

The Lifecycle Costs of Nuclear Forces: A Preliminary Assessment

Steven M. Kosiak

DISTRIBUTION STATEMENT A

**Approved for public release;
Distribution Unlimited**

19980309 089

**DEFENSE
BUDGET
PROJECT**

777 North Capitol St., NE
Suite 710
Washington, DC 20002

PLEASE RETURN TO:

**BMD TECHNICAL INFORMATION CENTER
BALLISTIC MISSILE DEFENSE ORGANIZATION
7100 DEFENSE PENTAGON
WASHINGTON D.C. 20301-7100**

U5343

Accession Number: 5343

Publication Date: Oct 01, 1994

Title: The Lifecycle Costs Of Nuclear Forces: A Preliminary Assessment

Personal Author: Kosiak, S.

Corporate Author Or Publisher: Defense Budget Project, 777 Nth. Capitol St., NE Washington, DC

Descriptors, Keywords: U.S. Nuclear Forces Cost Nuclear Posture Review NPR Clinton Administration
Lifecycle Assessment START ICBM Warhead Projected Future Table Chart

Pages: 46

Cataloged Date: May 25, 1995

Document Type: HC

Number of Copies In Library: 000001

Record ID: 30035

Source of Document: DBP

**DEFENSE
BUDGET
PROJECT**

777 North Capitol Street, NE ■ Suite 710 ■ Washington, DC 20002 ■ 202/408-1517 ■ Fax: 202/408-1526

**THE LIFECYCLE COSTS OF NUCLEAR FORCES:
A PRELIMINARY ASSESSMENT**

by

Steven Kosiak

**Defense Budget Project
October 1994**

ABOUT THE DEFENSE BUDGET PROJECT

The Defense Budget Project is an independent research organization committed to fostering a coherent U.S. national security policy, which reflects a realistic assessment of available fiscal resources and national security needs over the long term.

DBP works to achieve this goal by using its expertise to analyze national security policies and defense budgets and by communicating its findings to policymakers, opinion leaders, expert analysts, national organizations, and the media so that they can become more informed about defense budget and national security programs and options. DBP's work translates complex data into factual, credible, and timely analyses presented in clear language and useful formats to facilitate discussion and decisionmaking.

777 North Capitol Street, N.E.
Suite 710
Washington, DC 20002
(202) 408-1517

ACKNOWLEDGEMENTS

The author would like to thank the staff of the Defense Budget Project for their comments and assistance on this paper: Laureen Andrews, Richard Bitzinger, Elizabeth Heeter, Andrew Krepinevich, Carol Lessure, and Alan Adcock. This report is intended to contribute in part to a larger study by the working group on *Modeling the Full Economic, Social, Political and Military Consequences of the U.S. Nuclear Weapons Program: 1940-1995 and Beyond*. Members of this working group include, in addition to the author, David Albright, Bruce G. Blair, Tom Blanton, Tom Zamora Collina, Steven Kosiak, Arjun Makhijani, Robert S. Norris, Cristopher Paine, George Perkovich, Stephen I. Schwartz, and William J. Weida.

The analysis and findings presented here are solely the responsibility of the Defense Budget Project and the author.

The report was funded by a grant from the Rockefeller Foundation.

Contents

Executive Summary	i
I. Introduction	1
II. Past Costs of U.S. Nuclear Forces	2
III. Future Costs of U.S. Nuclear Forces	11
IV. Appendix	18

Executive Summary

In September 1994, the Clinton Administration released the long-awaited results of its Nuclear Posture Review (NPR). The NPR sets forth the administration's view of the size and type of nuclear forces the United States should maintain in the post-Cold War world. Less than a year later, the world will mark the fiftieth anniversary of the first and only wartime uses of the atomic bomb — the explosions that destroyed Hiroshima and Nagasaki in August 1945. Given the convergence of these two events, now is an especially appropriate time both to take stock of how much the United States spent on its nuclear arsenal in the past and consider how much it is likely to continue to spend in the future.

The Lifecycle Costs of Nuclear Forces: A Preliminary Assessment attempts to answer two questions. First, how much did it cost the United States over the past 50 years to create and sustain its Cold War nuclear force structure — including not simply the costs of developing, testing, producing and maintaining the nuclear warheads themselves, but also the costs of developing, procuring, operating and supporting the weapon systems designed to deliver or support the delivery and targeting of those warheads, as well as cleaning up past and ongoing nuclear weapons-related environmental contamination? Second, how much more will the United States have to spend over the coming decades to sustain the nuclear forces recommended in the NPR?

Among other findings, the results of this analysis suggest that:

- Over the past 50 years the United States has spent a total of nearly \$4 trillion on nuclear forces, an average of some \$75 billion a year. (All figures are in FY 1995 dollars unless otherwise stated.)
- Even if the United States adopts the smaller force structure recommended in the NPR, it might continue to spend as much as \$40 billion per year on nuclear forces over the long run.
- For every dollar spent on developing and producing nuclear warheads during the Cold War, the United States spent some \$10 more on equipping, operating, and otherwise supporting the weapon systems and personnel used to deliver and target those nuclear weapons.
- The United States has only begun to clean up the environmental contamination caused by its nuclear weapons activities during the Cold War. The total cost of those cleanup activities could ultimately exceed \$400 billion.

In addition to marking the anniversaries of the atomic explosions over Hiroshima and Nagasaki, 1995 will also include an international conference to consider the future of the

nuclear Nonproliferation Treaty (NPT). This review conference is likely to focus world attention on the ongoing debate over the cost-effectiveness of nuclear weapons and the potential dangers posed by nuclear proliferation.

Countries pondering the wisdom of pursuing or strengthening their own nuclear weapons programs would do well to consider the experience of the United States. Although there are limits to the relevance of the U.S. experience of the past 50 years for countries now considering the acquisition of nuclear weapons, it may, nevertheless, be possible to learn some important lessons.

Perhaps the most important lesson is that the true costs of being a nuclear power are likely to be far higher than the costs of simply acquiring the nuclear weapons themselves. While the development and production of *nuclear warheads* accounted for less than three percent of U.S. defense spending during the Cold War, the cost of fully operating, supporting, equipping and manning the *nuclear forces* armed with those warheads accounted for some 25 percent of U.S. defense spending over this period.

I. Introduction

This analysis provides an estimate of the total "lifecycle" costs of U.S. nuclear forces. The lifecycle costs of nuclear forces can be defined in a number of different ways. This analysis considers two approaches. The first is to include the total amount of money that the United States has spent on its nuclear forces to date, plus the amount of money that it must yet spend to clean up the environmental contamination caused by past nuclear weapons programs. The second approach is to include the costs of sustaining nuclear forces of a given size over the long run, expressed in terms of average annual costs. The first approach is useful because it provides an inclusive accounting of the nuclear weapons-related costs already incurred by the United States (if not yet necessarily paid, as in the case of environmental cleanup activities), while the usefulness of the second approach is that it creates a baseline from which the costs of future U.S. nuclear forces can be estimated.

The results of this analysis show that over the past 50 years the United States has spent a total of nearly \$4 trillion on nuclear forces.¹ The results also suggest that even if the United States adopts smaller forces consistent with the START I and START II Treaties, it might continue to spend over \$40 billion per year on nuclear forces over the long run. Finally, this analysis illustrates the breadth of different functions and programs required to support U.S. nuclear forces. Indeed, it suggests that for every dollar the United States spends on developing, testing and manufacturing nuclear warheads, it spends some \$10 more on developing, procuring, operating and supporting the weapon systems designed to deliver or support the delivery and targeting of those warheads, as well as cleaning up past and ongoing nuclear weapons-related environmental contamination.

This analysis comprises three main sections. The first section provides a brief, preliminary estimate of past spending on U.S. nuclear forces, including programs of the Department of Defense (DoD), Department of Energy (DoE), and other departments and agencies.² The second section provides a more detailed estimate of the costs of sustaining U.S. nuclear forces in the future — specifically, the costs of sustaining the administration's planned post-START nuclear force structure. The last section consists of a detailed appendix which describes the methodology used to estimate the average annual "steady-state" costs of one portion of that force structure: U.S. post-START *strategic* nuclear forces. In the future, as in the past, strategic programs will continue to absorb the lion's share of U.S. funding for nuclear forces.

¹ Unless otherwise noted, all cost figures in this analysis are expressed in (inflation-adjusted) FY 1995 dollars. Where cited figures were not expressed in FY 1995 dollars originally, they were converted to FY 1995 dollars using Department of Defense (DoD) deflator tables. See Department of Defense, *National Defense Budget Estimates for FY 1995*, March 1994, pp. 40-41.

² The Defense Budget Project is currently collaborating with a number of other research organizations, as part of a working group on the costs of nuclear forces, to develop a more comprehensive accounting of historical costs.

II. Past Costs Of U.S. Nuclear Forces³

The Department of Defense does not currently provide (at least in unclassified form) a comprehensive estimate of funding for U.S. nuclear weapons programs. The DoD budget breakdown that comes closest to providing such an estimate is its division of funding into *Major Force Programs*. This breakdown divides the defense budget into 11 different categories. Five of these categories correspond to what might be thought of as the five core "mission" capabilities of the U.S. military: strategic forces (program one), general purpose forces (program two), intelligence and communications (program three), airlift and sealift forces (program four), and special operations forces (program eleven). The remaining six categories constitute what are essentially various support functions.⁴ The strategic forces (program one) category includes those forces most closely identified in most peoples' minds with preparing for and, if necessary, waging nuclear war.

The strategic forces category includes both strategic offensive and strategic defensive forces. Strategic offensive forces include long-range bombers, intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs) and ballistic missile submarines (SSBNs). Strategic defensive forces include interceptor aircraft and surface-to-air missile (SAM) batteries assigned to the strategic air defense mission. Although strategic defensive forces currently account for a relatively small share of the costs of strategic forces, through the 1950s, 1960s and into the 1970s these costs were substantial. While today the United States deploys only about 10 strategic air defense fighter squadrons,⁵ as late as 1964 the United States deployed a total of nearly 70 fighter squadrons in this role.⁶ Likewise, while the United States currently deploys no surface-to-air missile (SAM) batteries in the strategic air defense role, the United States had some 147 SAM batteries deployed in 1964.⁷ Strategic defensive forces also include the costs associated with deployed ballistic missile

³ The period covered under this section is FY 1945 through FY 1994 — except in the case of nuclear weapons development and production, where funding provided from FY 1940 through FY 1994 is included. In addition, although routinely referred to in the text as the Cold War period, obviously a few of these years pre-date, and a few post-date, the Cold War period.

⁴ These categories consist of guard and reserve forces (program five), research and development (program six), central supply and maintenance (program seven), training, medical and other general personnel activities (program eight), administration and associated activities (program nine), and support to other nations (program ten). For a brief description of all eleven program categories, see Keith Berner and Stephen Daggett, *A Defense Budget Primer* (Washington, DC: Congressional Research Service, March 9, 1993), pp. 19–20.

⁵ Department of Defense, *Annual Report to the President and the Congress*, January 1994, p. D1.

⁶ Department of Defense, *Annual Report to Congress, Fiscal Year 1983*, February 8, 1982, p. A3.

⁷ Ibid.

defenses (e.g., the Safeguard system operated briefly at Grand Forks, North Dakota, in 1974). Finally, the strategic forces category includes a portion of the command, control, communications, and intelligence (C3I) assets used to support strategic nuclear forces.

Unfortunately, although the systems included within the strategic forces category are primarily geared toward waging nuclear war, *strategic* forces and *nuclear* forces are not synonymous, and the costs of the latter cannot simply be equated with the costs of the former. The DoD estimate of the costs associated with U.S. strategic forces fails to capture many costs that clearly should be included in any comprehensive accounting of U.S. nuclear weapons programs, while it simultaneously captures some costs that should not be included in such an accounting. By far the larger of these two problems is the failure of the strategic forces category to include the costs of many programs related to performing and supporting nuclear missions.

Those nuclear weapons-related costs not captured in DoD's strategic forces (program one) category include: the costs of developing, testing and producing the nuclear weapons themselves; the costs of theater and tactical nuclear weapons programs; the costs of centralized C3I activities associated with nuclear missions; the costs of airlift and sealift forces used to support strategic, theater and tactical nuclear forces; the costs of National Guard and Reserve forces that are assigned nuclear-related missions; most of the costs associated with the research and development (R&D) of nuclear weapon delivery systems and supporting equipment; the costs of many DoD support and overhead functions; the costs of cleaning up environmental damage caused by nuclear weapons production; the costs of nuclear-related civil defense efforts; and the costs of monitoring, verifying and complying with various nuclear arms control agreements.⁸

Those costs of strategic forces that should not be included in an accounting of the total costs of U.S. nuclear forces consist mainly of some portion of U.S. strategic bomber costs. Treating all strategic bomber costs as nuclear-related ignores the fact that the U.S. has used strategic bombers to perform conventional bombing missions on a significant scale during all three of the major regional conflicts in which U.S. general purpose forces have been involved over the past 50 years — the Korean War, the Vietnam War and Operation Desert Storm.⁹

While it is relatively easy to note the *kinds* of costs that should be added to (and subtracted from) DoD's official estimate of the costs of strategic forces in order to derive an estimate of the total costs of all U.S. nuclear forces, there is no entirely satisfactory way to

⁸ For further discussion of some of the elements included and excluded from DoD's strategic forces category, see Alice C. Maroni, "Estimating Funding for Strategic Forces: A Review of the Problems," (Washington, DC: Congressional Research Service, May 31, 1984).

⁹ Moreover, during the first few years of the Cold War — when the United States was producing nuclear weapons at a relatively slow rate — the vast majority of its strategic bombers were configured to carry conventional munitions.

estimate the *magnitude* of those costs. The greatest difficulties lie in trying to estimate the share of funding for U.S. general purpose forces (program two) that was absorbed by tactical and theater nuclear forces during the Cold War, and, conversely, the share of U.S. funding for strategic forces that was absorbed by preparing for and performing conventional bombing missions.

U.S. general purpose forces (program two) include Army divisions, Navy aircraft carrier battle groups, attack submarines, surface combatants, and amphibious ships, Air Force tactical fighter wings, and Marine Corps air and ground forces: in short, they include the forces comprising the bulk of U.S. combat capabilities in every major and minor military conflict the United States has been involved in over the past 50 years. Today, these forces train and are equipped primarily to fight conventional wars. By one estimate, even in the early 1980s, when the U.S.-Soviet nuclear rivalry was still very much alive, theater and tactical nuclear weapons programs accounted for only some five percent of the costs of U.S. general purpose forces.¹⁰ However, during earlier periods of the Cold War, especially the mid-1950s to early 1960s, U.S. general purpose forces clearly had a far more substantial nuclear role. Unfortunately, just how much more substantial this role was remains unclear. Identifying a method by which to quantify the share of strategic bomber costs associated with conventional missions during different periods of the Cold War has proven to be equally elusive.

Consequently, despite its obvious shortcomings, for purposes of estimating historical costs this analysis adopts the simplifying assumption that strategic forces account for all U.S. nuclear weapons' costs and that all strategic forces' costs are related to performing nuclear missions. Although it clearly provides an imperfect measure, this approach nevertheless seems likely to generate a reasonable estimate of the total costs of U.S. nuclear forces during the Cold War. This is true for at least two reasons. First, although an oversimplification, equating general purpose forces with conventional missions and strategic forces with nuclear missions is hardly farfetched. Certainly, throughout *most* of the Cold War, DoD attempted to justify funding for general purpose forces *primarily* on grounds that they were necessary to perform conventional missions, while, conversely, it attempted to justify funding for strategic forces *primarily* on grounds that they were necessary to perform nuclear missions. Second, to some extent any undercounting of nuclear-related costs caused by ignoring the nuclear missions of U.S. general purpose forces will be offset by the overcounting of such costs caused by ignoring the conventional missions assigned to some strategic forces.

The following analysis examines a broad range of programs and activities that accounted for the bulk of U.S. spending on nuclear forces during the Cold War. While this analysis relies on DoD's estimate of the costs of U.S. strategic forces as a starting point for estimating the total costs of U.S. nuclear forces, it provides a far more inclusive estimate of

¹⁰ This estimated share included the cost of the Pershing II and Ground-Launched Cruise Missile (GLCM) programs, as well as dual-use aircraft, naval air defense and ASW activities. Robert S. Norris, "More Bang, More Bucks: \$450 Billion for Nuclear War," *The Defense Monitor*, Vol. XII, No. 7, 1983, p. 3.

the costs of U.S. nuclear forces than does the official DoD estimate of the costs of strategic forces (program one).

Costs of Nuclear Forces by DoD Major Force Program

"Mission" Categories

Strategic Forces (Program One): Funding for programs included in DoD's official strategic forces mission category totalled nearly \$1.8 trillion over the Fiscal Year (FY) 1945–1994 period. As discussed above, while strategic forces have been used to perform conventional missions, as a simplifying assumption, this analysis treats all strategic forces' costs as nuclear-related.

General Purpose Forces (Program Two): As discussed above, although a portion of U.S. general purpose forces were, and continue to be, involved in preparing for theater and tactical nuclear missions, as a simplifying assumption, this analysis treats all costs associated with general purpose forces as related to conventional missions.

Airlift and Sealift Forces (Program Four): Elements in this category include airlift, sealift and traffic management activities primarily intended to transport forces and supplies to areas of potential conflict. While these forces could have played an important role in transporting nuclear weapons to forward theaters of operation in wartime, it appears reasonable to conclude that the primary mission of these forces during most of the Cold War was to support U.S. general purpose forces. This is the role for which they were used extensively in the Korean, Vietnam and Persian Gulf wars. This analysis makes the conservative — and, as in the case of the general purpose forces category, simplifying — assumption that all activities funded in this category are for conventional missions.

Special Operations Forces (Program Eleven): This category consists of elite land, air and sea forces designed to conduct small raids, rescues and other similar special operations. It is assumed here, as a conservative — and, as in the case of the general purpose forces and airlift/sealift categories, simplifying — assumption that all activities funded in this category are for conventional missions.

Intelligence and Communications (Program Three): This category includes funding for centralized C3I activities. Total funding in this category has amounted to some \$1 trillion over the past 50 years. During the last years of the Cold War the strategic mission area typically accounted for some 25 percent of total funding for centralized command, control and communications (C3) activities, while the theater and tactical mission areas accounted for about 35 percent of that funding, and defense-wide activities the remaining 40 percent.¹¹ The

¹¹ The Defense Department's annual budget presentation to Congress of C3 funding levels does not always include a breakdown by mission area. This estimate was derived by averaging the figures included in DoD's FY 1984, FY 1987 and FY 1988 C3 budget presentations, which did include breakdowns by mission area.

allocation of intelligence funding among these three different mission areas is classified. It seems reasonable, however, to assume that each mission area absorbed a similar share of funding for centralized intelligence activities.¹² This suggests that at the close of the Cold War, centralized strategic C3I accounted for between 25 percent and 40 percent of total C3I spending.¹³ The share of C3I funding absorbed by the strategic mission area was almost certainly much higher during earlier periods of the Cold War, when — by DoD's own accounting — strategic forces comprised a substantially higher percentage of U.S. combat forces than they did at the close of the Cold War. To be conservative, it is nevertheless assumed here that the strategic nuclear mission area accounted for an average of only 25 percent of funding for centralized C3I activities during the Cold War, or a total of \$256 billion.

"Support" Categories

Guard and Reserve Forces (Program Five): This category consists of all National Guard and Reserve forces. These forces are assigned to support the same set of five mission areas as active forces (e.g., the strategic, general purpose, C3I, airlift/sealift, and special operations missions). Reserve forces have long played an important role in performing the strategic nuclear mission. Air Force Air National Guard and Reserve forces have, in particular, traditionally made up a significant part of the tanker fleet used to support U.S. strategic bombers, as well as much of the strategic air defense fighter force. It is assumed here that all reserve forces are used either directly or indirectly to support the U.S. military's five core "mission" areas. Since strategic forces accounted for 20 percent of all DoD funding allocated directly to the five mission categories (described above) during the Cold War, it is assumed that 20 percent of the \$651 billion in funding absorbed by Guard and Reserve Forces (program five) over the past 50 years, or \$130 billion, was related to performing the strategic nuclear mission.

Research and Development (Program Six): This category consists of all R&D programs except those related to the further development of systems that have already been approved by DoD for operational use. DoD figures from the last 20 years (FY 1974 through FY 1993) indicate that strategic programs accounted for an average of about 20 percent of total DoD funding for R&D. By comparison, Pentagon figures show that tactical programs absorbed 34 percent of that funding; C3I programs, 11 percent; technology base and advanced technology development programs, 22 percent; and defense-wide management and support, 12 percent. These figures suggest that during this period, R&D on strategic programs

¹² This same assumption has been made by others attempting to estimate funding for strategic nuclear intelligence activities. See, for example, Congressional Budget Office (CBO), *The START Treaty And Beyond* (Washington, DC: Congressional Budget Office, October 1991), p. 66.

¹³ The higher estimate is derived by adding a proportional share of the defense-wide mission share of C3I to the 25 percent allocated to the strategic mission area, on grounds that all defense-wide activities are, ultimately, used to support either the nuclear or conventional forces of the U.S. military.

accounted for between about 20 and 37 percent of total DoD funding for R&D.¹⁴ Based on this plausible range, it is assumed here that strategic R&D accounted for an average of 30 percent of total DoD R&D funding during the Cold War, or a total of \$292 billion over the FY 1945-94 period.

Support Forces (Programs Seven through Ten): These four categories include central supply and maintenance (program seven), training, medical and other general personnel activities (program eight), administration and associated activities (program nine), and support to other nations (program ten). This analysis assumes that, as in the case of reserve and guard forces (program five), all of the activities funded in these five categories are ultimately used to support one of the five mission categories identified by the Defense Department (strategic forces, general purpose forces, airlift/sealift, SOF, and C3I). Since strategic forces accounted for 20 percent of all DoD funding allocated directly to the five mission categories during the Cold War, this analysis assumes that 20 percent of the \$4.3 trillion in funding absorbed by these support categories over the past 50 years, or \$859 billion, was related to performing the strategic nuclear mission.

Nuclear Warheads

While the Department of Defense funds the development, procurement, and direct and indirect operations and support costs of the weapon systems and other equipment used to transport, deliver and target nuclear warheads, it does not fund the research, development, testing and production of the warheads themselves. Initial efforts to develop the atomic bomb were carried out under the direction of the National Defense Research Committee (NDRC), which was established on June 7, 1940. Altogether, between FY 1940 and FY 1994 the NDRC and its successor organizations, including the Department of Energy — which has controlled nuclear warhead production since 1979 — spent a total of \$387 billion on atomic energy defense activities¹⁵ — including some \$19 billion to develop the first atomic bomb.¹⁶ The vast majority of this funding has been spent on the research, development, testing,

¹⁴ The higher estimate is derived by adding a proportional share of the C3I, defense-wide, technology base, and advanced technology programs to the 20 percent share of R&D funding allocated to strategic programs, on grounds that all of these R&D programs are, ultimately, related to the development of equipment for either strategic or tactical forces.

¹⁵ Funding totals for FY 1940 through FY 1985 are taken Thomas B. Cochran, William Arkin, Robert S. Norris, and Milton M. Hoenig, *Nuclear Weapons Databook, Volume II, U.S. Nuclear Warhead Production* (Cambridge, MA: Ballinger Publishing Company, 1987), p. 4. FY 1986-FY 1994 figures are from the FY 1995 *Budget of the United States Government, Historical Tables*, 1994, p. 46-47.

¹⁶ A total of \$23 billion was spent on the Manhattan Project between August 1942 and December 1946. Of this total, some \$19 billion was spent on the project through July 1945, when the first atomic bomb was tested. (Richard G. Hewlitt and Oscar E. Anderson, *The New World, 1939-1946*, Volume II of the Official History of the U.S. Atomic Energy Commission (University Park, Pennsylvania: Pennsylvania University Press), p. 724.)

production and maintenance of the U.S. stockpile of nuclear warheads, as well as (in recent years) associated environmental cleanup activities (see below). A small part of this funding has, however, been used to finance programs relating to the development of nuclear safeguards, security, arms control verification, and naval nuclear reactor technologies. As such, this figure somewhat overstates the level of funding spent on nuclear warhead development and production activities.

Environmental Cleanup

During the Cold War, the United States successfully produced an enormous stockpile of nuclear warheads. Unfortunately, the funds allocated to that effort (see above) covered only part of the actual costs of creating that stockpile. Acting under the perceived pressures of the U.S.-Soviet nuclear rivalry and protected from public scrutiny by a veil of secrecy, U.S. nuclear weapons production activities were carried out with — by today's standards — relatively little regard for environmental safety and public health. As a result, the United States is now left with an enormous unpaid bill covering the costs of cleaning up the Cold War nuclear weapons complex. Altogether, the Department of Energy is now responsible for environmental compliance and cleanup activities at 15 major facilities, a dozen smaller ones, and thousands of sites formerly used to support warhead programs and uranium processing, as well as the disposition of 100 million gallons of highly radioactive waste, 66 million gallons contaminated with plutonium and larger volumes of low-level radioactive waste.¹⁷

The Energy Department created the Office of Environmental Restoration and Waste Management (EM) in 1989, and over a period of just five years, its budget has grown from about \$1.6 billion to more than \$6 billion (FY 1994). Indeed, EM funding now exceeds funding for nuclear warhead production-related activities. Nevertheless, to date, the Department of Energy has barely scratched the surface in addressing environmental cleanup problems.¹⁸ Until the administration and Congress specify more fully the health and safety standards which cleanup activities must achieve, and the Energy Department better understands how best to carry out these activities, it is impossible to estimate nuclear weapons-related cleanup costs with a high degree of confidence. Current DoE estimates, however, range from about \$400 billion to some \$1 trillion (current dollars).¹⁹ Although these costs will be paid in the future, it should be understood that they were incurred during the Cold War. It is assumed in this analysis that cleaning up the environmental problems it

¹⁷ For an overview and discussion of DoE's environmental clean-up requirements, see CBO, *Cleaning Up the Department of Energy's Nuclear Weapons Complex*, May 1994.

¹⁸ Ibid.

¹⁹ CBO, p. ix. The higher of these estimates is from Thomas Grumbly, Assistant Secretary of Energy for Environment Restoration and Waste Management, as quoted in *Inside Energy/with Federal Lands* (New York: McGraw-Hill Inc., July 19, 1993), p. 10.

created during the Cold War will eventually cost the Department of Energy roughly \$400 billion.²⁰

Civil Defense

The United States spent at least \$15 billion over the past 50 years on civil defense activities.²¹ Although the United States generally spent much less on civil defense efforts than on offensive nuclear forces during the Cold War, at times funding for civil defense became significant. Funding for civil defense peaked at \$1.2 billion in 1962 — the year of the Cuban missile crisis.²² Moreover, in FY 1985 during the Reagan buildup, funding for civil defense rebounded to \$500 million before beginning to decline again.

Other

In addition to those cited above, there are a variety of nuclear-related costs borne by the United States during the Cold War that are more difficult to calculate in monetary terms, but not necessarily any less important. One example of such a cost are the numbers of cancer deaths related to the testing of nuclear weapons in the atmosphere. According to one estimate, past atmospheric testing by the United States and the other nuclear weapons states may be responsible for 320,000 to 650,000 deaths worldwide by end of the next decade.²³ Another example that is difficult to convert into monetary terms is the increased level of secrecy surrounding DoD activities and U.S. national security policy generally during the Cold War due, at least in part, to the existence of nuclear weapons. There is often a tendency to ignore those costs upon which a dollar value cannot easily be placed. But in fact, those

²⁰ This represents only a very rough estimate of possible costs. Both the \$400 billion and \$1 trillion estimates of potential DoE cleanup costs are apparently current dollar estimates. Unfortunately, without knowing over what period of years these cleanup activities are expected to take to take place, it is impossible to convert these figures into FY 1995 dollars with a high degree of confidence.

²¹ Between the early 1950s and the early 1980s, the U.S. spent roughly \$2.6 billion (current dollars) on civil defense activities related to preparing for nuclear war. (Robert S. Norris, "Preparing for Nuclear War: President Reagan's Program," *Defense Monitor*, Vol. X, No. 8, 1982, p. 16.) While, without knowing the annual totals for such spending, it is impossible to convert this estimate precisely into FY 1995 dollars (used throughout this analysis), a reasonable approximation can be derived by using the FY 1967 deflator (FY 1967 being roughly the midpoint of the period included in the \$2.6 billion estimate). Using this deflator implies total expenditures of about \$12.5 billion on civil defense through FY 1982. Between FY 1983 and FY 1994, U.S. funding for civil defense totalled another \$4 billion. Thus \$15 billion would appear to be a reasonable, and probably conservative, estimate of U.S. spending on civil defense during the Cold War.

²² Department of Defense (Office of Civil Defense), *Annual Statistical Report, Fiscal Year 1967*, p. 3.

²³ Arjun Makhijani, *Radioactive Heaven and Earth: The Health and Environmental Effects of Nuclear Weapons Testing In, On, and Above the Earth* (New York: The Apex Press, 1991) pp. 36-37.

costs may be among the greatest the United States incurred during the Cold War.²⁴

Total Cost and Spending on U.S. Nuclear Forces FY 1945–FY 1994
(in billions of FY 1995 dollars)

A:	Strategic Forces	\$1,780
B:	A + Strategic Share of C3I	\$2,036
C:	B + Strategic Share of Guard & Reserves	\$2,166
D:	C + Strategic Share of R&D	\$2,458
E:	D + Strategic Share of Support	\$3,317
F:	E + Atomic Energy Defense Activities	\$3,704
G:	F + Environmental Cleanup	\$4,104
H:	G + Civil Defense	\$4,119
I:	H + Other	?

Total Costs Incurred:	\$4,119
-----------------------	---------

Total Spending*:	\$3,719
------------------	---------

* Excludes environmental cleanup costs, which were incurred during the Cold War, but will be paid off in future years.

²⁴ One final element that should arguably be included in this estimate of the historical costs of nuclear forces are the costs associated with the negotiation, compliance and verification activities of various nuclear arms control treaties. Unfortunately, research for this analysis uncovered no comprehensive historical accounting of such costs. However, data was found for one element of these costs. Through FY 1994 a total of some \$1.2 billion was provided to the U.S. Arms Control and Disarmament Agency (ACDA) — much, though not all, of whose activities are related to nuclear arms control.

III. Future Costs Of U.S. Nuclear Forces

The first part of this analysis provides an estimate of the costs of U.S. nuclear forces over the past 50 years. The second part of this analysis attempts to estimate how much *more* the United States is likely to spend on these forces in the foreseeable future.

The Defense Budget Project (DBP) estimates that, under current plans, the United States will adopt a nuclear force structure with annual steady-state costs of some \$40 billion. This *may* be some \$35 billion a year less than the average amount the United States spent on nuclear forces during the Cold War.²⁵

At the end of September 1994, the Clinton Administration announced the long-awaited results of its Nuclear Posture Review.²⁶ Under this plan the U.S. post-START offensive nuclear force structure would include the following forces:²⁷

- 500 Minuteman III missiles;²⁸
- 14 Trident SSBNs, each carrying 24 Trident II (D-5) SLBMs;²⁹

²⁵ This level of savings assumes that, as derived in the first section of this analysis, the United States spent an average of just under \$75 billion a year on nuclear forces during the Cold War (\$3.719 trillion/50 = \$74.4 billion). Different methodologies were used in this analysis to estimate the past and future costs of U.S. nuclear forces. Among other reasons, this was necessary because the Defense Department does not provide (at least in unclassified form) a projection of funding broken down into Major Force Programs (i.e., Strategic Forces, General Purpose Forces, etc.) for the years beyond FY 1995. Since they were derived using different methodologies, figures for the past and future costs of U.S. nuclear forces are only roughly comparable.

²⁶ This review was conducted as a follow-up to the administration's Bottom-Up Review (BUR) of U.S. defense plans and requirements, which was released in October 1993. The BUR did not address nuclear force structure issues in detail.

²⁷ Deputy Secretary of Defense John Deutch, DoD Briefing, September 22, 1994 (Federal News Service transcript, DD-22-08), p. 1.

²⁸ Although Deputy Secretary of Defense John Deutch stated that 500 Minuteman III ICBMs would be retained under the Nuclear Posture Review, other DoD documents indicate that, depending on which three ICBM bases operations are consolidated to, it is possible that 450 rather than 500 Minuteman III ICBMs could be retained. DoD, "Nuclear Posture Review" briefing papers, September 22, 1994, p. 17.

²⁹ Under the Administration's plan all of the last 10 Trident SSBNs will be equipped with the Trident II (D-5) missile, and four of the first eight Trident SSBNs, which currently carry the Trident I (C-4) missile, would eventually be backfitted to carry the D-5 missile. The other four C-4 equipped Trident SSBNs would be retired.

- 66 B-52H bombers capable of both nuclear and conventional roles; and
- 20 B-2 bombers capable of both nuclear and conventional roles.

In addition, the administration announced its intention to convert existing B-1B bombers to a conventional only capability.³⁰ Prior to release of the Nuclear Posture Review, in the FY 1995 National Defense Authorization Act Congress — concerned that administration plans might provide for too few bombers³¹ — prohibited the retirement of any B-52Hs or B-1Bs in FY 1995, and directed that a number of studies be conducted to better define long-term bomber requirements. Nevertheless, for purposes of this analysis it is assumed that U.S. post-START nuclear bomber forces will consist of 66 B-52Hs and 20 B-2s as called for under the Nuclear Posture Review.

In addition, post-START U.S. nuclear forces are assumed to include:

- 150 Air Force Air National Guard strategic air defense fighters;³²
- Deployment of theater ballistic missile defenses;
- Continued development, but not deployment, of national ballistic missile defenses; and
- A total of about 8,500 strategic, theater and tactical nuclear warheads, including both warheads allocated to active forces and those in the reserve stockpile.³³

The estimated annual steady-state costs of this planned future U.S. nuclear force structures are broken down into a number of major cost categories in the following table.

³⁰ It is assumed in this analysis that under the Nuclear Posture Review the U.S. will retain 72 B-1 bombers for conventional-only missions, plus 24 in attrition reserve, as provided under earlier administration plans. See Secretary of Defense Les Aspin, *Annual Report to the President and the Congress*, January 1994, p. 27.

³¹ Among other factors, this concern stemmed from the fact that the administration's defense-wide "Bottom Up Review" (BUR) of U.S. defense requirements had originally indicated that as many as 184 bombers would be needed to meet the BUR's requirement for waging two nearly-simultaneous Major Regional Contingencies (MRCs), and retaining a credible nuclear capability.

³² This estimate assumes the United States would retain the same number of interceptor aircraft over the long term that it is currently projected to maintain through FY 1996. See *Annual Report to the Congress and the President*, p. D-1.

³³ This estimate consists of 5,000 nuclear warheads with U.S. active forces (including 10 percent spares for routine maintenance) and 3,500 in the reserve stockpile. Robert S. Norris, Chris Paine, and Tom Cochran, "Projected U.S. Nuclear Forces After START II (2003)," Natural Resources Defense Council (NRDC) News Release, September 22, 1994.

The methodology for estimating the costs of each of these categories is noted below the table.

Long-Term Average Annual Costs of Post-START U.S. Nuclear Forces³⁴
(in billions of FY 1995 dollars)

Strategic Offensive:	\$12
Strategic Air Defense:	\$1
Strategic C3I:	\$6
Strategic R&D:	\$6
Theater & Tactical Offensive:	\$1
Ballistic Missile Defenses:	\$4
Nuclear Warheads & Cleanup:	\$10
Other:	\$1
Total:	\$40 ³⁵

Sources and Costing Methodology

Strategic Offensive: See appendix.

Strategic Air Defenses: See appendix.

Strategic C3I: See appendix.

³⁴ These estimates represent the average annual costs of keeping the U.S. nuclear force structure called for under the Nuclear Posture Review adequately manned, supported and equipped over the long term (i.e., the "steady-state" costs of the planned force structure).

³⁵ Total does not add due to rounding.

Strategic R&D: Annual DoD funding for R&D is projected to drop to \$27 billion by FY 1999.³⁶ It is assumed in this analysis that the DoD R&D budget will remain at roughly this level over the long term, beyond FY 1999. In this case, if strategic programs were to continue to absorb the roughly 30 percent share of total DoD R&D funding they did during much of the Cold War,³⁷ R&D funding for strategic programs would average about \$8 billion annually. That figure was reduced to \$6 billion to reflect the assumption that the development of theater and national ballistic missile defense systems would be funded at roughly \$2 billion annually over the long run (this funding is included below, in the estimate of long-term ballistic missile defense costs).

Theater and Tactical Offensive: In a 1991 report, the Congressional Budget Office (CBO) estimated that sustaining theater and tactical nuclear forces organized around 1,400 warheads of various types over the FY 1992–FY 2006 period would cost about \$500 million annually (exclusive of the costs of the warheads themselves).³⁸ Since current plans apparently envision sustaining a force of nearly 1,000 theater and tactical warheads of various types in service³⁹ (compared to approximately 10,000 such warheads in the U.S. inventory in FY 1990), this CBO estimate would seem to provide a reasonable estimate of the costs of planned U.S. theater and tactical nuclear forces over the long run.

Ballistic Missile Defenses: This estimate was derived by combining two figures. The first figure is the projected average annual cost of administration plans to acquire theater ballistic missile defenses (TBMDs). Current plans call for developing and, around the turn of the century, deploying several TBMD systems, including the upgraded Patriot Advanced Capability, Level-3 (PAC-3), and Navy lower-tier point defenses, and the Theater High-Altitude Area Defense (THAAD) area defense system.⁴⁰ The costs of this effort are projected to exceed an average of \$3 billion a year over the next 15 years.⁴¹ It is assumed here that this \$3 billion estimate represents a reasonable estimate of TBMD average annual funding requirements over the long term (including \$1 billion for TBMD R&D). In addition, the administration plans to continue R&D on national BMD technologies, in order to ensure the

³⁶ CBO, *Planning for Defense: Affordability and Capability of the Administration's Program*, March 1994, p. 7.

³⁷ See discussion of R&D strategic programs cost on pages 6–7.

³⁸ In addition to 1,400 theater and tactical nuclear warheads with U.S. active forces, CBO estimated that another 600 warheads would be kept stockpiled in reserve. CBO, *The START Treaty and Beyond*, October 1991, p. 135.

³⁹ Robert S. Norris, Chris Paine, and Tom Cochran, "Projected U.S. Nuclear Forces After START II (2003)," Natural Resources Defense Council (NRDC) News Release, September 22, 1994.

⁴⁰ For a full discussion of administration plans, see CBO, *The Future of Theater Missile Defense*, June 1994.

⁴¹ Ibid, p. xx.

timely deployment of such a system should the need arise. It is assumed in this analysis that over the long term the Defense Department would continue to fund national BMD R&D efforts at about \$1 billion annually, roughly the level projected for FY 1999 under current plans.⁴² This \$4 billion estimate for the future annual costs of theater and national BMD activities combined is almost certainly conservative, since it includes only acquisition, and not operations and support costs.⁴³

Nuclear Warheads and Cleanup: The DoE defense activities budget includes funding both for the development, production, testing, maintenance, and dismantlement of nuclear weapons, and for environmental restoration and waste management. Current DoE plans call for funding environmental cleanup activities at about \$6 billion annually through 2000.⁴⁴ It is assumed here that the Energy Department would continue to fund cleanup activities at roughly this level over the long term. While this would appear to be a reasonable assumption, this estimate may substantially understate required funding levels. Moreover, at this rate of expenditure, it could take a *half century or more* to complete cleanup at DoE facilities.⁴⁵ DoE funding for non-cleanup related defense activities is projected under current plans to be nearly \$4 billion in FY 1999.⁴⁶ It is assumed here that this level of funding would be sufficient to sustain post-START U.S. nuclear forces over the long term. Thus, total DoE funding for the U.S. post-START nuclear force structure is estimated at just under \$10 billion annually.

Other: This category includes the costs of complying with and monitoring various nuclear arms control treaties, and the costs of civil defense efforts. Estimating the costs of activities such as on-site inspections and weapons dismantlement associated with the compliance and monitoring of nuclear arms control agreements such as the INF, START I and START II Treaties is very difficult.⁴⁷ According to CBO, the costs of compliance and

⁴² CBO, "Selected Weapons Costs from the President's 1995 Program," Memorandum, May 1994, p. J6.

⁴³ Unfortunately, it is difficult to estimate O&S costs for deployed BMD systems, both because there is little previous experience with such systems, and because it is as yet unclear how large a TBMD system would be deployed under the administration's plan.

⁴⁴ CBO, *Cleaning Up the Department of Energy's Nuclear Weapons Complex*, May 1994, p. 10.

⁴⁵ Indeed, assuming total DoE cleanup costs of \$400 billion, at \$6 billion annually, it would take 67 years to complete these activities.

⁴⁶ Total funding for DoE defense activities in FY 1999 is projected to be \$10 billion. (*Budget of the United States Government, Historical Tables, Fiscal Year FY 1995*, p. 69.) Assuming \$6 billion for environmental cleanup activities, this implies \$4 billion for all other DoE defense activities.

⁴⁷ For a thorough discussion of the issues involved, see CBO, *U.S. Costs of Verification and Compliance Under Pending Arms Treaties*, 1990.

monitoring activities were about \$200 million in FY 1990.⁴⁸ CBO also estimated that the costs of these activities could grow to some \$1 billion annually if an agreement were reached to adopt lower warhead levels — assuming that such an agreement would involve more extensive and intrusive activities, such as monitoring total quantities of warheads and fissile materials. Since current plans do not envision such intrusive activities, this estimate may well overstate the costs of future compliance and monitoring activities. Under the START Treaty, however, these costs are likely to amount to at least \$500 million annually.⁴⁹

It is assumed here that over the long term, U.S. funding for Federal Emergency Management Agency (FEMA) defense-related civil-defense programs would remain at roughly \$205 million annually, the level proposed by the Administration in its FY 1995 budget request.⁵⁰

Some Caveats

These estimates of the annual steady-state costs of U.S. post-START nuclear forces should be taken as rough approximations based on historical experience, rather than precise predictions of future costs. This is true for a number of reasons.

First, the estimates produced by this analysis — like the results of any analysis — are only as good as the assumptions upon which the analysis rests. While this analysis uses official sources where possible, it was necessary to make some subjective judgments. The effect of varying two of these judgments in particular — concerning the service lives assumed for various weapon systems and strategic R&D funding levels — is worth considering. In the absence of any rapidly modernizing nuclear competitor and facing increasingly tight budgetary constraints, the United States might decide to keep weapon systems in service longer than assumed in this analysis.⁵¹ For those same reasons, in contrast to the assumption made in this analysis, the United States might also decide to reduce the share of R&D funding absorbed by strategic forces to a level well below its Cold War share.

If U.S. nuclear weapon systems and supporting equipment were kept in the force structure an average of 30 percent longer, the average annual procurement costs of U.S. post-START nuclear forces could drop by as much as \$2 billion.⁵² If R&D programs were

⁴⁸ CBO, *The START Treaty and Beyond*, October 1991, p. 68.

⁴⁹ Ibid.

⁵⁰ DoD, *National Defense Budget Estimates for FY 1995*, March 1994, p. 7.

⁵¹ The service lives assumed in this analysis are 42 years for bombers, 30 years for SSBNs, 20 years for ICBMs and SLBMs, and 21 years for fighters. See appendix for further details.

⁵² Such an increase in the length of service lives may well be reasonable. Indeed, it may be likely for at least some systems. For example, Air Force officials have stated that B-52 bombers could be kept in service into the 2020s — implying service lives of 60, rather than 42, years. General Accounting Office, *Strategic*

similarly stretched out, R&D funding for strategic forces could also be cut by some \$2 billion annually.⁵³

A second reason the estimates of future costs included in this analysis should be taken as rough approximations rather than precise estimates is that the notion of "steady-state" costs, while useful for analytical purposes, is something of a fiction. By definition, steady-state costs are the average annual costs that would be incurred if the goal were to sustain essentially the same force structure indefinitely. In practice, of course, force structures do not remain static either in size or character. When weapon systems are retired, they are generally replaced by more capable, and often far more expensive, new weapon systems. Moreover, each new generation of a weapon system typically costs more to operate and support than the system it replaces. The combination of these two factors tends to increase the annual level of funding required to keep a given force structure adequately equipped, trained and ready over the long term. This suggests that the steady-state approach used in this analysis may actually *understate* the long-term average annual costs of the U.S. post-START nuclear force structure.

A third point worth emphasizing is that the estimates of annual steady-state costs included in this analysis tell us how much the United States would have to spend over the indefinite long term, given particular assumptions about weapon system service lives, etc., but do not tell us how much the United States must spend over any particular period of years. Over the next decade or more, for example, the United States may be able to live off of the weapon systems it bought in the 1980s, reducing procurement requirements significantly below the steady-state requirements suggested in this analysis. Eventually, however, if the force structure is to be preserved, these systems will have to be replaced, and procurement funding made available to pay for them.

Weapons: Long-Term Costs Are Not Reported to the Congress, August 1990, p. 37. Similarly, the Navy plans to reevaluate the service lives of SSBNs later in this decade in hopes of keeping them in service for up to 40, rather than 30, years. CBO, *Rethinking the Trident Force*, July 1993, p. xiv. On the other hand, this \$2 billion savings estimate would likely be at least partially offset by increased O&S costs and increased funding for modifications and upgrades.

⁵³ That is, if strategic R&D programs were slowed so as to take 30 percent longer to complete, average annual savings of as much as \$2 billion might be possible. On the other hand, given historical rates of cost growth in R&D programs, stretch outs alone might not be sufficient to generate savings of this magnitude.

IV. Appendix

STEADY-STATE COSTS OF U.S. STRATEGIC NUCLEAR FORCES

One of the main goals of this report was to derive an estimate of the average annual costs of sustaining U.S. nuclear forces over the long term: that is, to derive an estimate of how much it would cost the United States annually to keep its planned future (hereafter referred to as "post-START") nuclear force structure adequately manned, operated, equipped, modernized, and otherwise supported over the long term. Specifically, the goal was to derive the annual "steady-state" costs of the U.S. post-START nuclear force structure. This appendix describes how estimates of the steady-state costs of future U.S. *strategic* nuclear forces were derived.⁵⁴ As discussed earlier, the lion's share of funding for U.S. nuclear forces has been, and will continue to be, absorbed by strategic forces.

The operations and support (O&S) costs incurred by FY 1990 U.S. strategic forces were analyzed in depth to derive a baseline from which future O&S costs could be estimated — both for the planned post-START nuclear force structure as a whole and for different components of that force structure. Estimates of the procurement costs of *major* weapon systems included in this force structure were derived based upon steady-state replacement requirements, while the procurement costs of *minor* equipment was derived by using a "multiplier" based on the historical ratio of major to minor procurement costs.

Estimates of steady-state O&S and procurement costs were derived for each of the five major components of the U.S. strategic force structure: the bomber, ICBM, air defense fighter, SSBN/SLBM, and strategic C3I components.⁵⁵

The first section below describes how O&S costs for the various major components of the FY 1990 U.S. strategic force structure were derived, and uses those estimates as a basis for estimating the O&S costs of post-START U.S. strategic forces. For the purposes of this analysis, O&S costs include funding allocated to the military personnel, operations and maintenance (O&M), military construction, and family housing accounts. The readiness of forces to fight effectively on short notice is largely a function of the level of O&S funding they receive. O&S funding pays the salaries of both military personnel and civilian Department of Defense personnel. It also covers the costs of fuel, spare parts, and other

⁵⁴ See pages 15–17 of this analysis for a discussion of the methodology used to estimate the costs of future U.S. tactical and theater nuclear forces, strategic R&D programs, ballistic missile defenses, nuclear warhead and environmental cleanup activities, arms control compliance and verification measures, and civil defense activities.

⁵⁵ SSBNs and SLBMs are treated as a single component for costing purposes, since they are deployed together.

maintenance and overhaul activities required to keep equipment in working condition. It is assumed in this analysis that the level of funding provided for U.S. nuclear forces in FY 1990 accurately reflected the annual costs of keeping forces of that size and type at the relatively high levels of readiness they enjoyed in FY 1990. It is further assumed that the FY 1990 O&S funding level therefore provides a reasonable baseline from which to estimate the O&S costs of sustaining U.S. strategic nuclear forces over the long term.

The second section below describes how the annual steady-state procurement costs for the post-START U.S. strategic nuclear force structure and its major components were estimated. O&S programs must generally be funded at the same level year after year if a particular force structure or component of that force structure is to be kept at the same level of readiness. Procurement programs, on the other hand, can, and typically are, funded cyclically, with great variations in the level of funding allocated to procurement programs from year to year. This analysis attempts to estimate the level of procurement funding that would be required on an *average annual* basis to sustain the planned future U.S. strategic nuclear force structure and its major component parts over the long term.

Since the U.S. Army and Marine Corps have virtually no military forces assigned to strategic nuclear missions, the following analysis focuses exclusively on U.S. Air Force and Navy forces.

OPERATIONS AND SUPPORT COSTS

This section describes the methodology used to estimate the O&S costs of FY 1990 U.S. strategic nuclear forces, and explains how that estimate was used as a baseline for estimating the O&S costs of planned post-START U.S. strategic nuclear forces.

Personnel Costs

The first step in the analysis was to derive an estimate of the total military personnel costs associated with operating and supporting U.S. strategic forces in FY 1990. The Department of Defense's Manpower Requirements Report (MRR)⁵⁶ allocates all of the military personnel in each of the Services to one of the following 13 categories:⁵⁷

- 1) Strategic Forces
- 2) Tactical Forces
- 3) Mobility Forces
- 4) Communication/Intelligence

⁵⁶ Department of Defense, *Manpower Requirements Report, FY 1992*, February 1991.

⁵⁷ A fourteenth category, "Individuals," consists of a small number of personnel in transit, undergoing medical treatment, or engaged in a variety of other miscellaneous activities. As a simplifying assumption, in this analysis these personnel were allocated to the 13 other categories on a proportional basis.

- 5) Combat Installations
- 6) Force Support Training
- 7) Medical Support
- 8) Joint Activities
- 9) Central Logistics
- 10) Service Management Headquarters
- 11) Research and Development
- 12) Training and Personnel
- 13) Support Activities

According to the MRR, in FY 1990 a total of 89,000 active military personnel were assigned to U.S. strategic forces. However, this figure seriously undercounts the number of active military personnel actually required to operate U.S. strategic forces in FY 1990 because it does not include any of those personnel assigned to the various support categories listed in the MRR. This analysis attempts to correct this deficiency. It is assumed here that the first four categories listed in the MRR (Strategic Forces, Tactical Forces, Mobility Forces, and Communications/Intelligence — hereafter referred to as C3I) represent the core "mission" capabilities of the U.S. military, and that all personnel in the remaining nine MRR categories exist to support those in the four core mission areas.⁵⁸ Therefore, the number of active military personnel associated with U.S. strategic forces in FY 1990 is assumed to include all of the personnel assigned to the strategic forces category of the MRR plus a proportional share of all of the personnel assigned to the nine support categories of the MRR.

Once the total number of active military personnel required to operate and support the FY 1990 strategic forces of each of the services was calculated using this approach, the figure was divided by the total FY 1990 end strength for each service to derive an estimate of the share of each service's FY 1990 active military end strength allocated to the strategic mission area. This estimate was then used as a proxy to estimate the share of each service's FY 1990 active military personnel budget absorbed by strategic forces.

This same approach was used to estimate the military personnel costs associated with National Guard and Reserve military personnel used to operate and support each service's strategic forces in FY 1990. (The MRR provides the same service-level, 13-category breakdown for National Guard and Reserve personnel as it does for active military personnel.)

The above analysis provides a means of estimating the military personnel costs required to operate and support U.S. strategic forces in FY 1990 at both the Defense Department-wide and service levels. The next step was to divide these service-level estimates into specific types of forces — Air Force bomber, ICBM, air defense, and strategic C3I forces, and Navy SSBN/SLBM and strategic C3I forces. This was accomplished by once

⁵⁸ This is analogous to the treatment of the strategic forces, general purpose forces, airlift/sealift forces, C3I, and SOF *major force programs* as core mission areas in the section on historical costs. (SOF personnel are included in the Tactical Forces portion of the MRR.)

again making use of the MRR, which divides the 13 personnel categories into smaller subcategories, and breaks down those subcategories into individual line items.

Air Force

The MRR divides the Air Force's strategic forces category into three subcategories: offensive strategic forces, defensive strategic forces, and strategic control and surveillance forces (hereafter, referred to as Air Force strategic C3I).

The offensive strategic forces subcategory is further divided into 16 individual line items. Eleven of those line items are clearly associated with the strategic bomber force (e.g., bomber and tanker squadrons) and three are clearly associated with operating and supporting the ICBM force (e.g., Minuteman squadrons, Peacekeeper squadrons and Minuteman communications). It appears that two line items (mission evaluation activity and operational headquarters) could be associated with either or both the FY 1990 bomber and ICBM forces. It is assumed in this analysis that personnel grouped under these last two line items are in fact used to support both types of offensive forces. Thus the strategic bomber force is assumed to account for all of the personnel assigned to the 11 clearly bomber-related line items plus a proportional share of those assigned to the two ambiguous line items, while the ICBM force is assumed to account for all of the personnel assigned to the three clearly ICBM-related line items plus a proportional share of those grouped under the two ambiguous line items. These estimates of bomber force and ICBM force military personnel were then divided by the MRR's Air Force strategic forces military personnel total to derive an estimate of the share of the Air Force's FY 1990 military personnel budget that was absorbed by these two forces. This same approach was also used to generate estimates of the Air Force Air National Guard and Reserve military personnel funding totals associated with supporting the FY 1990 U.S. bomber and ICBM forces.

A slightly different approach was taken to estimate the military personnel costs associated with Air Force strategic air defense and strategic C3I forces. Under defensive strategic forces, the MRR includes both air defense fighter squadrons and some supporting strategic C3I systems (i.e., the joint surveillance system, surveillance radar stations/sites, distant early warning radar stations, and over-the-horizon radars). In order to avoid confusion and to make the breakdown more consistent with that provided for O&M funding (see below), it was decided to remove those surveillance systems from the defensive strategic forces subcategory and add them to the Air Force strategic C3I subcategory. These estimates of strategic air defense and strategic C3I personnel were then divided by the active Air Force strategic forces military personnel total to derive an estimate of the share of the Air Force's military personnel budget that was absorbed by these two forces. This same approach was also used to generate estimates of Air Force Air National Guard and Reserve military personnel funding totals associated with supporting the FY 1990 U.S. strategic defensive and strategic C3I forces.

The results of the above approach yielded the following estimates of Air Force FY 1990 total (active and reserve) military personnel costs (in billions):

Bombers:	\$4.0
ICBMs:	\$1.0
Air Defense Fighters:	\$0.2
Strategic C3I:	\$1.3

Navy

The MRR divides the Navy's strategic forces category into a total of only five separate line items, all of them clearly associated with operating and supporting the SSBN/SLBM force. Three of the line items (Fleet Ballistic Missile (FBM) System, Trident and Support Ships) cover activities directly related to operating SSBNs and SLBMs. A fourth line item (FBM Control System) includes the Navy's two squadrons of TACAMO aircraft — for communicating with SSBNs in wartime — and is clearly associated with supporting Navy strategic C3I activities. It appears that the last line item in this category, "Other Strategic Support," could be associated with supporting either or both the SSBN/SLBM forces or Navy strategic C3I activities (which, of course, are themselves primarily intended to support the SSBN/SLBM force).

Therefore, it is assumed in this analysis that all military personnel allocated to the first three line items of the Navy's strategic forces category plus a proportional share of those military personnel allocated to the "Other Strategic Support" line are assigned to operating and supporting the FY 1990 SSBN/SLBM force. The other major Navy strategic forces element costed out in this analysis, Navy strategic C3I, is assumed to consist of those military personnel allocated to the FBM Control System line plus the remaining share of "Other Strategic Support."

These estimates of military personnel associated with SSBN/SLBM and Navy strategic C3I forces were then divided by the total for Navy strategic forces military personnel to derive an estimate of the share of the active Navy's FY 1990 military personnel budget for strategic forces that was absorbed by each of these two elements. This same approach was also used to generate estimates of Navy Reserve military personnel funding totals associated with supporting the FY 1990 U.S. SSBN/SLBM and Navy strategic C3I forces.

The results of the above approach yielded the following estimates of Navy FY 1990 total (active and reserve) military personnel costs for strategic forces (in billions):

SSBNs/SLBMs:	\$1.5
Strategic C3I:	\$0.1

Operations and Maintenance Costs

The second step in the analysis was to derive an estimate of the total operations and maintenance (O&M) costs associated with operating and supporting U.S. strategic forces in FY 1990. The Department of Defense allocates all O&M costs incurred by active duty forces in each of the services to one of the following categories:

- 1) Strategic Forces
- 2) General Purpose Forces
- 3) Intelligence and Communications
- 4) Airlift and Sealift
- 5) Central Supply and Maintenance
- 6) Training, Medical, and Other General Personnel Activities
- 7) Administration and Associate Activities
- 8) Support of Other Nations
- 9) Special Operations Forces

The first four of these categories are essentially the same as the first four listed in the MRR's breakdown of military personnel (Strategic Forces, Tactical Forces, Mobility Forces, and Communication/Intelligence — hereafter referred to as C3I). As with the analysis of the MRR and military personnel costs, it was assumed in this analysis that the first four categories of O&M funding represent the core "mission" capabilities of the U.S. military, and that all O&M activities in the remaining categories exist to support those in the four core "mission" categories.⁵⁹ Therefore, the level of O&M funding for the Strategic Forces of each service in FY 1990 includes all funding in the Strategic Forces category plus a proportional share of all of the O&M funding included in the remaining four support categories.

It was not possible to use this same approach to estimate the O&M costs associated with National Guard and Reserve strategic forces activities, because the Department of Defense does not provide a similar nine-category breakdown of reserve O&M funding. Instead, it was assumed that each service's reserve strategic forces would absorb the same share of the service's overall reserve O&M budget as they absorbed of the service's overall reserve military personnel budget.

The above analysis provided a means of estimating the O&M costs required to operate and support U.S. strategic forces in FY 1990 at both the Defense Department-wide and service levels. The next step was to divide these service-level estimates into more specific mission areas.

⁵⁹ The one exception is the Special Operations Forces (SOF) O&M category. Rather than treating this as a support category, it was added to the General Purpose Forces category — making it consistent with the MRR, which apparently includes SOF personnel in its Tactical Forces category.

Air Force

For Air Force strategic forces, the goal was to break down O&M funding into the same components as had been done for military personnel costs (see above): bombers, ICBMs, air defense, and strategic C3I. The Air Force does not regularly provide a detailed breakdown of strategic forces O&M funding in its unclassified testimony to Congress. However, it did provide such a breakdown in its FY 1988 budget submission.⁶⁰ This testimony included projections of FY 1989 funding requirements. Since the Air Force bomber, ICBM and air defense forces projected in this testimony for FY 1989 closely resembled those actually deployed in FY 1990, it was decided to use the figures included in this testimony — adjusted to take into account the slightly lower number of bombers actually deployed in FY 1990 — as a basis for estimating the O&M costs associated with each of the four components of Air Force strategic forces.

The FY 1988 Air Force testimony broke down the O&M budget for active Air Force strategic forces into two subcategories, strategic offensive and strategic defensive. The strategic offensive category was further divided into five different line items: aircraft, missiles, other offensive operations, telecommunications and control, and base operations. It was assumed that the last three of these activities were essentially support functions, and their funding levels were allocated proportionally to the bomber and ICBM components.

The estimates of bomber O&M costs were then adjusted downward to reflect the fact that only 187 B-52s and 90 B-1Bs were deployed in FY 1990,⁶¹ compared to the 234 B-52s and 90 B-1Bs included in the FY 1988 Air Force projections.⁶² According to an estimate by the Congressional Budget Office (CBO), the unit O&S costs for the B-1B bomber are about 40 percent higher than they are for the B-52.⁶³ Assuming that the B-1B's O&M costs are similarly 40 percent higher than the B-52's,⁶⁴ the total O&M costs for the actual FY 1990 bomber force would be about 13 percent lower than projected in the FY 1988 Air Force

⁶⁰ Gen. Robert E. Swarts, Deputy Director of Budget (Operations), United States Air Force, Statement before the House Appropriations Defense Subcommittee, March 3, 1987, p. 294.

⁶¹ Figures reflect the number of primary aircraft authorized (PAA), including 33 B-52s assigned conventional missions. The figure for total aircraft inventory (TAI), including aircraft in depot maintenance and test aircraft, would be somewhat higher. Les Aspin, *Annual Report to the President and Congress*, January 1994, pp. D1-2.

⁶² Casper W. Weinberger, *Annual Report to Congress, Fiscal Year 1988*, January 12, 1987, p. 335.

⁶³ Congressional Budget Office (CBO), *The START Treaty And Beyond*, October 1991, p. 140.

⁶⁴ As described earlier, operations and support (O&S) costs consist of O&M plus military personnel, military construction and family housing costs.

testimony.⁶⁵ The ICBM and adjusted bomber figures were then divided by the total for the strategic offensive subcategory to derive the share of the Air Force's FY 1990 active strategic forces O&M budget allocated to these two types of forces.

Since, as mentioned earlier, no detailed breakdown was available for the O&M costs of Air Force reserve forces, this analysis assumed that the Air Force strategic force's O&M budget for reserve forces broke down into the same shares as its military personnel costs.

In contrast to the MRR, which has a separate subcategory for strategic C3I forces, these activities are included in the strategic defensive subcategory of the active Air Force's O&M budget. In order to avoid confusion and keep the O&M breakdown consistent with the military personnel breakdown (see above), this subcategory was split in two to create two distinct subcategories comparable to the air defense and strategic C3I subcategories into which military personnel costs were broken down. This air defense subcategory includes funding for "other defensive operations," while the strategic C3I subcategory includes funding for "surveillance radars" and "defensive operations." Funding in the other three lines listed under the strategic defensive subcategory in the FY 1988 Air Force testimony are assumed to be for support activities and are divided proportionally between the air defense and control and surveillance subcategories.⁶⁶

Once again, this analysis assumed that the Air Force strategic force's O&M budget for reserve forces broke down into the same shares as its military personnel costs.

The results of the above approaches yielded the following estimates of Air Force FY 1990 total (active and reserve) O&M costs for strategic forces (in billions):

Bombers:	\$3.7
ICBMs:	\$0.9
Air Defense Fighters:	\$0.6
Strategic C3I:	\$1.7

⁶⁵ If the unit O&S costs for the B-1B are 40 percent higher than for the B-52, the O&S costs for 90 B-1Bs would be equivalent to 126 B-52s, and total O&S costs for a force of 90 B-1Bs and 187 B-52s would be equivalent to the total O&S costs for a force of 313 (126 + 187) B-52s. By comparison, the total O&S costs of a force of 90 B-1Bs and 234 B-52s would be equivalent to the O&S costs of a force of 360 B-52s. This suggests that total O&S costs for the smaller (actual) bomber force would be about 87 percent (313/360) of the cost of the larger (projected) bomber force, or 13 percent lower.

⁶⁶ Although not explained in the Air Force's FY 1988 O&M testimony, "defensive operations" appears to include the same activities designated "surveillance satellite" in earlier Air Force O&M testimony. See Brig. Gen. Mark J. Worrick, Deputy Director for Budget, Operations, Department of the Air Force, statement before the House Armed Services Committee, March 21, 1985, p. 555 (Defense Department Authorization and Oversight Hearings).

Navy

The goal here was to breakdown Navy O&M funding into the same two components into which Navy strategic forces military personnel had been divided: SSBN/SLBM forces and Navy strategic C3I. Unfortunately, no Navy O&M funding documents with a level of detail comparable to that provided for Air Force strategic forces O&M funding were located. It was thus assumed in this analysis that the Navy's O&M budget for strategic forces was broken down proportionally in the same shares as the Navy's military personnel budget for strategic forces.

This approach yielded the following estimates of Navy FY 1990 total (active and reserve) O&M costs for strategic forces (in billions):

SSBNs/SLBMs:	\$3.2
Strategic C3I:	\$0.2

MILITARY CONSTRUCTION AND FAMILY HOUSING

Historically, military construction and family housing costs have tracked closely with the size of the force structure, or, more precisely, with the level of funding provided for military personnel. Over the FY 1983–FY 1993 period, Air Force annual funding for military construction and family housing (combined) amounted to an average of nine percent of the funding for military personnel. Likewise, over this same period, Navy annual funding for military construction and family housing on average equalled eight percent of the Navy's annual military personnel budget. Thus, in this analysis it is assumed that the annual steady-state military construction and family housing costs associated with sustaining U.S. Air Force and Navy strategic forces amount to, respectively, nine percent and eight percent of military personnel funding for Air Force and Navy strategic forces.

FY 1990 BASELINE

The next step was to add together the steady-state military personnel, O&M, and military construction and family housing costs estimated in the sections above to derive an estimate of the total O&S costs of U.S. FY 1990 strategic forces, broken down into major force components.

FY 1990 Strategic Forces O&S Costs By Major Component
(in billions of FY 1995 dollars)

	<u>Mil.</u> <u>Pers.</u>	<u>O&M</u>	<u>Mil.Con.</u> <u>Fam. Hsg.</u>	<u>O&S</u> <u>Total</u>
Air Force				
Bombers:	\$4.0	\$3.7	\$0.4	\$8.1
ICBMs:	\$1.0	\$0.9	\$0.1	\$2.1
Air Defense:	\$0.2	\$0.6	\$0.0	\$0.8
Strategic C3I:	\$1.3	\$1.7	\$0.1	\$3.1
Subtotal:	\$6.5	\$7.0	\$0.6	\$14.1
Navy				
SSBN/SLBM:	\$1.5	\$3.2	\$0.1	\$4.8
Strategic C3I:	\$0.1	\$0.2	\$0.0	\$0.4
Subtotal:	\$1.6	\$3.4	\$0.1	\$5.1
DoD Total:	\$8.1	\$10.4	\$0.7	\$19.2

A final refinement of these estimates was necessary to use them as a baseline for estimating the O&S costs of future U.S. strategic forces. It involved deriving O&S cost estimates for different weapon systems within each of the above four weapons-related force components (i.e., bomber, ICBM, air defense, and SSBN/SLBM forces). No attempt was made to further break out either the Air Force or Navy strategic C3I components.

Air Force

Bombers: In FY 1990, the U.S. Air Force deployed three different types of aircraft in its strategic bomber force: the B-1B, the B-52 and the FB-111. According to CBO, the annual O&S costs for the B-1B bomber are about 40 percent higher per aircraft than for the B-52.⁶⁷ Likewise, according to the Air Force, the annual O&S costs for the B-52 are about 35 percent higher than the O&S costs for the FB-111.⁶⁸ These estimates of the relative O&S costs of these various aircraft imply the following O&S cost breakdown of the bomber component of Air Force FY 1990 strategic forces (in millions).

⁶⁷ CBO, *The START Treaty and Beyond*, p. 140.

⁶⁸ In 1988, the Air Force estimated that the annual O&S costs for a squadron of 11 FB-111s would be about \$44.4 million, or \$4 million (FY 1987 dollars) per aircraft, while the annual O&S costs for a squadron of 19 B-52H aircraft would total \$102.5 million (FY 1987 dollars), or about \$5.4 million per aircraft. Department of the Air Force, *U.S. Air Force Cost and Planning Factors*, March 1988, pp. 121-122.

	<u>PAA</u> ⁶⁹	<u>Total O&S Costs</u> ⁷⁰	<u>O&S Costs Per PAA</u>
B-1B:	90	\$3,100	\$34
B-52:	187	\$4,500	\$24
FB-111:	28	\$500	\$18
Total:	305	\$8,100	

ICBMs: In FY 1990, the U.S. Air Force deployed three different types of ICBMs: the Minuteman II, the Minuteman III and the MX. According to CBO, the annual O&S costs for the MX missile are about 75 percent higher per missile than for the Minuteman (the CBO estimate does not distinguish between the costs of the Minuteman IIs and IIIs).⁷¹ These estimates of the relative O&S costs of the MX and Minuteman II and III ICBMs imply the following O&S cost breakdown of the ICBM component of Air Force FY 1990 strategic forces (in millions).

⁶⁹ The estimates for B-1B and B-52 PAA are from DoD, *Annual Report to the President and the Congress*, January 1994, pp. D1 and D2. According to DoD, the total aircraft inventory (TAI) of FB-111s in FY 1990 was 31. DoD, *Annual Report to the President and the Congress*, January 1991, p. 55. Assuming that, as with other strategic bombers, 10 percent of the FB-111 TAI were needed for backup (depot maintenance, etc.), a TAI of 31 aircraft would support about 28 PAA.

⁷⁰ If the unit O&S costs for the B-1B are 40 percent higher than for the B-52, the O&S costs for 90 B-1Bs would be equivalent to 126 B-52s ($90 \times 1.4 = 126$). Likewise, if the unit O&S costs for the B-52 are 35 percent higher than for the FB-111 (in other words the O&S costs for the FB-111 are about .75 times that of the B-52), the O&S costs for 28 FB-111s would be equivalent to 21 B-52s ($28 \times .75 = 21$). This means that the total O&S costs of the FY 1990 strategic bomber force were equivalent to the O&S costs of a force consisting of 334 B-52 bombers — 126 (90 B-1Bs) + 21 (28 FB-111s) + 187 (187 B-52s). These figures imply that the three main elements of the FY 1990 bomber force absorbed the following shares of total O&S funding for the bomber component of Air Force strategic forces in FY 1990: 90 B-1Bs, 38% ($126/334$); 187 B-52s, 56 percent ($187/335$); and 28 FB-111s, 6 percent ($21/334$). The totals presented in this column were derived by multiplying these shares by the estimated annual O&S costs of the FY 1990 strategic bomber component as a whole.

⁷¹ CBO, *The START Treaty and Beyond*, p. 140.

	<u>Number</u> ⁷²	<u>Total O&S Costs</u> ⁷³	<u>O&S Costs Per ICBM</u>
MX:	50	\$175	\$3.5
Minuteman II & III:	950	\$1,900	\$2.0
Total:	1000	\$2,075	

Air Defense: In FY 1990, U.S. strategic air defense forces consisted of 18 F-15s in the active Air Force and 216 F-16s in the Air Force Air National Guard. According to the Air Force, the annual unit O&S costs for the F-15 are about 35 percent higher than the O&S costs for the F-16.⁷⁴ In addition, the O&S costs of an Air National Guard fighter squadron are typically only about 70 percent of the costs of an equivalent active Air Force squadron. These estimates of the relative O&S costs of these various aircraft imply the following O&S cost breakdown of the air defense component of Air Force FY 1990 strategic forces (in millions).

⁷² The estimates for ICBM deployments are from DoD, *Annual Report to the President and the Congress*, January 1994, pp. D1.

⁷³ If the unit O&S costs for the 50 MX missiles are 75 percent higher than for the Minuteman ICBM, the O&S costs for 50 MX ICBMs would be equivalent to 88 Minuteman ICBMs ($50 \times 1.75 = 88$). This means that the total O&S costs of the FY 1990 ICBM force were equivalent to the O&S costs of a force consisting of 1038 Minuteman ICBMs — 88 (50 MX ICBMs) + 950 (950 Minuteman ICBMs). These figures imply that the MX and Minuteman elements of the FY 1990 ICBM force absorbed, respectively, 8.5 percent ($88/1038 = .085$) and 91.5 percent ($950/1038 = .915$) of total O&S funding for the ICBM component of Air Force strategic forces in FY 1990. The totals presented in this column were derived by multiplying these shares by the estimated annual O&S costs of the FY 1990 ICBM component as a whole.

⁷⁴ In 1988, the Air Force estimated that the annual O&S costs for a squadron of 24 F-16s would be about \$57.3 million, or \$2.4 million (FY 1987 dollars) per aircraft, while the annual O&S costs for a squadron of 18 F-15 aircraft would total about \$57.7 million (FY 1987 dollars), or about \$3.2 million per aircraft. Department of the Air Force, *U.S. Air Force Cost and Planning Factors*, March 1988, pp. 123-124.

	<u>PAA</u> ⁷⁵	<u>Total O&S Costs</u> ⁷⁶	<u>O&S Costs Per Fighter</u>
F-15 (active):	18	\$120	\$6.4
F-16 (Nat.Gd.):	216	\$710	\$3.3
Total:	234	\$830	

Navy

SSBNs/SLBMs: In FY 1990, the U.S. strategic ballistic missile submarine force consisted of 23 pre-Ohio class SSBNs equipped with 16 SLBMs each (10 carrying Trident I (C-4) missiles and 13 carrying Poseidon (C-3) missiles) and 9 Ohio class SSBNs equipped with 24 SLBMs each (8 carrying Trident I (C-4) missiles and 1 carrying Trident II (D-5) missiles).⁷⁷ No satisfactory Navy data could be found with which to derive an estimate of the annual unit O&S costs of each of these different SSBN/SLBM combinations.

Based on data provided in a July 1993 CBO report,⁷⁸ however, it was possible to derive an estimate of the relative *operating* costs of pre-Ohio class and Ohio class SSBNs in general.⁷⁹ These figures suggest that each Ohio class SSBN (whether equipped with D-5 or C-4 SLBMs) might cost twice as much or more to operate than each pre-Ohio class SSBN

⁷⁵ The estimates for fighter deployments are from DoD, *Annual Report to the President and the Congress*, January 1994, pp. D1.

⁷⁶ If the unit O&S costs for the F-15 are 35 percent higher than for the F-16, and the O&S costs for Air National Guard aircraft are only 70 percent as high as the O&S costs of equivalent aircraft in the active Air Force (in other words, the O&S costs for active squadrons are 40 percent higher), the O&S costs for 18 F-15s would be equivalent to the O&S costs for 34 Air Force Air National Guard F-16s ($18 \times 1.35 \times 1.4 = 34.2$). This means that the total O&S costs of the FY 1990 air defense force were equivalent to the O&S costs of a force consisting of 250 Air Force Air National Guard F-16s— 34 (18 active F-15s) + 216 (216 Air National Guard F-16s). These figures imply that the F-15 and F-16 elements of the FY 1990 air defense force absorbed, respectively, 14 percent ($34/250 = .14$) and 86 percent ($216/250 = .86$) of total O&S funding for the air defense component of Air Force strategic forces in FY 1990. The totals presented in this column were derived by multiplying these shares by the estimated annual O&S costs of the FY 1990 strategic air defense component as a whole.

⁷⁷ DoD, *Annual Report to the President and the Congress*, January 1991, p. 115.

⁷⁸ CBO, *Rethinking the Trident Force*, July 1993.

⁷⁹ Operations and support (O&S) costs are more inclusive than operating costs alone, which typically include only those costs directly associated with system use (e.g., operating costs may include fuel costs, but exclude the cost of repair and overhaul work).

(whether equipped with C-4 or C-3 SLBMs).⁸⁰ If O&S costs for Ohio class SSBNs are similarly double the O&S costs of pre-Ohio class SSBNs, the O&S costs of the SSBN/SLBM component of FY 1990 Navy strategic forces would break down as follows (in millions).⁸¹

	<u>No.</u> ⁸²	<u>Total O&S Costs</u> ⁸³	<u>O&S Costs Per SSBN</u>
Ohio class:	9	\$2,100	\$230
Pre-Ohio class:	23	\$2,700	\$120
Total:	32	\$4,800	

⁸⁰ According CBO, the operating costs of the U.S. SLBM force are projected to remain flat in real (inflation-adjusted) terms between FY 1994 and FY 1999, while the number and mix of SSBNs is projected to change from 14 Ohio class SSBNs and 10 pre-Ohio-class SSBNs in FY 1994 to 18 Ohio class SSBNs in FY 1999. Assuming that the main difference between the projected FY 1994 and FY 1999 SSBN forces is that the FY 1994 force includes 10 more pre-Ohio class SSBNs and the FY 1999 force includes 4 more Ohio class SSBNs, funding could be held constant over this period only if the total operating costs of these 10 pre-Ohio class SSBNs were equivalent to the total operating costs of these 4 Ohio class SSBNs. In other words, the CBO data suggest that the unit operating costs for Ohio class SSBNs are 2.5 times higher than for pre-Ohio class SSBNs. (CBO, *Rethinking the Trident Force*, July 1993, pp. 12-20.) This estimate seems reasonable, given that Ohio class SSBNs are twice as large, carry 50 percent more missiles, and because, historically, new systems have typically cost substantially more to operate and support than their predecessors. On the other hand, a Navy report estimates that the O&S costs for pre-Ohio and Ohio class SSBNs, exclusive of the O&S costs for the missiles themselves, are approximately equal. Department of the Navy, *Visibility and Management of Operating and Support Costs--Ships*, March 1989, pp. 248-271. Since Ohio class SSBNs and the SLBMs they carry each account for roughly half of total O&S funding requirements for the Ohio class SSBN/SLBM combination (see graph in GAO, *Strategic Weapons: Long-Term Costs Are Not Reported to the Congress*, pp. 62-63), it is difficult to see how O&S costs for Ohio class SSBNs, including the O&S costs of their missiles, could be as much as 2.5 times higher than the O&S costs for pre-Ohio class SSBNs, including the O&S costs of their missiles. This analysis, thus, makes the more conservative assumption that the O&S costs of Ohio class SSBNs and their missiles are twice — rather than 2.5 times — as high as the O&S costs for pre-Ohio class SSBNs and their missiles.

⁸¹ While it would be preferable to provide different cost estimates for pre-Ohio class C-3 and C-4 missile-equipped SSBNs as well as Ohio class C-4 and D-5 missile-equipped SSBNs, it was impossible to do so based on available data.

⁸² The estimates for SSBN deployments are from DoD, *Annual Report to the President and the Congress*, January 1994, pp. D1.

⁸³ If the unit O&S costs for Ohio class SSBNs are twice as high as the O&S costs for pre-Ohio class SSBNs, the total O&S costs of the 23 pre-Ohio class SSBNs in the FY 1990 strategic force structure would be equivalent to the O&S costs of 11.5 Ohio class SSBNs. This means that the total O&S costs of the FY 1990 SSBN/SLBM would be equivalent to the O&S costs of a force consisting of 20.5 Ohio class SSBNs — 11.5 (23 pre-Ohio class SSBNs) + 9 (9 Ohio class SSBNs). These figures imply that the pre-Ohio class and Ohio class elements of the FY 1990 SSBN/SLBM force absorbed, respectively, 56 percent ($11.5/20.5 = .56$) and 44 percent ($9/20.5 = .44$) of total O&S funding for the SSBN/SLBM component of Navy strategic forces in FY 1990. The totals presented in this column were derived by multiplying these shares by the estimated annual O&S costs of the FY 1990 SSBN/SLBM component as a whole.

PROCUREMENT COSTS

In contrast to O&S costs, it cannot reasonably be assumed that the annual steady-state costs of arming and equipping a particular component of U.S. strategic nuclear forces would equal, even roughly, the level of funding provided for that component in the FY 1990 defense budget. This is because, unlike the O&S account, which must be funded at a relatively constant rate from year to year if forces are to be kept continuously at the same level of readiness, the level of funding provided for the procurement of equipment can, and generally does, vary considerably over time, and even from one year to the next. Indeed, unlike the O&S account, where falling below the average annual funding requirement would likely have an immediate negative impact on readiness, falling below the average annual procurement funding requirement need not have any negative effect on capabilities — even if this underfunding continues for a period of years — so long as any such underfunding is later offset by a period of comparable overfunding.

The goal of this section was to derive an estimate of the annual steady-state procurement funding requirements of the post-START strategic nuclear force structure. As with the previous section on O&S costs, the goal was to estimate these costs not only for the strategic nuclear force structure as a whole, but also for the five main parts of that force structure: the bomber, ICBM, air defense, SLBM/SSBN, and strategic C3I components.

This analysis used a four-step approach to estimate the annual steady-state procurement requirements for various components of U.S. strategic forces. First, based on assumptions about the service lives of weapon systems, attrition rates, etc., estimates were derived for the number of major weapon systems (i.e., bombers, ICBMs, fighters, SSBNs, and SLBMs) that would have to be procured annually on average in order to sustain the bomber, ICBM, air defense, and SSBN/SLBM components of the U.S. post-START strategic force structure over the long term. These quantity estimates were then multiplied by the unit procurement costs of these systems to derive estimates of the annual steady-state procurement funding requirements for the *major weapon systems* associated with these various components. The costs of major weapon systems, however, typically account for only one-third to one-half of total spending on procurement. The rest of the procurement budget is used to purchase ammunition, supplies, support equipment and other *minor* procurement.⁸⁴ The second step of this analysis involved the use of historical ratios of *major* procurement spending to *total* procurement spending to derive estimates of the *total* annual steady-state procurement costs of U.S. post-START bomber, ICBM, air defense, and SSBN/SLBM forces.

The third step was to derive an estimate of the steady-state procurement requirements of the C3I component of U.S. post-START strategic forces. The above approach could not

⁸⁴ In this analysis, "major" procurement consists of combat aircraft, ICBMs, major surface combatants, submarines, and amphibious ships. All other procurement, including everything from tanker aircraft, and trainers to forklifts and trucks is considered "minor."

be used for C3I forces because there is no identifiable piece of C3I hardware comparable to a bomber, ICBM, air defense fighter, SSBN or SLBM for which lifecycle procurement costs can be easily estimated or could reliably serve as the core around which a total procurement multiplier could be derived. Instead, in the case of strategic C3I forces, steady-state procurement costs were estimated by multiplying the military personnel costs associated with these forces (derived in the previous section on O&S costs) by the ratio of military personnel costs-to-procurement costs experienced by U.S. C3I forces generally during the 1980s.⁸⁵

The fourth and final step was to adjust the total procurement multipliers derived for each of the major weapon systems downward to avoid the double-counting of C3I costs. This was necessary because C3I costs were one of the "minor" procurement costs captured by these various multipliers. These multipliers subsumed not only procurement costs associated with *strategic C3I forces* but the procurement costs associated with *centralized C3I forces* as well.⁸⁶ Thus, a separate estimate of the steady-state procurement costs of centralized C3I forces was derived (using essentially the same methodology used to estimate the procurement costs of strategic C3I forces) and both these costs and the costs associated with strategic C3I forces were excised from the initial set of total procurement multipliers, resulting in their downward adjustment. These revised multipliers were then applied to derive the steady-state total procurement costs of post-START U.S. bomber, ICBM, air defense, and SSBN/SLBM forces.

Major Weapon Systems

The first step was to derive an estimate of the annual steady-state procurement funding requirements for *major weapon systems* in the bomber, ICBM, air defense, and SSBN/SLBM components of the post-START U.S. strategic force structure.

Air Force

Two slightly different approaches were used to estimate the annual steady-state procurement requirements for strategic aircraft (bombers and air defense fighters) and ICBMs. The number of aircraft which must be procured annually on average to sustain a steady-state force is essentially a function of three factors: the total number to be kept in the inventory,

⁸⁵ The Defense Department provides relatively detailed information on the budgetary breakdown of strategic, tactical and defense-wide C3 forces, but provides very little budgetary data on funding for comparable intelligence activities. Since C3 activities typically account for two-thirds of all C3I activities, it seems reasonable to use the budgetary breakdown for C3 forces as a basis for estimating the budgetary breakdown of C3I forces.

⁸⁶ As noted earlier, *centralized C3I* is one of the four mission categories into which this analysis seeks to allocate all costs — the others being, strategic forces, general purpose forces, and mobility forces. The activities of centralized C3I forces support the forces in all of these other three mission categories. By contrast, *strategic C3I* forces are a component of the strategic forces mission category, and as such are used primarily for supporting strategic forces.

including backup aircraft; the expected service life of the aircraft; and the number of aircraft lost through attrition (training accidents, etc.) each year.

Bombers: As described earlier, current administration plans envision a post-START strategic bomber force consisting of 20 B-2 bombers and 66 B-52 bombers (TAI). This analysis assumes that each bomber would be kept in service for an average of 42 years⁸⁷ and that .4 percent⁸⁸ of the bomber force would be lost through attrition each year. This means that supporting this force structure indefinitely would require procuring an average of 2.3 bombers a year, including 2.0 to replace retiring aircraft ($86/42$) and .3 to cover attrition losses ($86 \times .004$). Of these 2.3 bombers, .5 ($20/86 \times 2.3$) would be required to replace B-2 bombers and 1.8 would be required to replace B-52 bombers ($66/86 \times 2.3$).

Assuming an average unit procurement cost of about \$1 billion,⁸⁹ buying an average of .5 B-2 bombers per year would require annual procurement funding of \$500 million ($\$1 \text{ billion} \times .5$).

Since the B-2 bomber is still in production, it seems reasonable to assume that it could be replaced at essentially the same price originally paid for it. It does not, however, seem reasonable to assume that the cost of replacing the B-52 bomber will approximate the original \$70 million per plane cost⁹⁰ of the B-52 bomber, the last of which was produced some 30 years ago. Using the unit cost of the B-2 would clearly overstate the cost of procuring a replacement for the B-52, since the B-2 is designed for a much more demanding

⁸⁷ Statement of Robert F. Hale, Assistant Director, National Security Division, CBO, before the Committee on Armed Services, U.S. House of Representatives, March 19, 1991, p. 31.

⁸⁸ In 1988, the Air Force estimated that .6 B-52 aircraft were lost through attrition for every 100,000 additional hours flown. Since each B-52 bomber is generally flown about 400 hours per year, this implies an annual attrition rate per bomber of .0024 ($400/100,000 \times .6$). See Department of the Air Force, *U.S. Air Force Cost and Planning Factors*, March 1988, pp. 78 and 108. Similarly, the annual attrition rate for the B-1B bomber has been about .006 (the Air Force has had approximately 100 B-1Bs deployed for the past seven years and has lost 4 aircraft through attrition — $4/100/7 = .006$). Thus, assuming an attrition rate of .004 for bombers in general seems reasonable.

⁸⁹ This estimate of B-2 unit procurement costs is based on data provided in DoD *Procurement Program (P-1)* documents from FY 1974 through FY 1995, compiled by CBO. (CBO, "Total Quantities and Unit Procurement Cost Tables, 1974-1995," April 13, 1994.) It was derived by dividing the total quantity figure for the B-2 provided in this compilation by the total procurement funding figure provided. Although referred to in this analysis as the unit procurement cost, this estimate excludes some procurement costs (e.g., funding for initial spares) commonly included in estimates of unit procurement costs (because these costs are not included in the P-1 "topline" procurement figure used in the CBO compilation). These costs are, however, accounted for indirectly through the use of a *total procurement* multiplier (as described later). This is essentially the same approach used to estimate the unit procurement costs of the other major weapon systems included in this analysis.

⁹⁰ Department of the Air Force, *U.S. Air Force Cost and Planning Factors*, March 1988, p. 16.

mission (deep penetration rather than standoff missile attack). Moreover, even the unit procurement cost of the B-1B bomber (about \$300 million)⁹¹ might overstate the costs of procuring a replacement for the B-52, since it too was designed for deep penetration of enemy air defenses.⁹² Because of its less demanding mission, this analysis assumes that a replacement for the B-52 would cost about one-third less than a B-1B bomber, or about \$200 million.⁹³ Thus, the steady-state major procurement costs for the planned future U.S. bomber force were estimated to be \$860 million annually (.5 B-2s x \$500 million + 1.8 B-52 replacements x \$360 million).

Air Defense Fighters: As described earlier, it is assumed here that over the long term, the United States would seek to maintain a strategic air defense force consisting of 150 operational F-16 fighters (PAA). This implies a total steady-state inventory goal of 208 F-16s (TAI).⁹⁴ Assume that each fighter would be kept in service for an average of 21 years⁹⁵ and that 1.5 percent⁹⁶ of the fighter force would be lost through attrition each year. This means that supporting this force structure indefinitely would require procuring an average of 13 fighters a year, including 9.9 to replace retiring aircraft (208/21) and 3.1 to cover attrition losses (208 x .015).

Since the F-16 fighter is still in production, it seems reasonable to assume that it could be replaced at essentially the same price originally paid for it. Assuming an average unit procurement cost of about \$20 million,⁹⁷ buying an average of 13 F-16 fighters per year would require annual procurement funding of \$260 million (\$20 million x 13).

⁹¹ This unit procurement cost estimate was derived using the same methodology described in footnote 89.

⁹² How effective the B-1B would be in this role because of its various technical problems is, of course, another question.

⁹³ This difference is roughly comparable to the proportional difference in cost between procuring high- and low-end mix tactical aircraft in the Air Force (F-15 versus F-16) and the Navy (F-14 versus F/A-18).

⁹⁴ Air Force planners generally assume that to keep a fighter wing of 72 PAA fully operational, another 28 aircraft are required for backup. Thus a total of 100 (TAI) fighters are required to support an operational (PAA) strength of 72. This implies that a total of 208 fighters would be required to support an operational strength of 150 fighters. CBO, *Tactical Combat Forces of the United States Air Force: Issues and Alternatives*, April 1985, p. 16.

⁹⁵ Statement of Robert F. Hale, Assistant Director, National Security Division, CBO, before the Committee on Armed Services, U.S. House of Representatives, March 19, 1991, p. 31.

⁹⁶ Air Force planners assume that over a 20-year period, a fighter wing of 100 aircraft (72 PAA) would suffer 30 aircraft losses through attrition. This implies an annual attrition rate of 1.5 percent. CBO, *Tactical Combat Forces of the United States Air Force*, p. 16.

⁹⁷ This estimate was derived using the same methodology and source described in footnote 89.

ICBMs: A slightly different approach was used to estimate the steady-state procurement requirements for the planned future ICBM force. The number of ICBMs which must be procured annually on average over the long term is essentially a function of three factors: the total number deployed, the expected service life of each missile, and the number required for spares and operational testing to ensure missile reliability. Post-START ICBM deployments are projected to consist of 500 Minuteman IIIs.

It was assumed that each ICBM would be kept in service for an average of 20 years and three Minuteman III missiles would be expended annually for follow-on operational testing.⁹⁸ This means that sustaining the planned future ICBM force over the long term would require procuring an average of 28 replacements per year for the Minuteman III ICBM, including 25 to replace retiring missiles and three to replace those consumed in operational testing.

It did not seem reasonable to assume that the Minuteman III ICBM, the last of which was procured some 20 years ago, could be replaced at its original price. On the other hand, using the unit procurement cost of the 10-warhead MX missile, the last of which was procured only a few years ago, as a basis for estimating the cost of procuring a replacement for a single-warhead version of the Minuteman III missile would clearly overstate those costs. As a compromise, it is assumed here that a replacement for the Minuteman III ICBM would be \$30 million per copy, the price projected for procurement of the single warhead Small ICBM ("Midgetman") before it was canceled in 1992.⁹⁹ Thus, the steady-state major procurement requirements for the planned future U.S. ICBM force were estimated to be \$840 million annually (28 x \$30 million).

Navy

The post-START U.S. strategic force structure is projected to include 14 Trident SSBNs. Assuming a 30-year average service life,¹⁰⁰ this means that over the long run the Navy would have to procure a average of .5 Trident SSBNs annually. The steady-state major procurement costs of sustaining a 14 SSBN Trident force was then derived by multiplying the \$1.8 billion unit procurement cost of the Trident SSBN¹⁰¹ by .5. Since the Trident submarine is still in production (with the last boat authorized in FY 1991), this unit procurement cost seemed to represent a reasonable estimate of future procurement costs. By this accounting, the annual steady-state major procurement costs of the post-START U.S.

⁹⁸ CBO, *Rethinking the Trident Force*, July 1993, p. 56.

⁹⁹ CBO, *The START Treaty and Beyond*, p. 139.

¹⁰⁰ Statement of Robert F. Hale, Assistant Director, National Security Division, CBO, before the Committee on Armed Services, U.S. House of Representatives, March 19, 1991, p. 31.

¹⁰¹ This unit procurement cost was derived using the same methodology described in footnote 89.

SSBN force would be \$900 million (.5 x \$1.8 billion).

Current administration plans call for deploying Trident II (D-5) SLBMs on the last 10 Trident SSBNs and to later backfit the D-5 missile onto four of first eight Trident SSBNs — which currently carry the Trident I (C-4) missile. Although Congress has expressed concerns about the backfit program, it is assumed in this analysis that ultimately the United States will adopt the administration's backfit plan. CBO has estimated that, given a 20-year service life, a total of 528 D-5 missiles would have to be procured to support a force of 14 Trident II SSBNs over a 20-year period.¹⁰² This means that over the long term the Navy would have to procure an average of 26 missiles annually (528/20). Thus, assuming a unit procurement cost for the D-5 of about \$40 million,¹⁰³ the steady-state major procurement costs of the post-START SLBM force would be about \$1.0 billion (26 x \$40 million).

¹⁰² This total includes missiles for deployment aboard SSBNs, maintenance and testing. CBO, *Rethinking the Trident Force*, p. 25.

¹⁰³ This estimate was derived using the same methodology and source described in footnote 89.

Summary of Major Procurement Funding Requirements for Post-START U.S. Strategic Forces
(millions of FY 1995 dollars)

	<u>Force¹⁰⁴ Goal</u>	<u>Annual Sustaining Quantity</u>	<u>Unit Proc. Cost</u>	<u>Annual Major Proc. Costs</u>
<i>Bombers:</i>				
B-2	20	.5	\$1,000	\$500
B-52	66	1.8	\$200	\$360
<i>ICBMs:</i>				
MM III	500	28	\$30	\$840
<i>AD ftrs:</i>				
F-16	208	13	\$20	\$260
<i>SSBNs/SLBMs:</i>				
SSBNs	14	.5	\$1,800	\$900
SLBMs	336	26	\$40	\$1,040
Total:	NA	NA	NA	\$3,900

Total Procurement Funding Requirements

The second step in this analysis involved deriving a number by which the annual estimates of procurement funding requirements for *major systems* (derived above) could be multiplied in order to arrive at an estimate that would capture the *total* procurement costs (for both major and minor equipment) associated with U.S. strategic forces. These multipliers were derived by analyzing the FY 1983 through FY 1991 Air Force and Navy procurement budgets.¹⁰⁵ Specifically, all funding for each of those nine budgets was allocated to one of the ten major weapon systems around which the main components of U.S. Air Force and Navy strategic, general purpose and mobility forces are organized. The 10 major weapon systems consist of bombers, ICBMs, air defense fighters, and SSBNs/SLBMs (around which Air Force and Navy strategic forces are organized), Air Force tactical fighters, and Navy surface combatants, attack submarines, amphibious ships, and combat aircraft (around which Air Force and Navy general purpose forces are organized), and airlift aircraft (around which

¹⁰⁴ Bomber and air defense fighter levels are expressed in terms of TAI. ICBM levels include all deployed missiles. The SLBM figures assumes 24 missiles per SSBN (14 x 24 = 336). However, one of these SSBNs will generally be in overhaul at any one time. Thus, the actual number of SLBMs deployed will generally be 312.

¹⁰⁵ Carrying out this exercise was greatly facilitated by access to a computerized version of the Department of Defense, *Procurement Programs (P-1)* document for the years FY 1983 through FY 1991.

Air Force mobility forces are organized). The portions of procurement funding allocated to the four weapon systems that correspond to the major components of U.S. strategic forces — bombers, ICBMs, air defense fighters, and SSBNs/SLBMs — are described below.

Air Force

Bombers: All funding from Aircraft Procurement (AP), Combat Aircraft (Strategic Offensive),¹⁰⁶ Modification of In-Service Aircraft (Strategic Aircraft) and Missile Procurement (MP), Other Missiles (Strategic); a proportional share [split among AP, Combat Aircraft (Strategic Offensive, Tactical Forces and Other Combat Aircraft) and Airlift Aircraft] of AP, Trainer Aircraft, Other Aircraft, Aircraft Spares and Repair Parts, Aircraft Support and Equipment Activities, and Modification of In-Service Aircraft (Trainer Aircraft, Other Aircraft and Other Modifications); a proportional share [split among Other Missiles (Strategic and Tactical)] of MP, Other Missiles, Industrial Facilities and Missile Replacement Equipment — Other; a proportional share [split among MP, Ballistic Missiles and Other Missiles (Strategic and Tactical)] of MP, Modification of In-Service Missiles, and Spares and Repair Parts; and a proportional share [split among AC, Combat Aircraft (Strategic Offensive, Tactical Forces, Other Combat Aircraft) and Airlift Aircraft, Modification of In-Service Aircraft (Strategic Aircraft, Tactical Aircraft, and Airlift Aircraft), and MP, Ballistic Missiles, Other Missiles (Strategic and Tactical)] of MP, Other Support and Other Procurement (OP), Vehicular Equipment, Electronics and Telecommunications Equipment, and Other Base Maintenance and Support Equipment.

ICBMs: All funding from MP, Ballistic Missiles; a proportional share [split among MP, Ballistic Missiles and Other Missiles (Strategic and Tactical)] of MP, Modification of In-Service Missiles, and Spares and Repair Parts; and a proportional share [split among AC, Combat Aircraft (Strategic Offensive, Tactical Forces, Other Combat Aircraft) and Airlift Aircraft, Modification of In-Service Aircraft (Strategic Aircraft, Tactical Aircraft, and Airlift Aircraft), and MP, Ballistic Missiles, Other Missiles (Strategic and Tactical)] of MP, Other Support and Other Procurement (OP), Vehicular Equipment, Electronics and Telecommunications Equipment, and Other Base Maintenance and Support Equipment.

Air Defense Fighters: All funding from AP, Combat Aircraft (Tactical Forces and Other Combat Aircraft), Modification of In-Service Aircraft (Tactical Aircraft), MP, Other Missiles (Tactical, Target Drones and Tactical Drones), and OP, Munitions; a proportional share [split among AP, Combat Aircraft (Strategic Offensive, Tactical Forces and Other Combat Aircraft) and Airlift Aircraft] of AP, Trainer Aircraft, Other Aircraft, Aircraft Spares and Repair Parts, Aircraft Support and Equipment Activities, and Modification of In-Service Aircraft (Trainer Aircraft, Other Aircraft and Other Modifications); a proportional share [split among MP, Other Missiles (Strategic and Tactical)] of MP, Other Missiles, Industrial

¹⁰⁶ In addition to the funding levels reported for this account in DoD's *Procurement Programs (P-1)* document, \$7.1 billion was added to reflect the level of classified procurement funding provided for this program prior to FY 1990 (when B-2 funding was first reported in the P-1).

Facilities and Missile Replacement Equipment — Other; a proportional share [split among MP, Ballistic Missiles and Other Missiles (Strategic and Tactical) of MP, Modification of In-Service Missiles, and Spares and Repair Parts; and a proportional share [split among AC, Combat Aircraft (Strategic Offensive, Tactical Forces, Other Combat Aircraft) and Airlift Aircraft, Modification of In-Service Aircraft (Strategic Aircraft, Tactical Aircraft, and Airlift Aircraft), and MP, Ballistic Missiles, Other Missiles (Strategic and Tactical)] of MP, Other Support and Other Procurement (OP), Vehicular Equipment, Electronics and Telecommunications Equipment, and Other Base Maintenance and Support Equipment. This total was then multiplied by .07 to reflect the portion of funding assumed to be absorbed by fighters assigned to the strategic air defense mission (with the other 93 percent of funding in these portions of the procurement budget assumed to be absorbed by fighters assigned to general purpose forces).¹⁰⁷

Navy

SSBNs/SLBMs: All funding from Shipbuilding and Conversion (SC), Fleet Ballistic Missile Ships and Weapons Procurement (WP), Ballistic Missiles; a proportional share [split among SC, Fleet Ballistic Missile Ships, Other Warships, Amphibious Ships, and Minewarfare and Patrol Ships] of Auxiliaries, Craft, and Prior-Year Program Costs; a proportional share of Weapons Procurement (WP), Torpedoes and Related Equipment (Mk 48 Torpedo, Mk 48 Torpedo mods,¹⁰⁸ Support Equipment and Logistics Support¹⁰⁹) and Spares and Repair Parts¹¹⁰; a proportional share [split among SC, Fleet Ballistic Missile Ships, Other Warships, Amphibious Ships, and Minewarfare and Patrol Ships] of Other Procurement (OP), Ship Support Equipment; a proportional share [split among WP, Ballistic Missiles, Other Missiles, Torpedoes and Related Equipment, Other Weapons, and Other Ordnance]; and proportional share [split among SC, Fleet Ballistic Missile Ships, Other Warships, Amphibious Ships, Minewarfare and Patrol Ships, and Auxiliaries, Craft, and Prior-Year

¹⁰⁷ Over the FY 1983–FY 1991 period, an average of seven percent of U.S. Air Force fighter aircraft were assigned to strategic air defense forces, while an average of 93 percent were assigned to general purpose forces. Since the same type of aircraft that were assigned to Air Force strategic air defense forces were also assigned to Air Force general purpose forces, it seemed reasonable to allocate seven percent of estimated total FY 1983–FY 1991 tactical fighter procurement funding to air defense fighters.

¹⁰⁸ SSBNs accounted for roughly 25 percent of all U.S. submarines (SSBNs and attack) over the FY 1983–FY 1991 period. It is thus assumed that 25 percent of all funding for Mk 48 torpedoes and Mk 48 torpedo modifications are attributable to the SSBN fleet.

¹⁰⁹ It is assumed that SSBNs account for about 12 percent of funding for Support Equipment and Logistics Support. The Mk 48 torpedo accounted for about 47 percent of torpedo and torpedo modification funding. Assuming SSBNs accounted for 25 percent of Mk 48 procurement funding (see footnote 108), it seems reasonable to allocate 12 percent (.47 x .25) of funding for torpedo Support Equipment and Logistics Support to the SSBN fleet.

¹¹⁰ This assumes that the SSBN fleet absorbs the same share of WP, Spare and Repair Parts, as it does of the rest of WP funding.

Program Costs and Aircraft Procurement (AP)].

Deriving the (Unadjusted) Multipliers

Over the FY 1983–FY 1991 period, procurement funding for the four *major* Air Force and Navy weapon systems described above amounted to a total of \$65 billion.¹¹¹ By comparison, *total* Air Force and Navy procurement funding allocated to these weapon systems through the multipliers derived above amounted to some \$150 billion. Thus, on average, for every dollar spent to procure a major strategic weapon system, another \$1.30 was spent to procure various types of "minor" equipment. In other words, the ratio of *major* to *total* Air Force and Navy procurement funding for strategic forces overall during this period was about 1:2.3. The results of this analysis suggest the following ratios of major procurement-to-total procurement funding for the weapon systems which correspond to four of the major components of U.S. strategic forces.

Air Force

Bombers:	2.8
ICBMs:	1.8
Air Defense Fighters:	3.8

Navy

SSBN/SLBM:	1.4
------------	-----

Applying these ratios to the estimates derived earlier for the steady-state procurement costs of *major weapon systems* yields the following estimates of the *total* annual steady-state procurement costs of the different major components of U.S. post-START U.S. strategic forces:

¹¹¹ This total was derived by adding together the top-line procurement figures included in DoD's annual *Procurement Programs (P-1)* document for each of these four major weapon systems over the FY 1983–FY 1991 period.

	<u>Force¹¹² Goal</u>	<u>Annual Sustaining Quantity</u>	<u>Unit Proc. Cost</u>	<u>Annual Major Proc. Costs</u>	<u>Multi- plier</u>	<u>Total Ann. Proc. Costs</u>
<i>Bombers:</i>						
B-2	20	.5	\$1,000	\$500	2.8	\$1,400
B-52	66	1.8	\$200	\$360	2.8	\$1,008
<i>ICBMs:</i>						
MM III	500	28	\$30	\$840	1.8	\$1,512
<i>AD ftrs:</i>						
F-16	208	13	\$20	\$260	3.8	\$988
<i>SSBN/SLBM:</i>	14/336	.5/26	\$1,800/\$40	\$1,940	1.4	\$2,716

As discussed previously, there are two main problems with the above methodology. First, it does not provide a means for estimating the steady-state procurement costs of the fifth major component of U.S. strategic forces, strategic C3I. Second, it includes some C3I costs that should be excluded from these components. These two limitations are addressed and corrected in the following two sections.

Procurement Funding for Strategic C3I

The third step in this analysis of steady-state procurement funding requirements was to derive an estimate for the C3I component of U.S. strategic forces. As mentioned earlier, since strategic C3I forces are not organized around a single, easily identifiable major weapon system comparable to the bomber, ICBM, fighter, SSBN, or SLBM a different approach had to be taken to estimate their steady-state procurement costs. The approach selected was to derive an estimate of procurement funding requirements based on the historical ratio of military personnel-to-procurement costs experienced by U.S. C3 forces generally.

Specifically, it was assumed that, over the long run, the ratio of military personnel costs-to-procurement costs in the C3I component of U.S. strategic forces would approximate the 1:1.8 ratio of military personnel costs-to-procurement costs experienced by U.S. C3 forces over the FY 1983-FY 1991 period.¹¹³ Since the FY 1990 military personnel costs associated with strategic C3I forces were estimated (see above) at \$1.4 billion, including \$1.3

¹¹² Bomber and air defense fighter levels are expressed in terms of TAI. ICBM levels include all deployed missiles. The SLBM figures assumes 24 missiles per SSBN (14 x 24 = 336). However, one of these SSBNs will generally be in overhaul at any one time. Thus, the actual number of SLBMs deployed will generally be 312.

¹¹³ As discussed earlier, the Defense Department provides relatively detailed information on the budgetary breakdown of C3 forces, but provides very little budgetary data on funding for comparable intelligence activities. Since C3 activities typically account for two-thirds of all C3I activities, it seems reasonable to use the budgetary breakdown for C3 forces as a basis for estimating the budgetary breakdown of C3I forces.

billion for Air Force and \$100 million for Navy personnel, this approach yields an estimated steady-state annual procurement cost for *FY 1990* strategic C3I forces of \$2.5 billion (\$1.4 billion x 1.8), including \$2.3 billion for Air Force and \$200 million for Navy strategic C3I. It is assumed in this analysis that this figure also represents a reasonable estimate of the steady-state procurement costs of post-START strategic C3I systems. This is based on the conservative assumption that strategic C3I requirements will remain at essentially Cold War levels, despite the adoption of a smaller nuclear force structure.¹¹⁴

Adjusting The Procurement Multipliers

The fourth and final step in estimating steady-state procurement requirements for U.S. strategic forces was to adjust the initial total procurement multipliers (derived above) to avoid the double-counting of C3I costs. This was necessary since C3I costs were one of the elements of "minor" procurement captured by the use of these multipliers.¹¹⁵ There were two parts to this double-counting problem. The first part of the problem was related to the fact that the multipliers captured the procurement costs associated with *centralized* C3I forces. The second part was related to the double-counting of procurement costs associated with *strategic* C3I forces.

In order to remedy the first of these double-counting problems, an estimate was derived of the total amount of procurement funding over the FY 1983-FY 1991 period that was absorbed by centralized C3I forces. This estimate was derived through use of the following methodology. First, an estimate of the annual military personnel costs associated with supporting centralized C3I forces was derived for the FY 1983-FY 1991 period.¹¹⁶

¹¹⁴ This may be an overly conservative assumption. While it may not be possible to reduce some strategic C3I assets, such as the number of early warning radars, a smaller nuclear force structure should allow some reductions in command, control and communications systems. On the other hand, in the case of weapons-related components of U.S. strategic forces it is assumed in this analysis that procurement and O&S costs would fall at the same rate as reductions in the size of each force component. This may be an overly optimistic assumption: in practice, some overhead elements of these components might be "fixed" — that is, they may not respond fully and proportionately to reductions in the size of the force elements of these components.

¹¹⁵ This resulted from the fact that, because there is no major weapon system (comparable to bombers, ICBMs, air defense fighters, or SSBNs/SLBMs) corresponding to C3I forces to which associated minor procurement funding could be reliably allocated, it was not possible to generate a separate procurement multiplier for C3I forces.

¹¹⁶ These estimates were derived using essentially the same methodology described in the O&S section of this analysis for deriving FY 1990 military personnel costs by major mission category, except that they were derived using DoD rather than service-level data. That is, the number of military personnel required to support the C3I mission category and the C3I component of the Strategic Forces mission category was assumed to include both the personnel assigned to each of these mission areas and a proportional share of all of the military personnel assigned to the nine support categories identified in DoD's annual breakdown of military manpower by function (these figures, taken from DoD's 1984 through 1992 issues of the *Defense Almanac*, are service-level summaries of the data provided in the MRR). The annual military personnel totals derived for the C3I mission

These annual centralized C3I military personnel funding totals were then multiplied by the ratio of military personnel costs-to-procurement costs experienced by C3 forces generally in each of those years to derive annual estimates of the procurement costs associated with centralized C3I forces.¹¹⁷ The results of these calculations suggested that, over the FY 1983-FY 1991 period, procurement funding for centralized C3I forces totalled \$69 billion. This figure was then divided by \$749 billion, the grand total for FY 1983-FY 1991 procurement funding. The resulting figure, .09, is the proportion of total procurement funding accounted for by centralized C3I costs. These costs were then removed from the various multipliers by reducing each of those multipliers by this same proportion.

The second part of the double-counting problem was to adjust the multipliers to avoid double-counting the procurement costs associated with *strategic C3I forces*. This situation was remedied using essentially the same methodology described above for *centralized C3I forces*. The only differences were that in this case: the FY 1983-FY 1993 military personnel costs of *strategic C3I* rather than *centralized C3I* forces were derived; these military personnel costs were derived by service (rather for DoD as a whole); and, after these totals were multiplied by the historical military personnel-to-procurement cost ratios for C3 forces to derive an estimate of each service's strategic C3I procurement costs, this figure was divided by the FY 1983-FY 1991 procurement funding total for each service's *strategic forces*, rather the DoD-wide grand total for all procurement over this period. The resulting figures, .12 and .04, represent the proportion of FY 1983-FY 1991 procurement funding for each service's strategic forces that was accounted for by C3I costs. These costs were then removed from the Air Force bomber, ICBM and air defense fighter multipliers, and the Navy SSBN/SLBM multiplier by reducing each of these multipliers a second time, by 12 and four percent, respectively.

The new *adjusted* total procurement multipliers for the major components of U.S. strategic forces are as follows:

Air Force

Bombers:	2.2
ICBMs:	1.5
Air Defense Fighters:	3.1

category and the C3I portion of the Strategic Forces mission category were then divided by the total DoD end strength for each year, providing an estimate of the share of active military personnel associated with each of these two C3I elements. Finally, these proportions were multiplied by the total DoD military personnel budget for that year to derive an estimate of the military personnel costs associated with each of these two C3I elements.

¹¹⁷ As described earlier (see footnote 85), it seems reasonable to assume that the ratio of military personnel costs to procurement costs experienced by U.S. *centralized C3I forces* approximates the ratio of military personnel to procurement costs experienced by U.S. *C3 forces generally*.

Navy

SSBNs/SLBMs: 1.2

Applying these ratios to the estimates of the steady-state procurement costs of *major weapon systems*, yielded the following estimates of the *total* annual steady-state procurement costs of the different major components of post-START U.S. strategic forces:

	<u>Force¹¹⁸ Goal</u>	<u>Annual Sustaining Quantity</u>	<u>Unit Proc. Cost</u>	<u>Annual Major Proc. Costs</u>	<u>Multi- plier</u>	<u>Total Ann. Proc. Costs</u>
<i>Bombers:</i>						
B-2	20	.5	\$1,000	\$500	2.2	\$1,100
B-52	66	1.8	\$200	\$360	2.2	\$792
<i>ICBMs:</i>						
MM III	500	28	\$30	\$840	1.5	\$1,260
<i>AD ftrs:</i>						
F-16	208	13	\$20	\$260	3.1	\$806
SSBN/SLBM:	14/336	.5/26	\$1,800/\$40	\$1,940	1.2	\$2,328
Strategic C3I:	NA	NA	NA	NA	NA	\$2,488
Total:						\$8,774

The final step of this analysis was to add together the estimated O&S and procurement costs of the various components of the planned post-START U.S. strategic force structure. The O&S costs for each component were derived by multiplying the projected number of deployed systems¹¹⁹ in each component by their estimated O&S costs (see pp. 19-22). The one exception to this approach was for the B-2 bomber. Since no B-2s were deployed in FY 1990, it was not possible to project future B-2 costs based on FY 1990 actual costs. Instead, it was assumed that B-2 O&S costs would be the same as those for the B-1B bomber.¹²⁰ Combining the above derived estimates of O&S and procurement costs yields the following estimates of the annual steady-state costs of various components of U.S. post-START strategic forces:

¹¹⁸ Bomber and air defense fighter levels are expressed in terms of TAI. ICBM levels include all deployed missiles. The SLBM figures assumes 24 missiles per SSBN (18 x 24 = 432). However, one of these SSBNs will generally be in overhaul at any one time. Thus, the actual number of SLBMs deployed will generally be 418.

¹¹⁹ Planned PAA levels for bombers and air defense fighters and deployed ICBMs and SLBMs.

¹²⁰ This is almost certainly an optimistic assumption, since new weapon systems tend to have higher O&S costs than the weapons they replace. Moreover, such cost growth is especially likely when the new systems are highly complex ones like the B-2.

Summary of Steady-State O&S and Procurement Costs of U.S. Post-START Strategic Forces¹²¹
(in billions of FY 1995 dollars)

	<u>Force Goal¹²²</u>	<u>O&S Costs¹²³</u>	<u>Procurement Costs</u>	<u>Total Costs</u>
<i>Bombers:</i>				
B-2	20	\$0.6	\$1.1	\$1.7
B-52	66	\$1.4	\$0.8	\$2.2
<i>ICBMs:</i>				
MM III	500	\$1.0	\$1.3	\$2.3
<i>AD ftrs:</i>	208	\$0.5	\$0.8	\$1.3
<i>SSBNs/SLBMs:</i>	14/336	\$3.2	\$2.3	\$5.5
<i>Strategic C3I:</i>	NA	\$3.5	\$2.5	\$6.0
Total:	NA	\$10.2	\$8.8	\$19.0

¹²¹ Totals may not add due to rounding.

¹²² Bomber and air defense fighter levels are expressed in terms of TAI. ICBM levels include all deployed missiles. The SLBM figures assumes 24 missiles per SSBN (14 x 24 = 336). However, one of these SSBNs will generally be in overhaul at any one time. Thus, the actual number of SLBMs deployed will generally be 312.

¹²³ The PAA number for bombers (which is used in estimating their O&S costs) is assumed to be 10 percent lower than the figure for TAI cited in the first column (i.e., 18 B-2s and 59 B-52s).