (MIT Press: 2001).

This study has demonstrated there are significant costs for strategic nuclear offensive forces outside of the formally designated costs of those forces. Those costs almost equal the formally designated costs. By arriving at this estimate through a distinct methodology, it has in turn validated the claims of previous independent estimates, which have argued there are greater costs than MFP-1.

However, the study has hopefully also demonstrated that a definitive cost will always be elusive because of the definitional and methodological problems. Official estimates are understated not because the government agencies do not track the costs associated with their program. They are understated because they are more bound by the methodological difficulty of assigning costs that support multiple missions to a single mission. The vast bulk of the costs this study noted are not exclusively dedicated to strategic nuclear offensive forces. Certainly strategic nuclear offensive forces could not be operated without these costs, but these costs would not disappear totally if all strategic nuclear offensive forces disappeared.

By clarifying the ambiguity found in previous cost estimates while demonstrating that some ambiguity will always remain, this study places the debate about nuclear weapons back in the policy realm it belongs. The question the country truly faces is determining the right offensive strategic nuclear forces that the United States should maintain and operate.

Appendix A: Command and Control Systems

<i>FY11 Dollars in thousands</i>	Program Element	Total Spending	Nuclear Spending
Air Force Operations and Maintenance		\$2,178,536	\$1,501,273
Subactivity Group: Global C3I & Early Warning		\$1,442,016	\$1,133,013
	Joint Surveillance System long-range radar sites		
	North Warning System*		
	North Atlantic Defense System*		
	Integrated Tactical Warning and Attack Assessment		
	Ballistic Missile Early Warning System		
	SLBM Radar Warning System		
	Space-Based Infrared System		
	Nuclear Detonation Detection System		
	MILSTAR		
	MILSATCOM		
	Shared Early Warning System		
	Space Professional Development Program*		
	Air Force Air Traffic Control and Landing System		
	Air Force Weather Program		
Subactivity Group: Space Control Systems		\$736,520	\$368,260
	Air Force Satellite Control Network		
	Missile Test Evaluation Center		
	Defense Meteorological Satellite Program*		
	NAVSTAR GPS*		
Navy Operations and Maintenance		\$946,968	\$420,428
Subactivity Group: Combat Communications		\$722,457	\$240,819
	Naval Network and Space Operations Command		
	Satellite Monitoring		
	Anti-Submarine Warfare Operation Centers*		

<i>FY11 Dollars in thousands</i>	Program Element	Total Spending	Nuclear Spending	
	Operation Support System*			
	Navy Tactical Command Systems Afloat			
	Global Command and Control System*			
	Cooperative Engagement Capability			
	Navigation System Management*			
	Ring Laser Gyro Navigator*			
	Joint Maritime Command Information Systems*			
	Fleet Satellite Constellation			
	START			
	CWC*			
	Open Sky*			
	BWCA*			
	Mobile Ashore Support Terminal*			
	Mobile Integrated Command Facility*			
	AN/MSQ Tactical Command System*			
	Subactivity Group: Space Systems and Surveillance	\$224,511	\$179,609	
	Naval Network and Space Operations Command			
	Space Systems Management			
	Tracking, Telemetry, and Control			
	Sound Surveillance System			
	Surveillance Towed Arrayed Sensor System*			
	Air Force Other Procurement	\$338,116	\$338,116	
	Nuclear Planning and Execution	PE0303255F	\$2,320	\$2,320
	USSTRATCOM C2 Modernization	PE0303255F	\$10,262	\$10,262
	STARS	PE0303255F	\$1,500	\$1,500
	Distributive C2 Network	PE0303255F	\$2,136	\$2,136
	SBIRS	PE0305915F	\$24,667	\$24,667
	NUDET	PE0305913F	\$5,893	\$5,893
	SLBM detection	PE0305912F	\$8,825	\$8,825
	ICBM detection	PE0305909F	\$18,670	\$18,670
	AFSCN	PE0305110F	\$60,050	\$60,050
	MILSATCOM	PE0303601F	\$188,164	\$188,164
	Cheyenne Mountain Complex	PE0305903F	\$15,629	\$15,629

<i>FY11 Dollars in thousands</i>	Program Element	Total Spending	Nuclear Spending
Air Force Missile Procurement		\$1,012,905	\$1,012,905
	Minuteman MEECN Modification	\$9,746	\$9,746
	Advanced EHF	\$29,691	\$29,691
	SBRIS	\$973,468	\$973,468
Air Force - RDT&E		\$1,617,389	\$1,617,389
	Wideband MILSATCOM	\$74,857	\$74,857
	Advanced MILSATCOM	\$385,033	\$385,033
	Polar Satellite Operations	\$138,051	\$138,051
	Next-Generation MILSATCOM Technology	\$19,898	\$19,898
	Spaced Based Infrared System (SBIRS) High	\$523,788	\$523,788
	Integrated Command and Control Applications	\$10	\$10
	E-4B NAOC	\$12,105	\$12,105
	MEECN	\$67,912	\$67,912
	MILSATCOM Terminals	\$298,736	\$298,736
	Satellite Control Network	\$25,652	\$25,652
	NUDET (Space)	\$71,347	\$71,347
Navy RDT&E		\$410,015	\$410,015
	EHF SATCOM Terminals	\$18,026	\$18,026
	FLTSATCOM	\$607	\$607
	MUOS	\$391,382	\$391,382
Command and Control Systems			
Total		\$6,503,929	\$5,300,126

* indicates system is not included in nuclear total.

Appendix B: Research, Development, Testing and Evaluation

<i>FY11 Dollars in thousands</i>	Program Element	Total Spending	Nuclear Spending
Air Force - RDT&E		\$760,116	\$760,116
	ICBM - DEM/VAL	\$67,242	\$67,242
	Next Generation Bomber	\$192,816	\$192,816
	Rocket Propulsion Technology - Major Thrust 6	\$7,791	\$7,791
	Rocket Propulsion Technology - Major Thrust 7	\$2,029	\$2,029
	Aeros Prop and Power Tech- Major Thrst 3	\$2,409	\$2,409
	Advd Spacecraft Tech - Ballistic Missiles Tech	\$5,053	\$5,053
	Nuclear Weapons Support	\$59,591	\$59,591
	ICBM - EMD	\$66,342	\$66,342
	Physical Security Equipment	\$967	\$967
	CVLSP	\$3,980	\$3,980
	Ballistic Missile T&E	\$332,009	\$332,009
	KC-135s	\$19,887	\$19,887
Navy RDT&E		\$829,564	\$741,043
	Undersea Warfare Applied Research	\$66,505	\$17,092
	Undersea Warfare Advanced Technology	\$51,283	\$13,180
	Radiological Control	\$1,292	\$287
	SBSD Advanced Submarine System Development	\$431,422	\$431,422
	SBSD Nuclear Technology Development	\$178,345	\$178,345
	SSN-668 & Trident Modernization	\$100,717	\$100,717
RDT&E			
Total		\$1,589,680	\$1,501,159

