
# The Future of the U.S.-Soviet Nuclear Relationship



## DETAILS

76 pages | 6 x 9 | PAPERBACK
ISBN 978-0-309-04582-7 | DOI 10.17226/1846

## AUTHORS

Committee on International Security and Arms Control, National Academy of Sciences

# The Future of the U.S.-Soviet Nuclear Relationship

Committee on International Security and Arms Control
National Academy of Sciences

NATIONAL ACADEMY PRESS
Washington, D.C. 1991

NOTICE: The members of the committee responsible for this report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by the president of the National Academy of Sciences.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Frank Press is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Robert M. White is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the service of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Samuel O. Thier is president of the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. Functioning in accordance with the general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Frank Press and Dr. Robert M. White are chairman and vice-chairman, respectively, of the National Research Council.

The work that provided the basis for this volume was supported by funding from the Carnegie Corporation of New York and the John D. and Catherine T. MacArthur Foundation.

Library of Congress Catalog Card Number 91-66231
International Standard Book Number 0-309-04582-7
Additional copies of this report are available from: National Academy Press
National Research Council
2101 Constitution Ave., N.W. Washington, D.C. 20418 (202) 334-3313

S445
Printed in the United States of America
**First Printing, August 1991**
**Second Printing, January 1992**

## COMMITTEE ON INTERNATIONAL SECURITY AND ARMS CONTROL

MITCHEL B. WALLERSTEIN, Acting Director, Committee on International Security and Arms Control, National Academy of Sciences, and Deputy Executive Officer, National Research Council

JO L. HUSBANDS, Acting Staff Officer, Committee on International Security and Arms Control, National Academy of Sciences

LA'FAYE LEWIS, Administrative Secretary, Committee on International Security and Arms Control, National Academy of Sciences

# Contents

# Foreword

This study has been prepared by the Committee on International Security and Arms Control (CISAC), which is a standing committee of the National Academy of Sciences. Many of its members have held responsible positions in the government on security issues in the past, and all present members of CISAC are involved in security affairs on at least a part-time basis.

As a standing committee, CISAC's members were not chosen especially for this study. Rather, the committee decided that, considering the drastic changes that have been set in motion since 1985 in the security environment of the United States, an independent reassessment of the future of the U.S.-Soviet nuclear relationship could be of great value.

This report is a consensus document resulting from that study. Rather than developing major new ideas, the study's greatest value lies in the remarkable degree of consensus that the group was able to achieve on a wide array of important security issues. It is testimony to the profound changes that have taken place in the international system in recent years. The study offers a comprehensive synthesis of the major issues facing U.S. nuclear policy over the coming decades. One common factor of the assessment is that U.S. national security can be greatly increased if nuclear forces are substantially reduced, drastically beyond those levels now foreseen in START or that will result from the unilateral withdrawals and reductions contemplated by the Soviet Union and NATO. While individuals within CISAC might have preferred somewhat more aggressive or less aggressive

steps in this direction, the consensus expressed in this report is the result of a remarkably narrow spread in views in this respect.

Dr. Michael May, Director Emeritus of the Lawrence Livermore National Laboratory, directed the study for CISAC. He has been deeply concerned with this topic for many years and has worked on studies touching on different elements of the subject matter treated here under a variety of auspices. The Academy owes him a great debt for his devotion to this project. The committee also wishes to express its profound thanks for the assistance it has received in its work. During the early periods of the study, then CISAC Staff Director Lynn Rusten ably coordinated, modified, and edited the diverse inputs prepared by individual CISAC members. Jo Husbands, the acting CISAC staff officer, has continued this work most successfully. La'Faye Lewis and David Hambric provided administrative support, and Elaine McGarraugh copy edited the manuscript. Some of the supporting material for the study has been prepared by others at the request of the committee. Specifically, George Bing and Roger Speed of Lawrence Livermore National Laboratory (LLNL) have compiled the targeting and vulnerability data relating to the Soviet Union found in Appendix B, and Paul Chrzanowski of LLNL has provided the quantitative analytical work relevant to targeting optimization found in Appendix C.

The report has the unanimous endorsement of all the members of CISAC. It has been reviewed and approved under the traditional review procedures of the National Academy of Sciences.

FRANK PRESS, PRESIDENT
NATIONAL ACADEMY OF SCIENCES

# Executive Summary

The remarkable political changes in the Soviet Union and Eastern Europe call for a fundamental revision of United States nuclear policy, which for the past 45 years has been principally focused on the containment of the Soviet Union. The Soviet Union retains formidable conventional forces, but the Soviet military threat has receded, and the danger of a surprise Soviet conventional attack in Europe has virtually disappeared, given the demise of the Warsaw Pact, the unification of Germany, the ongoing withdrawal of Soviet forces from Central and Eastern Europe, and Soviet preoccupation with internal affairs. Moreover, while the Soviet Union still has an immense nuclear arsenal that could devastate the United States, the likelihood of such an attack, always remote, seems to have diminished even further.

Despite major uncertainties about the outcome of current internal Soviet developments, the reduction of the Soviet military threat to the United States and its allies is likely to continue in the near future. Repression, conflict, or disintegration within the Soviet Union would present immensely difficult political problems for U.S.-Soviet relations. Such developments alone, however, would not restore the NATO-Warsaw Pact confrontation that drove postwar nuclear planning on both sides, justifying immense arsenals and nuclear forces poised for immediate response. The disappearance of that confrontation and the unification of Germany have transformed the security landscape almost irreversibly. And even if the Soviet Union reverts to a cen

trally controlled authoritarian regime, such a government would likely be too preoccupied with internal problems to engage in external aggression. Beyond this, the future Soviet Union, or any successor government with control over its nuclear weapons, may well wish, for reasons of cost, security, and diplomacy, to continue reducing the nuclear arms competition with the United States and to seek some level of cooperative security arrangements with the United States and the new European community.

In the face of these uncertainties, we believe it is possible and desirable to seek a new nuclear policy, with appropriate hedges against unanticipated adverse outcomes. The challenges to the United States lie in developing policies and procedures that would encourage any future Soviet leadership to continue engaging in actions that would reduce military expenditures, increase international stability, and encourage joining with the West in a variety of cooperative ventures.

The reduced Soviet threat and political changes in Eastern Europe have further decreased the already declining European willingness to rely on nuclear weapons for defense. European governments are actively seeking a new organizational framework involving some level of cooperative security, probably including a measure of joint management of nuclear weapons. Joint management would serve to reduce incentives for proliferation and further constrain the role of nuclear weapons to that of ultimate deterrent.

In East Asia the situation is not as clear, and there is more potential for nuclear arms competition and proliferation. Opportunities exist, however, to reduce the risks to regional security. These could extend to cooperation with China on command and control problems, enhanced cooperation on security and safety measures for nuclear weapons, and broadened agreements on verifiable deployment and exercise restraints. Taking advantage of these opportunities will also require careful attention to sustaining United States-Japanese cooperation in security matters.

Conflicts involving major U.S. interests remain possible in many parts of the world. The danger of nuclear proliferation in unstable areas may increase. The increased commercial availability of the advanced technologies supporting nuclear weapons and their delivery systems has now put nuclear weapons technically within reach of a growing number of developing countries, as well as all of the major industrial nations. Successful efforts to control nuclear proliferation will require reducing the political demand for nuclear weapons as well as much more effective efforts to control the supply of the specific technologies.

While defenses against nonnuclear tactical missiles are, under some circumstances, feasible and desirable, United States and Soviet strategic nuclear missiles continue to have an advantage over any defenses thus far considered. This study assumes no strategic antimissile systems beyond the minimal capability permitted by the Antiballistic Missile (ABM) Treaty.

Under these circumstances, some of which are new and some of which represent a continuous evolution over the past several decades, we believe that the security of the United States will rest to a large degree on cooperative measures involving other countries. We believe this is especially true for nuclear weapons. We conclude that the principal objective of U.S. nuclear policy should be to strengthen the emerging political consensus that nuclear weapons should serve no purpose beyond the deterrence of, and possible response to, nuclear attack by others.

In judging future requirements for nuclear weapons, one must avoid both the conclusion that acquiring more weapons is always more "conservative" and the conclusion that reducing the number of weapons is always more "stabilizing."[1] Instead, we seek an appropriate balance between the positive and adverse effects of nuclear weapons in the face of many uncertainties. We recommend, in furtherance of a new nuclear policy, that:

(1) In the agreements that follow the Strategic Arms Reduction Treaty (START), the United States and the Soviet Union should reduce the number of nuclear warheads in their strategic forces to 3,000–4,000 actual war-heads, a reduction of as much as a factor of 3 below anticipated START levels. The remaining strategic forces of both sides should be made more survivable, both by eliminating the most vulnerable forces (in particular MIRVed ICBMs) and by reducing the vulnerability of retained forces. To these ends, agreements should be crafted so that both sides are permitted to develop more survivable, less threatening systems and are discouraged from retaining or building systems that do not meet these criteria. Concurrently, U.S. tactical nuclear forces based in Europe should be reduced by an even larger factor or eliminated entirely in coordination with U.S. allies. Nuclear weapons should also be removed from surface ships.

(2) As world conditions permit, the United States should seek further reductions in the number of nuclear warheads in U.S. and Soviet strategic forces. The nuclear forces of all other nuclear powers should be included in these reductions as well. The appropriate new levels cannot be specified at this time, but it seems reasonable to the committee that U.S. strategic forces could in time be reduced to 1,000–2,000 nuclear warheads, provided that such a multilateral agreement included appropriate levels and verification measures for the other nations that possess nuclear weapons. This step would require successful implementation of our proposed post-START U.S.-Soviet reductions, related confidence-building measures in all the countries involved, and multilateral security cooperation in areas such as conventional force deployments and planning.

(3) As part of any agreements that follow START, the United States should seek to incorporate procedures to actually destroy the nuclear war-heads associated with reduced strategic systems. Initially, either the entire

warhead or preferably the contained fissionable material could be placed in secure monitored storage. As a separate initiative, the United States should seek to negotiate agreements with the Soviet Union to ensure that additional fissionable material would not enter the weapons cycle from new production or the nation's peaceful nuclear program.

(4) The United States should continue to improve the survivability and reliability of the nuclear warning, communication, command, and control system regardless of how many nuclear warheads are retained. Progress in these areas requires improved hardware and software, increased transparency between the United States and the Soviet Union, decreased reliance on destroying time-urgent targets, and assurance that even partially destroyed forces can threaten the minimum set of targets essential for deterrence. Specifically, to improve command and control, the United States should install permissive action links (PALs) or equivalent devices on all sea-based nuclear weapons, including sea-launched ballistic missiles (SLBMs). At the same time, the United States should encourage other nuclear powers to install PALs in all their forces. A continued effort should be made to review and improve these systems and the human and electronic organizations operating them.

(5) With respect to Europe, the United States should continue to support the evolution of cooperative security arrangements. NATO can still play a useful role, but the United States should encourage the creation of a broader European organization, which would not exclude any major regions, for the purpose of achieving more lasting security cooperation, including cooperation in the nuclear field. Such an organization could serve the following purposes:

- improving transparency among the present nuclear states regarding deployments, safety, command and control, and warning systems affecting possible nuclear threats inside and outside Europe;
- reviewing plans for any new nuclear system, upgrade, or deployments, or any increase in the levels of systems, and making recommendations regarding these plans to the appropriate political body;
- preparing to participate in the next reduction negotiations between the United States and the Soviet Union; and, eventually,
- providing for some measure of joint management of the nuclear forces remaining in Europe, including those of Great Britain and France under agreed political auspices.

(6) Sustained U.S.-Japanese cooperation on security is crucial to limit both security threats and nuclear proliferation in East Asia. Accordingly, despite economic rivalries, attention to continuing this cooperation deserves high priority. Beyond this, prospects for regional cooperation in East Asia are more uncertain. The groundwork should be laid now for cooperation in

nuclear matters among concerned countries, including the four major powers in the region (Japan, China, the United States, and the Soviet Union), each of which has independent sources of strength and its own security agenda. The United States should seek cooperative efforts with the powers concerned on:

- security and safety measures,
- command and control, and
- declaration and verification of present deployments and future plans.

(7) The United States should continue to give high priority to efforts to prevent the further Proliferation of nuclear weapons. Emphasis should be given to decreasing the demand or incentives for proliferation as well as to limiting the supply of technology. The United States should take the lead in supporting international efforts to:

- strengthen the existing Nonproliferation Treaty (NPT) regime by augmenting the safeguards required of treaty signatories on their own programs and on the programs of countries to which they export materials and equipment;
- strengthen existing international agreements restricting technology applicable to nuclear weapons programs and related delivery systems and, where necessary, negotiate new ones;
- promote parallel declarations by all nuclear weapon states that they will not use or threaten to use nuclear weapons against nonnuclear weapon states in any circumstances and that their nuclear weapons serve no purpose beyond the deterrence of, or possible response to, the use of nuclear weapons by other nuclear weapon states; and
- support regional arms control efforts aimed at limiting arms races and local security threats.

## NOTE

1. As used in this report in reference to nuclear weapons, the term is restricted to what is commonly referred to as "crisis stability." This designates the condition under which the ability of a nation's forces to deliver "unacceptable" retaliation is not impaired by being struck first by an opponent's forces.

# I

# Introduction: the Changing Political/ Military Environment for U.S. Nuclear Weapons Policy

## THE EMERGING SECURITY POLICY

When Mikhail Gorbachev came to power in the Soviet Union in 1985, he set in motion a dramatic shift in Soviet security policy, which continues 6 years later in spite of severe economic setbacks and the recent rise of substantial opposition to his policies. As officially articulated, the essence of Gorbachev's change was to make the prevention of war the dominant security objective and to make cooperative diplomacy—rather than offensive military capabilities—the dominant means. The unspoken purpose was to relieve the Soviet economy and military establishment of the burden of maintaining a competitive confrontational posture against a coalition of Western industrial democracies with decisively superior economic and technical potential. A peaceful international environment and the maintenance of Soviet security at lower cost were necessary to the success of economic perestroika. These goals required a radically reduced sense of the threat from NATO, the ending of the Afghanistan War, the acceptance of intrusive verification in order to achieve substantial arms reductions, increased trade and investment from the West, and eventually Western economic assistance.

To accomplish these goals the Soviet Union has undertaken a number of actions that have transformed the military situation in central Europe. These include: far-reaching unilateral reductions of Soviet forces in Eastern Europe begun in 1989; further reductions mandated by the Conventional Forces

in Europe (CFE) Treaty signed in November 1990; the scheduled withdrawal of all Soviet forces from Central and Eastern Europe as a result of the revolutions of 1989; and the dissolution of the Warsaw Pact in 1991. Furthermore, the Soviet Union has moved toward restructuring its military forces in a more defensive manner, has withdrawn a large fraction of its forces from the Far East, and has implemented the Intermediate-Range Nuclear Forces (INF) Treaty, which eliminates a class of missiles in which Soviet forces far outnumbered those of NATO, In response, the nature of NATO and Western European defense policy is also undergoing a rapid restructuring.

The profound and largely unexpected shifts of the last 6 years have changed the security landscape in two fundamental ways. First, the dangerous confrontation of NATO and Warsaw Pact forces in the center of Europe has dissolved; the threat to peace in Europe that defined East-West forces for decades has largely disappeared. In its place is a new "zone of peace" hundreds of miles wide that separates Soviet and NATO forces. This means that neither side could mount an aggressive thrust without months of easily visible preparations. It also means that the Central and Eastern European states are left outside of any binding security framework. Second, the Soviet Union has evolved part way toward being accepted as a partner of the West, cooperating in security endeavors on a broad front. Most recently, Soviet cooperation made it possible to form and operate the coalition against Iraq under a United Nations umbrella.

Strong conservative opposition to rapid liberalization has now emerged in the Soviet Union and has succeeded in slowing or reversing a number of policies. This opposition has gained influence by opposing the secession of any of the Soviet republics and urging armed intervention, if necessary, in quelling ethnic conflict. Much of its strength is drawn from the Communist Party and the military (although significant parts of the military are not involved), and since both of these policies involve greater reliance on the armed forces, the influence of the conservative military has grown.

It is difficult to foresee the extent to which the positive developments of the Gorbachev era may be put at risk. The political shape and governance of the Soviet Union during the next decade are an even greater unknown. Regression toward a repressive, centrally controlled dictatorship or fragmentation into many separate republics would clearly interrupt the flow of change that has taken place. Such developments alone, however, would not restore a credible Soviet external threat. The two decisive achievements of 1989–1990—Soviet withdrawal from Eastern Europe and the unification of Germany within the NATO framework—have decisively changed the geopolitical map of Europe in crucial, almost certainly irreversible, ways.

The various possible outcomes in the Soviet Union must be taken into account in examining potential changes in U.S. nuclear policy. The chal

lenges to the United States lie in developing policies and procedures that would encourage any future Soviet leadership to continue engaging in actions that would reduce military expenditures, increase international stability, and encourage joining with the West in a variety of cooperative ventures.

## EUROPE

The framework of security in Europe remains a central strategic concern for the United States and the Soviet Union. Recent months have seen some sobering of earlier hopes for a rapid transition to a new, more cooperative regional political and military order. The dazzling pace of change in 1989 and 1990 has slowed. Fears about instability and authoritarian trends in Soviet domestic politics, the specter of a disintegrating Soviet Union, and the harsh requirements of economic reconstruction now felt throughout Central Europe have become urgent political issues. Nonetheless, there is still a remarkable convergence of European, American, and Soviet interests in the creation of a different, more cooperative European security system. Europe is likely to be the major test bed for post-Cold War security, the region in which a range of new approaches to cooperation and to the control of risk can be developed and refined.

Some of the elements of a new European security order are already visible. Both the United States and the Soviet Union are seen by all states and by each other as key actors in the new system, albeit in changed roles. The Warsaw Pact has now been formally dissolved; all Soviet forces are to be withdrawn by the end of 1994. NATO remains the core European-Atlantic security framework but, after the London Declaration of 1990, with a set of multinational institutions, procedures, and force structures on which to build new patterns of cooperation and transparency with Eastern Europe and the Soviet Union. There will be far fewer standing forces; American deployments in Europe will be cut in half over the next 5 years. The far looser Conference on Security and Cooperation in Europe (CSCE), which encompasses 35 members, has an important menu of confidence-building measures and has also taken initial steps toward new cooperative institutions and procedures for conflict prevention and policy coordination. There are also a number of new supporting multilateral institutions and political initiatives. These range from the emphasis on developing a new European defense identity within both the 12-member European Community and the 9-member Western European Union (WEU)[1] to the revival of old Hapsburg Empire ties in the Pentagonale[2] or the new Baltic regime grouping involving parts of Central and Northern Europe. Last but not least are the thickening skein of far-reaching bilateral guarantees of cooperation and peaceful

settlements, such as those between the united Germany and its Soviet and Polish neighbors, or between the Soviet Union and its former allies.

The evolution of the post-Cold War military and diplomatic balance in Europe clearly means a new, more favorable environment. The smooth road to German unity was reassuring; so too was the acceptance, East and West, of a united Germany's continued NATO membership and the explicit recognition of the legitimate Soviet stake in European stability. Ratification of the CFE treaty will be another major step. So will further actions by many European states—by treaty or unilaterally—to reduce standing forces by at least 50 percent if only to quickly reap the domestic economic benefit. Moreover, the complexities and delays of negotiated arms control in the past have sparked new interest in the use of regular political dialogue to increase coordination and ensure transparency and confidence, whether the subject is force cuts, doctrinal differences, or comparative warning procedures. Most dramatically, Soviet withdrawals from Central and Eastern Europe and American unilateral assurances on the withdrawal of its short-range nuclear forces foreshadow the elimination of all non-European ground-based nuclear forces in the foreseeable future. Pressures may mount against the one ground-based system that is still in prospect—the French Hades short-range nuclear missile scheduled for deployment in the 1990s.

There are still important continuing differences over the scope and the purposes of a new "European defense identity." German Chancellor Kohl and French President Mitterand have proposed one plan—an increasingly powerful WEU that would become part of the new European Political Union in the mid-1990s and in the interim would adopt security policies on its behalf. British proposals, backed explicitly by the Dutch and more indirectly by the United States, reject the merger with the evolving European Community and instead see WEU as the increasingly independent European pillar within a central NATO framework. Both designs reject the rapid expansion of the European framework to include the new democracies of Central Europe, in part because of sensitivity to Soviet security concerns and internal balances. The final choices will have to await the further political, economic, and military evolution of Europe—most especially of the European Community, and the paths of the Soviet Union, Germany, and Central Europe. A totally fragmented Europe seems unlikely, but the probability of the various alternatives is hard to estimate.

For the Soviet Union, the critical questions beyond its national political future will depend on the role it and the new Germany will play in any European security arrangements. Soviet statements stress its aspirations to substantially greater economic and political integration with Europe. Militarily, the Soviet Union wants assurance that it faces no threat of future military confrontation from Europe, particularly from a nuclear or conventionally dominant Germany. Similarly, the Western and Central European

nations seek assurance that Soviet withdrawals will be irreversible and that they will face no new military threat or pressure.

A united Germany, now the strongest economic power in the European Community and increasingly dominant in trade with Central and Eastern Europe, faces different questions. Some external critics charge that a German push for military dominance or for nuclear weapons like those of Britain and France is inevitable. In response, Germans and many others point to the long-standing German commitment to the principles of common security, to popular reluctance to use German forces outside its national territory, and to the iron-clad guarantees given in the unification treaties against production or possession of mass destruction weapons of any kind. At present, all conceivable future governing coalitions define German security in terms of interlinked structures—economic and military, European and Atlantic, Community and pan-European, ties to both the United States and the Soviet Union. Current political and economic tasks, primarily the urgent daily adjustments to unification, leave few financial or political resources in the short run either for Eastern European economic reform or for expanded activity in the Soviet Union.

For the United States, the emerging European security order will mean significant shifts in relations with its NATO allies, especially its proclaimed "strategic partnership" with Germany. The task is to adjust to changing circumstances and emerging European political choices, not all of which are clear or certain. Whatever final choices about a new European security architecture emerge, a critical instrument to achieve new stability and a new European-American relationship will be progress toward a more cooperative Soviet-American nuclear relationship. Most importantly, it would make both Soviet and American publics more willing to accept the new Europe. It would also provide a predictable core element for Europeans seeking new stability and new assurance against nuclear threat as well as a pattern for emulation by, or expansion to, the present and future European nuclear powers, however improbable that now appears.

## EAST ASIA

In the post-World War II era, the United States cast its security interests in East Asia largely in terms of U.S.-Soviet rivalry, but the political and security dynamics of the region have in significant measure stood apart from the East-West divide. Over time, collaborative relations have developed among Japan, China, and the United States, including acceptance by both Tokyo and Beijing of the continued presence of American forces in the region.

Although the pace and scope of the political changes in East Asia are not equivalent to those under way in Europe, major new developments are likely

to emerge that could significantly affect American security interests. The normalization of Sino-Soviet relations has already reduced the level of military confrontation between these two nations, lowering regional tensions in the process. The fault lines of the Cold War remain largely intact in two of the central U.S. security relationships in Asia—the continued military confrontation between the two Koreas and the absence of any meaningful political breakthrough between the Soviet Union and Japan—but the substance and framework of these relations appear likely to change as well. This judgment seems especially true for the Korean peninsula, where the Soviet Union has opted to recognize both Korean states and to diminish its political, economic, and military support of Pyongyang. None of the trends necessarily foreshadows a major erosion of U.S. regional influence, although that is one possible outcome.

The prospects for collective security in East Asia appear much more problematic than in Europe. Although the area has witnessed repeated U.S and Soviet military involvement over the past 40 years, the political complexity of the region and the rapid changes there have not been conducive to effective multilateral security mechanisms. Bilateral arrangements between regional actors and the United States or the Soviet Union or the autonomous exercise of power by states such as China have been the primary sources of security and insecurity. Among the avowed nuclear weapons states, China is the only power whose nuclear activities and plans remain outside any extant alliance or arms control framework. At the same time, some local states have seen more of a threat from their immediate neighbors than they have from geographically remote major powers.

U.S.-Japanese relations face especially important potential changes. U.S. extended deterrence guarantees to Tokyo, although less explicit than those provided to Germany, were central to Japanese security calculations throughout the Cold War. In the past, Tokyo was prepared to accept a subordinate status in the U.S.-Japanese alliance. Now, however, U.S.-Japanese relations are marked by increasingly rancorous disputes over economic and technological competition. Although these developments do not presage a breakdown in the U.S.-Japanese relationship—an outcome that nearly all the states of East Asia would consider an unmitigated disaster—they suggest a more competitive relationship between Washington and Tokyo. But most Japanese continue to emphasize the importance of sustaining the alliance with the United States, in which U.S. nuclear guarantees assume an integral if understated role.

The central challenge for U.S. long-term policy in the Pacific will be to adapt the U.S.-Japanese relationship to these changing circumstances, without calling into question the underlying American commitment to Japan's security. Without such a commitment, Japan could chart a far more inde

pedent political and security course that could create enormous anxieties and pressures for increased defense expenditures throughout East Asia.

The stability of China's political-military directions also seems uncertain. The country's internal leadership crisis of 1989 has had a pronounced effect on Chinese foreign policy. Chinese interest in collaboration with the Western industrial democracies and with its neighbors remains undiminished, but China's capacity to do so appears more questionable. If the Chinese concluded that the prospects for long-term political and economic collaboration with the United States were problematic, their incentives for cooperation on international security and arms control (including restraints on ballistic missile sales) could diminish accordingly. North Korea's efforts to develop a nuclear weapons option are especially worrisome. Dangerously high levels of armaments are already amassed on the Korean peninsula, and a nuclear weapons capability in the North could greatly reduce the inhibitions against comparable efforts by South Korea and Japan. All the major powers will need to vigorously pursue efforts to control the possibility of nuclear proliferation on the peninsula. At the same time, the United States and the Soviet Union should continue to pursue steps to reduce the likelihood of any renewed military crisis.

## OTHER STRATEGIC AREAS

Over 100 conventionally armed conflicts have broken out since World War II, almost all of them in the developing nations. The United States and the Soviet Union have taken an interest in many of these, have become involved in some through aid or through proxies, and have intervened directly in a few. The waning of the Cold War has changed the incentives and inhibitions for U.S. and Soviet interest in regional conflicts. The pattern of assistance, especially arms transfers, from the developed to the developing countries may change as well. The security interactions of the United States, the Soviet Union, and other major powers with various regions of the developing world in this new era will be matters of increasing importance.

In a few areas, there is a genuine risk that nuclear weapons could be introduced into future conflicts. The Middle East is one such area, given Israel's undeclared nuclear arsenal and the apparent interest of other nations in acquiring their own nuclear capabilities. The continuing tensions between India and Pakistan, both near-nuclear states, also pose serious risks. In other areas the risk may be diminishing; for example, Brazil, Argentina, and South Africa all seem to have abandoned or scaled back their earlier nuclear ambitions.

A cooperative relationship among the major powers could contribute to the resolution or management of regional conflicts, or at least could avoid

exacerbating them. The recent Gulf War demonstrated that, when the permanent members of the United Nations Security Council reach agreement, the U.N. can act effectively as a force for collective security.

In addition, groups of nations in several areas of the world have taken or attempted measures to limit regional arms races and attendant insecurities. Some of these, such as the initiatives Brazil and Argentina have taken to address their political-military rivalry, have a nuclear dimension. These cooperative, demand-limiting steps may become an essential ingredient in maintaining regional environments free of the kind of security concerns that in the past led nations to initiate nuclear weapons programs.

In the following chapters, we translate these general observations into more specific conclusions for future nuclear policy. Chapter II considers the main thrust of U.S. nuclear weapons policy in light of the changes just outlined. In Chapter III, we examine prospects for developments in cooperative security arrangements in various parts of the world and assess the status of the efforts to stem nuclear proliferation. We discuss specific nuclear force levels and configurations for the United States in the post-START era in Chapter IV, along with associated arms control measures. In Chapter V, we take up the question of the command and control and operational management of nuclear forces and recommend steps to meet the new situation.

## NOTES

1. The membership of WEU is not identical to that of either NATO or the European Community and includes Great Britain, France, Germany, Belgium, The Netherlands, Luxembourg, Italy, Spain, and Portugal.

2. The original participants included Austria, Czechoslovakia, Hungary, Italy, and Yugoslavia.

# II

# New Objectives for Nuclear Weapons Policy

## INTRODUCTION

Causes for conflict are not going to disappear and neither will the potential for disaster inherent in the existence of nuclear weapons. Given the terrible consequences of modern war and the likely continued presence of nuclear weapons, security considerations should impel the developed countries, particularly the United States and the Soviet Union, toward resolving differences cooperatively despite differences in policies and interests. This is particularly true when the conflicts have a potential nuclear dimension.

We believe that the creation and maintenance of effective cooperative security institutions and arrangements, particularly in the nuclear area, should replace containment of the Soviet Union as the United States' major security goal. This goal is not new. It was introduced in 1945 and has played an understated but significant role in U.S. policy ever since. Placing that goal at the center of policy will require the United States to take a different approach to nuclear deterrence and nuclear deployments. We address these two related matters in turn.

## U.S. DETERRENCE POLICIES

The two primitive fission bombs detonated over Japan caused approximately 150,000 immediate casualties. Since the end of World War II, the

world's stockpile of nuclear weapons has grown to some 50,000 warheads, most of which have greater explosive power than those used on Japan. The use of only a small fraction of today's nuclear weapons would be an unprecedented catastrophe. Over almost the entire postwar period, minimizing the risk of such an event has therefore been a major goal of U.S. policy.

At the same time, the adversarial relationship between the United States and the Soviet Union has led to a U.S. nuclear deterrence policy with the twin, if sometimes conflicting, goals of minimizing the risk of nuclear war and deterring certain classes of conduct by the Soviet Union and, at times, other nations as well. The objectives of deterrence have been the prevention of nuclear attacks on U.S. or allied territories and forces abroad, as well as some kinds of aggression not involving nuclear forces, such as the invasion of Western Europe.

We cannot know the extent to which either nuclear deterrence or the present vast numbers of nuclear weapons have deterred war. The existence of nuclear weapons has certainly added caution to the conduct of U.S.-Soviet relations. The risk of regional conflict escalating into unlimited warfare has constrained the behavior of both countries. Beyond these qualitative observations, we have no way to assess how the number and type of nuclear weapons, their deployment, or the declaratory policy governing their mission have determined the two nations' conduct during the Cold War. The end of the Cold War gives us both incentive and opportunity to examine afresh the objectives of nuclear weapons policy and the mission of nuclear weapons.

The principal U.S. objective remains the prevention of nuclear war, which perhaps alone of all external threats could threaten the continued existence of the United States. Preventing nuclear war means first of all preventing nuclear attack. It also means preventing the occurrence of situations so dangerous that they might lead to the use of nuclear weapons against the United States. In the past, these postulated situations included some massive nonnuclear attacks, and the United States sought to extend nuclear deterrence to prevent them.

Any concept of "extended" deterrence, to deter massive nonnuclear attack on one's own country or its allies, suffers from a basic tension of values. The credibility of a U.S. threat of nuclear retaliation against a nonnuclear attack, however dire its consequences, is impaired if the U.S. homeland would then itself be subject to a nuclear counterstrike (as symbolized by the remark that the United States would not have traded New York for Paris). Therefore, an aggressor planning to initiate a massive non-nuclear attack may or may not be willing to accept the risk of nuclear escalation.

So long as war is possible and nuclear weapons exist, this tension cannot be eliminated; for many years the West decided to live with it. But the

tension could be reduced. Reduced risk of conventional invasion, such as has now occurred in Europe, can considerably diminish the tension, and has in fact already led to a major decrease in the U.S. nuclear presence in Europe. The tension can be further reduced by shrinking the size of the nuclear forces on both sides. Lessening the need for time-urgent steps in major crises, which now also seem less likely, would help as well.

The size and nature of the present nuclear forces were reached on the basis of Cold War conditions that no longer hold. Reducing the forces bilaterally would provide both sides' political and defense establishments with needed confirmation that these conditions have changed. Retaining the forces as they are would convey the opposite message.

We note that, at any level of force, the success of deterrence can never be fully assured. This is one reason for limiting the world's inventory of nuclear weapons, thus limiting the worst case consequences of the complete failure of deterrence. Unfortunately, so long as cities are subject to nuclear attack, either as deliberate targets or through collateral damage, the consequences of failure would still be very large even at the reduced levels discussed in this report. We do not believe that the present world situation will lead to relief from this danger, although we believe the steps recommended here can move us toward such relief.

We also note that retaining nuclear weapons in excess of what is needed to deter the Soviet Union is a liability for other reasons. At a time when both the defense and the overall federal budgets face severe constraints, maintaining excessive numbers of nuclear weapons would come at the expense of improvements in their quality, safety, and survivability. The potential for accidents and diversion, although mainly determined by qualitative factors, nevertheless increases with greater numbers of weapons.

Finally, nuclear weapons require the maintenance of an infrastructure for safety and security involving continuously alert and disciplined personnel, transportation, the control and remediation of the environmental effects of the military fuel cycle, and the replenishment of tritium, all of which are burdens that increase with the size of military nuclear stockpiles.

## NUCLEAR DEPLOYMENTS

In judging future requirements for nuclear weapons, one must avoid both the conclusion that acquiring more weapons is always more "conservative" and the conclusion that reducing the number of weapons is always more "stabilizing." Instead, we seek an appropriate balance between the positive and adverse effects of nuclear weapons in the face of many uncertainties. A departure from that balance in the direction of excessive nuclear weapons would increase the financial and environmental burdens and could even

increase the likelihood of nuclear war. On the other hand, reducing nuclear weapons without appropriate attention to survivability could lead to dangerous instability in the event of a crisis.

Our assessment of the optimal balance in the post-Cold War era leads us to conclude that numbers of weapons much below present stockpiles could provide adequate strategic deterrence. The extent of the reductions, however, cannot be rigorously derived for several reasons:

- The international security framework under which nuclear weapons will exist cannot be predicted, although alternative developments and cooperative security arrangements can be identified.
- The fundamental tension between "deterrence" and "credible use" can be reduced but cannot be eliminated. Thus a sharp delineation between what hostile conduct is to be deterred by nuclear weapons and what conduct will be unaffected is unlikely to emerge.
- Deterrence describes a state of mind of national leaders, not a more concrete reality. Thus a quantitative basis for specific "requirements" of nuclear forces to support specified deterrent missions cannot be established.

With these caveats, we conclude that both the Soviet Union and the United States can be more secure with fewer, more survivable, nuclear systems.

At the same time, smaller deployments of nuclear weapons must remain secure from attack, as must the warning, communication, and command and control systems that are needed to operate them. Without such survivability, reduced deployments could contribute to instability rather than to deterrence. Furthermore, the United States cannot gain its security at the expense of increased insecurity for other nations, in particular the Soviet Union. U.S. nuclear forces of all classes should be designed for maximum survivability and the United States should not attempt to lessen the ability of the Soviet Union to develop survivable forces. The transition from the current large arsenals to smaller forces, either through independent action or negotiated arms control, must be managed to preserve, and where possible increase, the survivability of nuclear forces throughout the process.

The minimum number of nuclear weapons needed to deter a nuclear attack depends on the country to be deterred and the circumstances under which deterrence is to be effective. The number needed to deter a nuclear attack on the United States from Great Britain or France is zero. This may become the case with the Soviet Union. We are not there yet. For our work in this report, rather than attempt to prescribe the minimum number of weapons needed to deter at various stages between the Cold War and some future era, we describe cuts that in our judgment would leave ample forces to cover any likely target for nuclear weapons and at the same time would

be politically feasible under certain likely specified future situations. At each stage, we assume that overall parity between the United States and the Soviet Union would be maintained, if only for the sake of political stability, although parity among the individual components of the force (such as submarines or mobile missiles) would not be necessary.

These deterrence policies would continue the dependence we have had on offense-dominating defense, that is, on "offense-dominated stability." In principle, there could be "defense-dominated stability" if technology permitted nations subject to nuclear attack to prevent the arrival of nuclear weapons through adequate defenses. This is not the place to discuss critically the long-range technical prospects for converting the current offense dominance to a defense-dominated world or to examine whether a transition to such a world could be executed stably. The advent of nuclear weapons has strongly tilted the traditional offense-defense competition in favor of the offense since each delivered nuclear weapon possesses such great explosive power. This fact, combined with the wide variety of means to deliver nuclear weapons and to ensure that they reach their targets, has led to the present situation. No technical developments are expected to upset this condition in the foreseeable future.

# III

# Prospects for Cooperative Security Arrangements and Nuclear Nonproliferation

## EUROPE

We expect two key factors to control the evolution of new European security arrangements: (1) the continued improvement of U.S.-Soviet nuclear cooperation and (2) the roles assumed by the new united Germany and the two European nuclear powers, France and Great Britain. Both the United States and the Soviet Union will have to agree that each other's participation in Europe is critical to successful cooperation in nuclear matters. With such agreement, they can then decide cooperatively with the Europeans on new levels of dialogue and transparency extending well beyond formal arms control negotiations. Without it, they will neither attract the cooperative involvement of the major European players nor successfully counter domestic critics of the less dominant role they will play in Europe in the future. The theme must be cooperative security in, with, and for Europe, not U.S.-Soviet condominium.

The U.S. role should be to help facilitate this transition, both to greater reliance on a European defense organization and to what we hope would be the cooperative reconfiguration of all nuclear forces—American, Soviet, and European—at sharply reduced levels. Toward that end, there are a number of steps that could greatly enhance nuclear cooperation in Europe.

- *Cooperation toward a minimum level of strategic and tactical forces.* This includes the elimination of all U.S. and Soviet ground-based tactical nuclear systems and, if possible, the French Hades as well. Decisions about basing for other U.S. systems would have to be made jointly.
- *Support for NATO as the link in the transition to cooperative management.* Whatever happens, NATO is likely to be the primary link for the United States in its new relations with the emerging European security community.
- *Support for development of cooperative security in Europe*. The new arrangements will evolve in stages, and participation may initially be more narrow than the United States prefers. The institutions could include the CSCE and other regional groups that can provide frameworks for further specialized discussions. A first step could be declaratory policies to provide assurance or reassurance of cooperative intentions and goals. Next could come cooperation to improve transparency among the present nuclear states regarding conditions of deployment, safety, command and control, and warning systems affecting possible nuclear threats inside and outside Europe. Over time, these could foster steps toward mutually responsive planning and the development of constraints on deployments, modernization, and use.
- *Due recognition of all European security interests*. Even if the Soviet Union is not directly involved in many U.S.-European and intra-European decisions, it is essential that the Soviet Union not be made, or made to feel, a marginal participant in European security issues. The same holds true for the nations of Central and Eastern Europe, where security cooperation may be expected to lag behind economic and political ties to the rest of Europe.

## ASIA

The balance of power in East Asia has clearly entered a period of substantial flux. The task at hand, therefore, is to devise security understandings that will permit all the principal actors to pursue their national goals without stimulating an intraregional arms competition that could destabilize East Asia for years to come. These new arrangements need to assure that no single state or new coalition of states assumes a position of political or military predominance within the region. A serious, sustained effort must also be made to avoid any prospect of nuclear proliferation on the Korean peninsula. If Japan or China moved into a vacuum created by the drawing down of Soviet and American power, or if nuclear proliferation did take place in Korea, regional security would suffer. Thus, the United States and the Soviet Union, in conjunction with major actors within the region, have a stake in helping to define collaborative security and arms control arrange

ments, including in the nuclear area, that imply neither condominium nor the abdication of responsibilities for peace and stability.

Such arrangements would have to be useful and politically attractive to the United States, to the Soviet Union, to Japan, and to China. Three possible examples are:

- *Cooperation on command and control problems*. This has already started between the United States and the Soviet Union, although it could be expanded significantly. Extending such cooperation to China as it becomes politically possible would help ensure that its nuclear operations are carried out without causing undesired alarm, especially if there are internal struggles in China. Possible specific measures include hotlines, crises centers, and technical assistance in keeping track of the status of nuclear systems.
- *Cooperation on security and safety measures*. This kind of cooperation is needed between the United States and the Soviet Union, but is still at the talking stage. Much can be shared without going into the classified design of the nuclear weapons, even though some important safety features do depend on design.
- *Agreement on verified deployment and exercise restraints*. The aim here would be increased transparency in both nuclear and conventional deployments in the region. The main thrust may well be conventional, but a nuclear component should be included so long as there are nuclear forces in the region. The Soviet Union could improve the transparency of its activities and should encourage the same on the part of North Korea as well. It is in U.S. and Soviet interests to have regional participation in agreements on restraints and transparency be as broad as possible. The nuclear dimension provides an entry into this form of cooperation that may be politically palatable.

Japan and other countries concerned with nuclear deployments should be a party to the arrangements involving the United States, the Soviet Union, and China. Japan should generally share in arrangements such as confidence-building measures, transparency agreements, communication agreements among naval headquarters, and intelligence sharing. In some of these areas, U.S.-Japanese relations have been close, while in others, Japan has sometimes been left out.

## NUCLEAR NONPROLIFERATION

As the U.S.-Soviet confrontation fades, the relative significance of the dangers associated with further nuclear weapons proliferation may increase. Therefore, the new environment should also induce the international community to undertake further cooperative measures to prevent proliferation and to reduce its consequences.

Although nuclear proliferation has in fact progressed much more slowly than consistently predicted over the past 30 years, it has now become easier, from a purely technical perspective, for states to develop nuclear weapons. The technology has become more widely understood, and associated non-nuclear components have become more readily available in international commerce. Therefore, the future of proliferation depends primarily on political, military, and economic considerations, not on technical factors, and will be substantially influenced by the evolution of U.S.-Soviet relations and the development of institutions based on cooperative security. The key is to reduce security incentives for nonnuclear weapons states to seek such weapons.

Today, there are three states—India, Israel, and Pakistan—with undeclared nuclear weapons capabilities,[1] and a few other countries that may be interested in developing such capabilities. The recent Persian Gulf conflict brought the nuclear risks in the Middle East into sharp focus. The greatest uncertainties concern North Korea, which remains unusually isolated from the rest of the world.

The nuclear proliferation problem would be seriously complicated if the Soviet Union disintegrated into a large number of separate, potentially hostile entities, even though Soviet nuclear weapons would probably all remain under the control and custody of the Russian Republic. Even if such new states—with nuclear weapons or weapons-related facilities, together with personnel with previous experience in the Soviet nuclear program—eschewed development of independent nuclear capabilities, they might be tempted to export nuclear materials, equipment, or know-how. In their initial nationalist fervor, some states might also wish to leave the nuclear option open and eventually could seek to develop their own nuclear capability.

There have also been favorable developments recently, with other countries, including Argentina, Brazil, and South Africa, apparently abandoning their previous pursuit of nuclear weapons. The case of South Africa, which may already have an undeclared nuclear weapons capability, is particularly significant. Its announced decision to join the Nonproliferation Treaty (NPT) would require it to destroy any weapons it may have and to reincorporate the contained fissionable material into its inventory of fissionable material for peaceful purposes monitored by the International Atomic Energy Agency (IAEA). In addition, the newly unified Germany, which like a number of other advanced countries could easily develop nuclear weapons, has unequivocally renounced the right to develop nuclear weapons in the future.

In these circumstances, substantial reductions in U.S. and Soviet nuclear arsenals, especially if coupled with progress toward an international collective security regime, could contribute to maintaining and strengthening the existing nonproliferation regime. Major reductions in strategic and tactical nuclear weapons would go a long way toward meeting the obligation in

Article VI of the NPT for nuclear weapons states to end the nuclear arms race. They would help answer the charge that the nuclear powers are obtaining unilateral advantage from an inherently discriminatory nonproliferation regime.

Most of the strategic and political influence associated with having nuclear weapons does not depend much on the number of weapons once that number climbs above several hundred reliable, deliverable, survivable weapons. What probably matters more is a minimum deterrent and membership in the nuclear "club." Thus, the political context of the effort to stem proliferation could change as the situation evolves from a tense bilateral confrontation to a more politically nuanced, and also more treacherous, multipolar situation. In this new context, the nuclear forces of China, France, and the United Kingdom might appear more important relative to those of the United States and the Soviet Union. It might not be effective to call for disarmament or arms reductions by citing the U.S.-Soviet example since that example could seem less relevant. Any further nuclear proliferation, especially to less stable regimes, could thus enhance both the importance of existing nuclear status and active efforts to manage the danger.

Three specific types of nonproliferation measures deserve attention:

- *Controlling sensitive exports* to states outside the NPT regime or to those believed to be violating its provisions. A cooperative security regime could greatly facilitate the implementation of even more restrictive measures, including severe restrictions on the export of high-technology systems and components suitable for the delivery of nuclear weapons.
- *Strengthening the safeguard requirements of the NPT*. One measure, for which there was an apparent consensus at the NPT Review Conference in mid-1990, would be the extension of existing safeguard provisions to cover "suspect" nuclear facilities as well as the declared facilities currently inspected. Another measure, for which there was also strong support, would tighten export controls by requiring all NPT members to restrict exports of nuclear equipment and materials to nonnuclear weapons states that are willing to accept safeguards on *all* of their nuclear facilities and materials ("full-scope" safeguards). At present, while nonnuclear weapons states that are NPT members are already required under the treaty to have "full-scope" safeguards, the only treaty condition on exports by treaty members to nonmember states (which obviously have no inherent safeguard obligations under the treaty) is that the exporter require that the actual exported materials or equipment be safeguarded. These new measures need not involve amending the treaty.
- Promoting *parallel declarations by all nuclear weapons states that they will not use or threaten to use nuclear weapons against nonnuclear weapon states* in any circumstances and that their nuclear weapons serve

no purpose beyond the deterrence of, and possible response to, the use of nuclear weapons by other nuclear weapon states. Only such constraints can maintain and strengthen the political consensus against the acquisition of nuclear weapons.

These are all "supply side" arguments, sponsored or undertaken by potential suppliers of nuclear technology and materials, and designed to limit the availability of supplies or to reduce the incentives for procuring them. Equally or more important are "demand side" agreements, undertaken by some or all nonnuclear states in order to bolster the nonproliferation regime. These agreements may be purely nuclear or contain broader regional arms control arrangements. To be effective and durable they must be solidly grounded in the local political framework. An adequate discussion of such agreements is beyond the scope of this report, but we wish to point out their increasing relevance to U.S. nuclear weapons policy.

## NOTE

1. Most experts agree that Israel has produced a small number of nuclear weapons. India exploded a nuclear device in 1974, but it is not certain that the country has ever produced nuclear weapons. Pakistan is generally considered to possess all the necessary elements to produce nuclear weapons, but experts do not agree on whether it has a nuclear device.

# IV

# Nuclear Forces

## INTRODUCTION

In this chapter, we discuss the quantitative and qualitative implications for U.S. nuclear forces of the changes and opportunities discussed in previous chapters. Given the present uncertain state of the world, the possible roles of nuclear forces in it, and the opportunities for nuclear cooperation, what are the desirable numerical levels and technical characteristics of future U.S. nuclear forces, and what are desirable arms control agreements? In the next five sections we discuss the implications for: (1) central strategic nuclear forces, (2) nuclear forces in Europe, (3) other nuclear forces, (4) nuclear materials, and (5) a nuclear test ban.

## CENTRAL STRATEGIC NUCLEAR FORCES

The numbers, structure, and characteristics of the current U.S. nuclear forces (see Appendix A) reflect choices that were made under Cold War conditions. Given the major changes the committee now anticipates in the post-Cold War world, we should expect to find new optima in the effort to provide the nuclear deterrent deemed necessary at the least cost and risk. In the process, however, we need to recognize that we are not starting with a clean slate. Considering the enormous investment in nuclear systems, the transition to more survivable systems should be managed by selectively

removing less survivable ones, while continuing to invest as necessary in the forces retained.

One further factor should affect future nuclear weapons choices: there is little need to match specific characteristics of Soviet nuclear deployments. Deterrence of nuclear war is not impaired if the nuclear deterrent systems of the United States and its adversaries are substantially different in type and deployment, so long as they are survivable. Different nations may best meet their nuclear systems' increasing need for survivability in diverse ways.

In this discussion, we turn first to the question of estimating the appropriate numbers of central strategic nuclear systems and then to sample survivable force structures.

## Numbers of Targets and Weapons

Since the beginning of the Cold War, the United States acquired strategic systems on the basis of political assessments of what was necessary to deter a nuclear war with the Soviet Union under the worst case scenarios perceived by the United States at the time. The number of weapons systems procured resulted more from the perceived need for redundancy as a hedge against uncertainties than from the number of targets for these weapons. Providing the most effective employment of the available weapons inventory in terms of some generally stated national guidance set the plans for target coverage. Except in some special cases, the number of targets did not determine numerical weapons requirements.

Under the existing general guidance and given the existing weapons inventory, the U.S. list of targets to be threatened has included: (1) most Soviet nuclear and conventional forces against which nuclear weapons could be thought effective; (2) the industrial and logistical base for supporting and reconstituting these forces, which includes most of the Soviet urban-industrial complex; and (3) the significant targetable command and control and leadership elements. One official study put the number of targets in the 5,000–9,000 range.[1] Unofficial estimates of what a more limited but adequate target list might be have led to numbers in the 2,000–3,000 range.[2] Even within this latter set, there are significant diminishing returns (that is, substantially less important targets would be hit) as the number of targets increases within each category.

Given that not all weapons are reliable or available at all times, that not all delivery systems will survive attack or reach their target, and that some weapons are devoted to suppressing air defenses, there must be significantly more weapons than there are targets to be struck. The ratio of weapons-to-target is highest if it is derived using the assumption that the essential nuclear missions would have to be carried out from a peacetime, nonalert posture, after U.S. forces had suffered a full-scale Soviet nuclear attack. In

such a case, survivability and reliability would be lower than if the United States had acted when it received warning of an attack. Using this assumption, the overall ratio of weapons to targets (in actuality there are different ratios for different nuclear missions) has been estimated to lie in the 3–5:1 range.[3] With this ratio, covering a list of 3,000m targets would require a total of 9,000–15,000 strategic nuclear weapon systems.

Clearly, if the conditions for use are less adverse than assumed, the United States could strike far more targets in the Soviet Union. In particular, more nuclear targets could be struck. While the United States has not had a disarming first-strike capability at any time in the last 25 years, it could come much closer to disarming the Soviet Union if, for instance, Soviet submarines were in port, Soviet bombers were not on alert, and the Soviet leadership were vulnerable. In that case, the United States could anticipate, albeit not with great confidence, that any Soviet retaliatory strike would be weakened and any damage to the United States would be limited. The same would hold true for a Soviet first strike against the United States. The possession of large, partially vulnerable forces on both sides has thus created an unknowable potential for instability in crises fueled by the perceived value of striking first rather than in retaliation. This potentially disastrous instability may be partially alleviated, though probably never fully remedied, by lower numbers, in conjunction with more survivable systems and better operating procedures.

The current numbers of central strategic nuclear weapons have seemed excessive for some time. The START agreement will lower them by about 25 percent (see Appendix A). These numbers will still be very high for a purely deterrent posture. Given the prospects for changed conditions outlined previously, significant further cuts should be possible. These additional cuts, for the reasons noted earlier, would alleviate the risks and costs of maintaining forces excessive to need at no cost in lessened deterrence. The principal task facing planners will be to work out the steps needed for a secure transition.

In what follows, we consider two possible lower levels of strategic weaponry. We believe each level would be stably associated with a possible future set of political and technological circumstances, which we briefly outline.

## A Next Step After START

Negotiations for the force levels described in this section could begin right after the signing of START, predicated on the following circumstances:

- U.S. and Soviet experience carrying out the provisions of START is favorable during the succeeding negotiations. Transparency and coopera

tion in verification and in communicating deployment plans in both countries continue to improve.

- The Soviet Union maintains its forces within CFE limits.
- Both countries begin to posture their nuclear forces to make the remaining forces more survivable, so that nuclear weapons systems worth targeting decrease both in absolute numbers and as a fraction of the whole.
- Neither country deploys a strategic defense system. Development and test activities are carried out subject to agreement, whether the current one embodied in the Antiballistic Missile (ABM) Treaty or some agreed modification.
- Neither China, France, nor Great Britain builds up nuclear forces beyond current levels. These are currently below 1,000 in France and Great Britain. Chinese force levels are not known for certain, but could be of the same order of magnitude. No other major power (for example, Germany or Japan) acquires nuclear weapons.

These circumstances, taken together, describe a situation in which the United States and the Soviet Union could bilaterally reduce their nuclear forces well below START levels. It is of course no more possible to derive uniquely the specific number of weapons systems needed for deterrence under the evolving political climate described than it was possible to derive the pre-START levels from the then-existing situation. Despite this, whatever next step is taken would have to specify some reduced overall force level.

The desired level will depend in part on the nature of the remaining forces. In what follows, we assume that forces on both sides will become more survivable and less highly MIR Ved (see below). Under that assumption, the targets for the reduced forces would not include alert deployed nuclear forces such as silos or mobile missiles, since these would cost more of the attackers' remaining weapons than they would be worth. In addition, we include no targets outside the Soviet Union; deterring China or possibly other nuclear powers may be taken as a lesser, included case. We further assume that the remaining categories of targets (nuclear submarine and air bases, major conventional military bases and command and control centers, war-supporting industries) would be covered up to approximately 60–70 percent of total capability.

These assumptions lead to a total of 1,000–1,600 targets, depending on the mix of yields of the nuclear systems, distributed as shown in Table 1. Lower yields might require allocating more warheads to a given target (a target may thus represent more than one aimpoint), but could mean significantly less collateral damage and fewer total casualties.

The discussion and "saturation" curves in Appendix B show how these estimates were made. Clearly there is considerable leeway in choosing cutoff points in each target category.

TABLE 1 Sample Target Allocation

| Target Category | Aimpoint Range |
|---|---|
| War-supporting industry and energy sources | 300–600 |
| Conventional forces | 400–600 |
| Naval bases, airfields, etc. | 200–300 |
| Strategic command and control | 100 |
| Total | 1,000–1,600 |

The weapons-to-target ratio under the same assumptions could decrease to about 3:1 while providing much the same assurance of retaliation as today.[4] The total number of strategic warheads under these assumptions would thus be 3,000–4,000, a reduction by a factor of 2 to 3 below the START limits. At these levels, despite the reductions, little would change in the (very uncertain and very high) casualties a nuclear war would cause, although there would be less worldwide environmental damage and fewer casualties outside cities. This is because we have not changed the assumption of targeting war-supporting industries, which are located in and near cities.[5] There is little question that a nuclear exchange between the United States and the Soviet Union would remain catastrophic. We see no escape from that circumstance even at much lower levels of weapons unless cities, and the industries and leadership targets located in and near them, are avoided altogether.

## A Lower Level for Later

At some later time, if the following circumstances apply, even greater reductions would be possible.

- Continued favorable experience in U.S.-Soviet nuclear relations leads to a high degree of mutual confidence on both sides regarding each other's nuclear development and deployment capabilities.
- The United States and the Soviet Union are engaged in security cooperation in regions of mutual interest, such as Europe and East Asia. Neither is posing a military threat to the other, and the conventional military dispositions, capabilities, and plans are again well enough understood on both sides to reduce the likelihood of surprises to a minimum. Maintaining such security cooperation would provide the positive incentive necessary to lead the security establishments in both countries to further arms reductions.
- Remaining nuclear systems attain a higher degree of survivability, availability, and reliability than they have now. Countermeasures on both sides are relatively well understood.

- Confidence-building measures that further enhance the assurance of warning of deviations from this situation are in place.
- Efforts in the strategic defense field, to the extent they are carried out at all, are carried out cooperatively or sufficiently transparently to obviate the possibility of surprises.
- The other nuclear powers accept appropriate strategic arms limitations.
- The nuclear nonproliferation regime is preserved or enhanced.

Under such circumstances, it is difficult to posit any particular target set or number of weapons as most appropriate. There might be less need to deter the Soviet Union than some other country. Weapons systems might not be pretargeted at all. If the Soviet Union remains the main country to be deterred, if only because it remains the main military power outside the United States and its future remains uncertain, a minimum number target set may be put together by adding: (1) the most important 200–300 defense-related industrial targets, which comprise over half of the total Soviet industrial capacity, both defense-related and other; (2) the main airfields, naval bases, and other force projection targets, totaling about 200–300; and (3) a small reserve. This adds up to about 500–800 targets. An optimistic view by historical standards of survivability, availability, reliability, and similar factors leads to a weapons-to-target ratio of 2–3: 1. Achieving this ratio would require a continued qualitative development program. Together, these assumptions lead to a total number of strategic weapons of about 1,000–2,000.[6] Clearly this is a highly uncertain number.

We have postulated, as noted above, that neither side deploys effective missile defenses. While defenses against nonnuclear tactical missiles are under some circumstances feasible and desirable, U.S. and Soviet strategic nuclear missiles continue to have an advantage over any defenses thus far considered. If partial, possibly tactical, defenses are acquired, and if their sophistication increases, a vigorous research and development (R&D) program will be needed to provide the basis for confidence in the continuing ability of the central strategic forces to penetrate against possibly poorly known, unacknowledged partial defenses. It might become impossible to maintain this confidence at the postulated 2–3:1 ratio of weapons-to-targets mentioned above. The issue, however, is beyond the scope of this report.

We note that the number of strategic nuclear weapons systems can be drastically reduced without going to a purely counter-city targeting doctrine, one consequence of which might be that nothing short of a nuclear attack on U.S. cities could be deterred. In the end, if the day comes that the relationship between the United States and the Soviet Union is like the relationship between the United States and its Western European allies, no nuclear weapons will be needed to deter the Soviet Union, whether aimed at its cities or at its military capabilities. Until then, a general targeting doc

trine threatening both can be retained and still accommodate the type of large-scale reductions described here.

The eventual number of systems as a function of time and circumstances is less important than ensuring that the process of managing that number is cooperative to the extent possible and accompanied by efforts to improve the stability of the deterrent situation through improvements in survivability and operational practices. The two ranges presented—about 3,000–4,000 and 1,000–2,000—illustrate what might be achieved given appropriate political and technical developments.

## Sample Survivable Force Structures

As much as the state of the art and budget strictures permit, the structure of strategic forces at these reduced force levels must be optimized for survivability, availability, and reliability. There is a synergistic relationship between survivability and reductions, with each facilitating the other. Thus, for example, when the number of weapons that can promptly destroy detectable systems goes down, the survivability of such systems is increased. When the survivability of deterrent forces is increased, for example by making them harder to find, the attractiveness of the opposing systems designed to kill such forces is reduced, and the systems are more easily limited. This kind of trade-off is part of the value of START for both sides.

The survivability of specific forces changes with time and the state of technology. A combination of different forces, with different strengths and vulnerabilities, can be less vulnerable than any single force element. This is the case for the triad of U.S. nuclear forces of land-based intercontinental ballistic missiles (ICBMs), aircraft, and submarine-based missiles (SLBMs). We propose that such a mix of forces be retained even at the lowest force level suggested, since survivability becomes even more important as levels of forces are reduced.

For some time, quiet submarines have appeared to offer the most assured and lasting degree of survivability when they are operating at sea. Most informed scientists believe that, given an adequate R&D program, this situation can continue, even though signals that lie considerably below backgrounds, such as the surface effects of internal waves generated by moving submarines, may become increasingly detectable as both sensors and rapid computing capabilities improve. At present, most of the survivable fraction of U.S. strategic forces now resides on submarines, and the committee has assumed that this would continue.

Present-day U.S. submarines are not ideally configured for much reduced forces and target sets, however. Each is large, carrying up to 24 missiles, and each missile now carries up to eight warheads. Five such submarines thus could carry an entire 1,000-warhead force. If carried this way, these

warheads would have to be delivered eight at a time, with the eight falling within a fairly restricted area.

At the same time, the submarines represent a significant investment and will not be replaced soon. If submarines are to carry half of the force—a reasonable assumption for planners in the absence of a sure understanding of future vulnerabilities—it will be desirable to reduce gradually the number of warheads on each missile until eventually each carries a single wahead.

For instance, if 1,800 warheads of a force of 3,000 were to be carried on the currently procured 18 Trident submarines, the 100 warheads per submarine would be distributed over 24 missiles, for a little over four warheads per missile. If 600 warheads of a force of 1,000 were to be carried by the same number of Trident submarines, there would be a little over 30 war-heads per submarine or a little over one warhead per missile. This might be considered an unnecessarily expensive force per warhead, although the total cost would be less than that of the current force. On the other hand, the de-MIR Ved payload would increase range, footprint, and operating area, all of which would enhance the survivability and operational flexibility of the force.

Besides submarines, the current strategic forces include fixed, land-based ICBMs and strategic aircraft. The land-based ICBMs would presumably continue to be vulnerable to a first strike and should therefore be de-MIR Ved so as to remove incentives for such an attack. Their relatively low operating cost would keep them economically competitive even if de-MIR Ved. They are not as survivable as submarines, but they can extract a cost in weapons that an attacker would have to use against them exceeding, or with some development, at least comparable to, the destruction achieved. To maintain a mix of systems with different vulnerabilities and other characteristics, we recommend that some fixed land-based ICBMs be retained even at the lowest force levels discussed. The present 1,000+ ICBMs could go down to 500 de-MIR Ved missiles if the overall level is 3,000–4,000 war-heads, and down to 200–300 if the overall level is 1,000–2,000 warheads.

As an alternative to the current basing in hardened silos, the United States could deploy either mobile land-based missiles or a multiple aimpoint system, in which many empty silos are constructed for each missile. Both systems have the advantage of extracting a greater cost from an attacker. A well-designed mobile system could require 5–10 attacking warheads to assure the destruction of a single missile. A well-designed multiple aimpoint system could exceed that number and maintain that advantage against a surprise attack without any tactical warning, as long as an attacker remains uncertain about the position of the actual missiles.

This is not the place to evaluate the relative merits of these systems. They are more costly than the current silo basing and less well understood than the submarines, both of which, in addition, have already been pro

cured. While we believe that R&D on these systems should continue as a hedge against developing vulnerabilities in existing systems, we would not recommend their deployment under the circumstances we have projected.

Dual-capable aircraft, both long-range, U.S.-based and shorter-range sea and forward land-based, offer different characteristics from missiles: they can be recalled over a period of time after launch, are less detectable at launch than missiles, and under some circumstances may be able to carry out a variety of missions. On the other hand, they can be destroyed by air defenses and are vulnerable unless kept on short enough alert that they can take off on receiving tactical warning. Currently about 30 percent of the force is kept on tactical alert, which could be increased to 50 percent or more if needed. Aircraft involve other inefficiencies, in particular the need to allocate weapons to destroy enemy air defenses, although these drawbacks may be minimized by stealth techniques.

The flexibility gained by including aircraft in the strategic forces is thus accompanied by added technical risk and cost. Aircraft will probably continue to be included for their flexibility, as well as to complicate an attacker's plan, and as a hedge against weaknesses in the missile force. U.S.-based intercontinental bombers, whether they deliver bombs or cruise missiles, could be allocated 20–30 percent of the warheads at both the contemplated levels.

A comparable Soviet force optimization process might emphasize mobile ICBMs as the primary deterrent, with lesser dependence on SLBMs and aircraft. The Soviet Union would have to move away from its highly MIRVed silo-based ICBMs to retain a highly survivable force at reduced levels. Assuming they do, given the technologies now on the horizon, neither force would pose a serious threat to the other, except possibly through the vulnerability of their command systems. In particular, the primary components of the two forces, mobile Soviet ICBMs and U.S. SLBMs, would not threaten each other at all, since each is essentially invulnerable under current conditions.

## NUCLEAR WEAPONS IN EUROPE

At the present time, several thousand U.S. nuclear weapons assigned to NATO remain in Europe. These are now air-delivered weapons, short-range missile warheads, and nuclear artillery shells. They are the remainder of a much larger deployment of tactical nuclear weapons in Europe intended to deter or respond to a nuclear or, if necessary, conventional Warsaw Pact attack on NATO.

This mission has now been largely overtaken by the changes in Europe. The current NATO Strategy Review, building on President Bush's description of nuclear weapons as "truly weapons of last resort," is likely to call

for a U.S. nuclear presence in Europe of fewer than 1,000 air-delivered nuclear weapon systems and no short-range ground-based nuclear systems. Implementing this step is presumably contingent on the almost certain withdrawal of Soviet short-range nuclear systems before or as the Soviet ground and air forces withdraw from Central and Eastern Europe.

Once these withdrawals are completed, the Soviet nuclear forces closest to Europe will be those in the Western military district of the Soviet Union. The INF Treaty ban on ground-based missiles in the 500–5,000-kilometer range, which applies to Soviet territory, means that the only Soviet missiles to threaten Europe will be those limited by START. Evidence suggests that the Soviet military also wishes to retain the option of air-delivered weapons, but under negotiated restrictions on the number of dual-capable aircraft, including naval air, in Europe.

Under these circumstances, and more generally given a political framework along the lines discussed above as part of the committee's proposed next step after START, we believe the level being considered by the NATO Strategy Review is appropriate and compatible with our recommended policy of nuclear cooperation. The main purposes of American nuclear forces in Europe are to deny incentives for nuclear proliferation and to help provide a secure transition to whatever new nuclear configuration the European powers and security organizations adopt. The eventual U.S. nuclear deployment in Europe needed for these purposes will depend on future events and decisions that cannot be forecast with confidence. This is good reason not to reduce the U.S. nuclear presence in Europe to zero now. It may go to zero later, depending principally on the contribution that such a reduction would make to supporting European cooperation in security matters.

There are two other nuclear forces to be considered in Europe. By the end of the decade British nuclear forces are slated to be increased to around 500 SLBM warheads based on three or perhaps four new submarines. Present plans also foresee replacement of their only other significant nuclear system, the British air-delivered gravity bombs, with a smaller number of bombs and air-to-surface missiles, to be acquired from the United States or produced jointly with France. The eventual total will be under 1,000 weapons, and perhaps considerably less than that, given uncertainties about fiscal constraints, British political developments, possible future arms control, and intra-European cooperation agreements.

France plans to increase the number of its strategic nuclear warheads to around 700 over the next decade, largely through modernization of the submarine-based force. There are pressures on the government to retire the land-based strategic missiles, to substantially cut (perhaps to 60–80) or even eliminate the new ground-based short-to-intermediate-range surface-to-surface missile Hades, and to invest in a new air-delivered tactical missile. These pressures result in part from domestic reassessments of the new stra

tegic environment that call into question the existing French nuclear strategy, in part from perceived new opportunities for European cooperation, and in part from German concerns about the range and utility of Hades and the need for greater coordination on nuclear issues in Europe.

In Europe as in the United States, retained nuclear forces, along with their command and control systems, should be as survivable against attack as possible. Survivability of land-and air-based systems against a Soviet opponent is harder to achieve than in the United States because tactical warning times are shorter. For that reason, the bulk of British and French forces are sea-based, and eventually U.S. forces committed to Europe may be as well. Any remaining air-based forces may have to rely on longer-term strategic warning.

In summary, the committee comes to the following conclusions:

- Withdrawal of all U.S. and Soviet short-range ground-based nuclear forces from Europe, now viewed as very likely, is very desirable. At this time, a U.S. force level below 1,000 air-delivered nuclear weapons, to be further reduced in cooperation with other nuclear powers, is a realistic objective.
- The decision whether to maintain a U.S. nuclear presence in Europe in the long term should depend principally on whether it helps support European cooperation in security matters.
- Nuclear forces in Europe should be configured to approach as closely as possible the strict standards of survivability and controllability posited for the United States and Soviet strategic forces.

## NUCLEAR WEAPONS ELSEWHERE

In recent decades, the United States has maintained several thousand nuclear weapons that are neither strategic nor stationed in Europe. The largest single component was that deployed on naval units, not counting SLBM warheads. These systems were to deter and, if necessary, respond to hostile actions, probably Soviet, against the United States Navy and also to other conventional and nuclear threats in Europe and throughout the world.

These missions and these forces have already undergone substantial change in the past several years. The United States has unilaterally withdrawn a significant number of the tactical nuclear weapons systems deployed on or planned for U.S. surface vessels. These decisions reflected considerations of military utility and cost—not arms control. We see this as a stabilizing trend and believe U.S. security would be served by agreements with the Soviet Union to eliminate all nuclear weapons from surface ships. The possibility of nuclear attack by either navy on the other or on land-based targets adds little or nothing to deterrence, while the presence of nuclear weapons on potentially vulnerable surface ships detracts from stability.

We recognize the difficult challenge of verification, especially for the current sea-launched cruise missile (SLCM). We believe that means can probably be found to adequately assure that SLCMs on surface ships are armed with conventional, not nuclear, warheads. Over the long term, this will be easier if modernized SLCM systems are developed only with nonnuclear payloads.

This will leave only the question of dual-capable aircraft on carriers. The numbers and deployment conditions for these aircraft should be negotiated. While there should be no peacetime storage of nuclear weapons on board, the dual-capable option should be retained on carriers, as in Europe, as an element of force reconstitution to deal with future crises, such as one in which the Soviets abandoned the cooperative regime. These aircraft may be subject to general agreements to reduce or constrain all U.S. forward-based, nuclear-capable tactical aircraft still dedicated to deterring regional threats and providing political reassurance.

From these arguments flow three specific recommendations:

- Through unilateral action and negotiated agreements with the Soviet Union, all nuclear weapons stationed on surface ships should be reduced to zero.
- There must be renewed positive efforts to meet the verification challenges, particularly for SLCMs.
- Dual-capable carrier-based aircraft should be retained but with no nuclear weapons stationed on board under normal conditions. If nuclear weapons are removed from surface ships by negotiations as recommended, the current policy that the United States will "neither confirm nor deny" the presence of such weapons will no longer be necessary.

## REDUCTIONS IN THE STOCKPILE OF NUCLEAR WEAPONS

The START agreement, which establishes ceilings on strategic systems at lower levels, is formulated in terms of limits and sublimits on both nuclear warheads and delivery vehicles (aircraft and missiles or their launchers). Provisions for verified reductions from current inventories and controls on production relate only to delivery vehicles, however; warheads are not controlled except indirectly by constraints on associated delivery vehicles. This emphasis is reasonable given the immediate threat and the verifiability of the limits. Eliminating warheads in a verifiable manner could further strengthen the regime, however, by reducing the threat that an adversary could "break out" by rapidly rearming "downloaded" MIRVs and dual-capable cruise missiles or aircraft. Such a measure could also advance nuclear nonproliferation objectives by helping to persuade nonnuclear nations that the nuclear weapon states were actually reducing their stockpiles of nuclear weapons, not simply putting them in reserve. It would also help address the hazard posed by

the most readily transferable element (by sale, theft, or civil war) of nuclear weapons capability—the weapons themselves.

In approaching this problem, it should be recognized that U.S. and Soviet civilian and military fissile material production complexes and weapons fabrication facilities differ significantly. For environmental and safety reasons the United States has ceased producing plutonium for military purposes and is not reprocessing civilian reactor fuel for recovery of plutonium. The Soviet Union is still doing both. U.S. law separates civilian and military production processes, while Soviet processes are not as clearly separated and Soviet weapons manufacturing and handling facilities are more widely dispersed. In addition, there may be a question regarding undeclared facilities in the Soviet Union. The regime considered here thus implies an asymmetric verification burden on the United States unless the asymmetries are substantially reduced by negotiation. At the same time, redressing such asymmetries, in particular gaining Soviet agreement to cease producing plutonium for weapons, would be a clear gain for U.S. national security. We note that neither the United States nor the Soviet Union requires continued plutonium or highly enriched uranium production to meet current weapons requirements.

Reductions in the stockpile of nuclear weapons could be implemented in the following stages:

- Initially all the nuclear warheads associated with delivery vehicles that are eliminated or downloaded would be either stored or destroyed in a secure monitored facility. If destroyed, all recovered fissionable materials should be either retained in secure monitored storage or turned back to the country of origin for peaceful purposes. The verification of such a destruction process could be conducted in a cooperative fashion that would not reveal information about weapons design.
- Separately, there could be a ban on the further production of weapons-grade fissile material for weapons purposes.
- An effective system of safeguards (monitored bilaterally or through the IAEA) should be established over the peaceful nuclear program, including all declared facilities capable of producing, utilizing, and processing fissile material to ensure that all such materials are accounted for in the peaceful inventory. This would essentially utilize existing IAEA full-scope safeguard procedures now effectively applied to nonnuclear weapon states under the NPT.
- Over the longer term, there could be verified declarations of remaining nuclear stockpiles.

The nuclear weapons reduction regime could be further strengthened by requiring the declaration of any facility engaged in the continued fabrica

tion of nuclear warheads. The facility could then be subject to continuous perimeter monitoring to ensure that any warheads produced were in fact replacements for permitted warheads on no more than a one-for-one basis. Tagging procedures could help ensure that the weapons turned in for refabrication were those permitted under the agreement. This type of arrangement would prevent the fabrication of undeclared material into weapons, while providing a mechanism to fabricate new weapons for modernization, reliability, or safety reasons from material from permitted weapons.

The most serious problem with this direct approach to controlling the nuclear weapons stockpile is the uncertainty about the size of the total stockpile of fissionable material at the time of the agreement. Declarations of these stockpiles could be useful as a confidence-building measure. IAEA access would help narrow estimates of past production. However, the complex operating histories of these facilities and the lack of critical past information would still prevent accurate estimates. Given the current large inventories of weapons, this would not be a problem in initial reductions. At lower levels, however, unless more complete transparency developed, this uncertainty could pose a significant risk if breakout from the reduction agreements occurred. If the problem proves to be serious as arsenals are drastically reduced, agreed quantities of weapons-grade U-235 or plutonium could be held in monitored reserve.

In such a regime, special provisions would have to be made for tritium, a fusionable isotope of hydrogen that is critically important for thermonuclear weapons. Although it decays relatively rapidly (5.5 percent per year), the weapons reductions projected in this study would assure that present tritium holdings suffice for several decades. If needed, future supplies could be manufactured in existing or new reactors fueled by monitored excess U-235 withdrawn from the weapons or peaceful stockpiles or by new, more environmentally benign, technologies outside the nuclear fuel cycle. Special provisions for supplying highly enriched uranium for naval propulsion would also be needed.

## BAN ON NUCLEAR TESTING

The contribution of a comprehensive test ban as a collateral measure in the proposed reduced role for nuclear weapons in a cooperative security regime is more difficult to assess. The importance assigned to such a ban depends on the subjective estimate of its value in supporting the regime's nonproliferation objectives, since its impact on the U.S.-Soviet nuclear balance at substantially reduced levels is debatable.

With U.S. and Soviet nuclear arsenals at much reduced levels, continued testing would allow design improvements to optimize warheads for new, more survivable systems or to react to future reliability or safety problems.

At the same time, future testing might result in or create concerns about new nuclear weapon developments. In the absence of testing, basically new and newly optimized weapons on either side would be impossible. Consequently, new, more survivable delivery systems would have to be designed around existing warheads, and new reliability and safety problems might have to be dealt with in less than the optimum fashion by refabrication of existing weapons or modifications in nonnuclear components or operational procedures.

Politically, on the other hand, the failure of the United States, the United Kingdom, and the Soviet Union to negotiate a comprehensive test ban has become a symbol of the discriminatory nature of the NPT regime. As a consequence, the United States, which has borne the burden of this complaint because of its open advocacy of continued testing, may have lost some of its credibility as a leader in international efforts to control proliferation. There is concern that, when the future duration of the NPT is addressed at the 25th anniversary review conference in 1995, lack of progress on a test ban could jeopardize extension of the treaty. How difficult this issue will actually be remains to be seen, particularly if START is in place and the United States and the Soviet Union are making demonstrable progress toward substantial reductions in their nuclear arsenals in a cooperative security environment.

In the final analysis, most countries will make their decisions about the utility of the NPT regime or their maintenance of a nuclear option on the basis of their perceptions of their own security interests, not on the actions of the United States and Soviet Union or other nuclear weapons states on testing. The committee does not believe that a comprehensive nuclear test ban is critical to the policies recommended in this report and does not have a recommendation regarding one.

## NOTES

1. D. Ball, "The Development of the SIOP, 1960–1983," D. Ball and J. Richelson. *Strategic Nuclear Targeting*. Ithaca, N.Y.: Cornell University Press, 1986, p. 81.
2. L.R. Leavitt, *Reforging European Security: From Confrontation to Cooperation*. Boulder, Colo: Westview Press, 1991, Appendix; M. M. May, G.F. Bing, and J.D. Steinbruner, *Strategic Arms Reduction*. Washington, D.C.: The Brookings Institution, 1988.
3. May, *Strategic Arms Reduction*.
4. *Ibid*.
5. *Ibid*., and H.A. Feiveson and F.N. von Hippel, "Beyond START: How to Make Much Deeper Cuts," *International Security*, Vol. 15, No. 1 (Summer 1990), pp. 154–180.
6. An example of analysis that has resulted in similar suggested numbers of warheads is R.D. Speed, *Strategic Forces: Future Requirements and Options*. Livermore, Calif.: Lawrence Livermore National Laboratory, Report UCRL-ID-105336, November 1990, pp. 52–53.

# V

# Controlling Strategic Force Operations

## INTRODUCTION

As strategic forces are reduced to levels more nearly matching their core deterrent requirements and are reconfigured to make them less vulnerable to preemptive attack, it becomes increasingly important to regulate their operational practices as well. Force reductions and improvements in survivability promise to diminish incentives to initiate a strategic attack, but by themselves do not suffice to stabilize the interaction of deterrent forces, especially in times of crisis. In particular, these measures do not directly resolve the problems of stability that arise from the vulnerability of the underlying command systems.

Even modest numbers of nuclear detonations could seriously disrupt command and control systems. Additional investment in various methods of direct protection to reduce this effect have and should continue to be made, but the vulnerability cannot be entirely eliminated. As a result, existing U.S. and Soviet strategic command systems are prepared to perform their critical functions within the few minutes—30 or less—that would elapse between detection of the launch of a major intercontinental strategic attack and the initial nuclear explosions resulting from it.

With each of the opposing strategic organizations prepared for rapid retaliation, each must also assure itself that the preparations will not be susceptible to a catastrophic mistake. A policy based on deterrence inher

ently requires that assurance of reliable control be conveyed as credibly as the threat of retaliation. If one side ever interpreted the alerting procedures the other undertook as a protective precaution as decisive evidence of an impending attack, an unintended war might be triggered, with consequences well beyond any other imaginable human disaster.

The United States and the Soviet Union have devised weapons design principles and organizational procedures to assure both themselves and their opponents that deployed nuclear weapons will not operate unless instructed to do so. They have also deployed multiple warning systems designed to preclude any misjudgment by central political authorities. These provisions are a necessary complement to the many measures taken to assure that strategic forces will retaliate successfully if attacked. They have been successful for over 40 years in avoiding any actual or imminent explosion of a nuclear weapon. Assisted by an overriding political judgment that war is not in fact imminent despite the preparations that make it thoroughly possible, the warning systems have recorded and corrected numerous false indications of attack without ever approaching a catastrophic misjudgment or a breakdown of control. But the command structures of U.S. and Soviet strategic forces have never experienced the pressures of an intense crisis involving the *simultaneous* alerting of forces. While reassuring, experience to date cannot give definitive evidence about what would happen if a severe crisis altered operational routines and normal political judgments.

With accustomed patterns of evidence and inference disrupted, current warning systems could encounter serious difficulty in proving that an attack was not underway when the prevailing judgment began to suspect that it was.[1] The probability of that happening is presumably very low, but it can only be surmised, not demonstrated. This uncertainty and the enormous potential consequences argue that measures should be taken to strengthen reassurance as the problem of deterrence becomes less demanding.

In our view, four steps could help remedy this situation. The first is a continued program to improve the protection of the command and control system even while the forces are being reduced. The second involves fitting naval weapons with the devices commonly known as permissive action links (PALs) that have been used on other components of U.S. strategic force to physically embody authoritative political control. When installed, PALs make enabling the weapon or gaining access to the warhead itself dependent on receiving a special code from a higher command. The third involves cooperative measures that could increase the ability, if doubts ever arose, to prove that a strategic attack was not under way. The fourth involves a review of targeting practices to ensure that reductions in numbers of weapons systems do not lead to any questions about coverage of essential targets or to pressures for rapid reaction.

## COMMAND SYSTEM PROTECTION

The operational measures for preserving confidence in core deterrence all depend on effective protection of the command system. This must continue to be a high priority for additional investments in strategic forces. Substantial improvements have been made in this regard over the past decade by using the basic methods of hardening, redundancy, dispersion, and reliability. Even greater progress could be made, however, if deterrence were recognized as the principal strategic problem and investments were focused on strengthening that objective. The command functions that are critical to enhancing confidence in core deterrence are much simpler than those required, for example, to manage a protracted nuclear exchange.

If the command systems could be given greater confidence that their core functions would survive the attack that even much smaller forces could carry out, or if they could be confident of reasonably timely reconstitution, then the danger of an explosive crisis interaction could be meaningfully reduced. There is no reason to believe that core deterrence would be diminished by such measures.

## PERMISSIVE ACTION LINKS (PALS)

With the exception of sea-based systems, permissive action links have been incorporated in all U.S. nuclear weapons or weapons systems in order to provide additional assurance against their unauthorized launch.[2] The rationale for exempting the sea-based leg of the strategic triad rested on concerns that incorporating a PAL would compromise the dependability of our most survivable force by adding dependence on a communications link that a sophisticated adversary might be able to interrupt. It also recognized the unique nature of the SLBM weapon system, which requires the active cooperation of much of the submarine's crew in order to launch a missile.

Nevertheless, there are major changes in the nuclear relationship that now justify reconsidering the SLBM exemption. We propose a PALs concept for the SLBMs that would fail "armed," that is, the PALs could have a mode in which it could be armed without the requirement for a message. In other words, successful jamming of communications links, after an appropriate time delay, could remove the PALs. This would effectively incorporate additional security against unauthorized launch at the possible expense of some effectiveness against time-urgent targets.

In Chapter IV, we recommended agreements with the Soviet Union to eliminate nuclear weapons from all surface ships. Until that goal is achieved, all sea-based nuclear weapons should be outfitted with PALs. Deploying PALs on all U.S. nuclear warheads should bolster U.S. efforts to persuade other nations to provide comparable control for all of their own nuclear weapons.

## COOPERATIVE WARNING

The judgment to withhold or to authorize strategic nuclear retaliation is supported by tactical warning systems designed to observe missile launches and aircraft flights. Under normal peacetime operations, the overall performance of the system has been highly reliable. The possibility that a strategic attack will be falsely perceived is considered negligible despite occasional errors produced by elements of the system. Since the system has never encountered a massed strategic attack, the possibility of its giving false reassurance under those conditions cannot be ruled out, but as long as the sensors are operating, that is also considered extremely remote.

There is inherently greater uncertainty, however, about intermediate conditions. The risk is that, in time of crisis, when an attack is perceived to be plausible, leaders will be persuaded to respond to poor-quality indicators of enemy attack. The alert procedures associated with a serious crisis could cause strategic force operations to vary substantially from normal practices, posing the risk that an attack could be initiated as a result of operations that are inherently difficult to detect and interpret.

Cooperative measures can be devised that would substantially strengthen the capacity of warning systems even in crisis. For missile silos, which currently house the strategic systems most likely to be used in the initial stages of an attack, cooperative devices can be designed that would transmit reliable indications that the missiles within had not been launched. For mobile missile forces, the problem is more demanding since their protection depends on concealing their exact location. Nonetheless, some increased reassurance might also be possible for these systems. The problem of designing cooperative warning indicators for aircraft and submarines would be substantially more difficult.

## RESILIENT SECOND STRIKE TARGETING

At present, all available strategic weapons are assigned to targets according to a single integrated plan. The integrated plan assures systematic target coverage, meaning that forces are allocated to targets according to their perceived relative importance and that the highest priority targets are covered by two or more categorically different delivery systems. The plan also controls the relative sequence and timing of force operations in order to minimize mutual interference among the retaliating weapons and to assure that penetrating bomber missions are supported by prior missile strikes on air defense installations. The plan offers a wide variety of attack options within the context of a single menu. The menu itself is laborious to construct and cannot be rapidly altered, particularly if the command system that creates and disseminates it is damaged.

After detecting the launch of an attack, the authorization to retaliate must be disseminated and the choice of an attack option made from the available menu before the command system suffers too much damage. Otherwise, target coverage and operational timing could be severely compromised. The high priority given to destroying an opponent's strategic weapons also gives substantial impetus to rapid reaction since these missions must be accomplished before the opposing weapons are launched. The integrated targeting plan itself does not at present contribute to the inclination for rapid retaliation, however, since current strategic forces substantially exceed the numbers required for effective retaliation. There is so much redundancy for the coverage of priority targets that damage sufficient to deter is a statistical near certainty whatever the exact allocation of weapons might be.

As forces are sharply reduced and tailored more closely to the levels believed necessary for deterrence, the details of operational coordination and of allocating warheads to a smaller number of targets become more important. This effect should not and need not be allowed to lead either side to adopt a posture that relies on prompt retaliation for deterrence in order to avoid operating with a damaged control system. The problems associated with more effective allocation of resources after an attack are difficult and this is not the place to discuss them in detail. We simply note that opportunities exist to mitigate the problem, for example, by giving weapons systems a suitable targeting option beforehand. Using statistical procedures for assigning weapons to targets and assuming survival rates appropriate to the particular weapons system concerned, a high degree of confidence that the highest priority targets will be covered can be assured, and operational interference minimized no matter which particular weapons systems escape destruction. (Appendix C contains a fuller discussion of this point.) This could also be done after an attack has taken place, if the command, control, and communication system is capable of assessing the survival rates, but the returns may not warrant the added complications and risks.

## NOTES

1. B.G. Blair and J.D. Steinbruner, *The Effects of Warning on Strategic Stability*, Brookings Occasional Paper. Washington, D.C.: The Brookings Institution, 1990.
2. D.R. Cotter, "Peacetime Operations: Security and Safety," in A.B. Carter, J.D. Steinbruner, and C.A. Zraket, *Managing Nuclear Operations* . Washington, D.C.: The Brookings Institution, 1987, p. 51–52.

# VI

# Summary of Conclusions

This chapter highlights important statements and conclusions reached in the body of the report. The *recommendations* of the committee can be found in the Executive Summary at the beginning of the report.

## THE CURRENT SECURITY CONTEXT

(1) The change from the bipolar contest between NATO and the Warsaw Pact to a multipolar world has had a profound impact on the future role of nuclear weapons. The dissolution of the Warsaw Pact seems irreversible; a massive surprise conventional attack by demonstrably superior Soviet forces against the Western countries is no longer credible.

(2) Although important parts of the Soviet military are resisting political and military changes, the Soviet political leadership under Gorbachev has taken significant steps by initiating major force reductions and withdrawals, adopting a defensive military posture, and accommodating to Western positions in START and CFE. At the same time, the large inventory of Soviet nuclear weapons implies a continued need to deter their use.

(3) Political developments in the Soviet Union, including the future status of the various Soviet republics, cannot be predicted; however, many of the changes in Soviet society appear irreversible.

(4) Europe, both West and East, is now engaged in the search for a new comprehensive European security system that will both build on existing institutions and ties and evolve new mechanisms and processes.

(5) In the past, U.S. security policy in East Asia has rested on collaboration with Japan and South Korea and a tacit security relationship with China. The future of this framework is threatened by the uncertainties of Chinese internal politics, contentiousness in U.S.-Japanese relations, continued tensions between North and South Korea, and North Korea's apparent interest in acquiring nuclear weapons.

(6) Currently India, Israel, and Pakistan have undeclared nuclear weapons capabilities. While some nations continue interest in acquiring nuclear weapons, others, including Brazil, Argentina, and South Africa, seem to have abandoned past programs.

## THE FUTURE EVOLUTION OF THE SECURITY CONTEXT

(1) Security alignments in Europe will undergo major changes in the future. The major powers, including the United States, are expected to move further toward cooperative measures for resolving differences; the participation of the Soviet Union is expected but not assured.

(2) The nature of the European security structure of the future is not certain, but foreseeable needs include:

- institutionalizing the Conference on Security and Cooperation in Europe (CSCE);
- a set of new and old multilateral structures, with overlapping memberships and missions; and
- substantial bilateral guarantees.

(3) Nuclear cooperation will be part of any future system of security cooperation in Europe. Such a system could involve joint planning for forces at significantly lower levels, detailed data exchange, and cooperation on matters such as political guidelines for use, safety, and transparency, as well as European cooperation with the United States and the Soviet Union on command and control, on safety and security, and on agreed restraints and verification of deployments and exercises.

(4) Notwithstanding the many uncertainties in the security relationships in Asia, U.S. interests demand sustained collaboration with Japan to forestall an autonomous Japanese security posture.

(5) A number of nuclear cooperative arrangements in Asia involving the United States, the Soviet Union, Japan, and China appear useful. Among these are cooperation on command and control and on safety and security, and agreed restraints and verification of deployments and exercises, paralleling those planned or in place for Europe.

(6) Substantial reductions in U.S. and Soviet nuclear arsenals should strengthen the nuclear nonproliferation regime.

(7) Reduced U.S.-Soviet confrontation and shared interest among the

major powers should facilitate the imposition of controls on sensitive exports beyond those provided in the NPT regime; moreover, that regime could be strengthened by inclusion of controls over currently undeclared facilities and other measures.

(8) Extension of full-scope IAEA safeguards to all nuclear facilities of all countries importing nuclear technologies, whether signatories to the NPT or not, would be an important measure.

(9) Guarantees by the nuclear powers not to use, or threaten to use, nuclear weapons against nonnuclear powers would strengthen the nonproliferation regime by reducing both the threat and the perceived utility of nuclear weapons.

(10) Equally important as these "supply side" agreements, and of increasing relevance to U.S. policy, will be "demand side" agreements among potential nuclear weapons states designed to limit, by arms control and other measures, the potential threat that nations in a region may pose to one another.

## GENERAL PRINCIPLES AFFECTING THE EVOLUTION OF NUCLEAR FORCES

(1) Both the Soviet Union and the United States can be more secure with fewer, more survivable systems. Neither country can nor should try to make gains in its national security at the expense of the national security of the other.

(2) U.S. national security with respect to nuclear weapons rests primarily on deterring nuclear attack against the United States and its allies, minimizing the number of nations possessing nuclear weapons, and minimizing the likelihood that nuclear weapons will be used anywhere.

(3) Cooperation in nuclear policy is an essential element of U.S. security and a necessity for preventing incentives for the major nonnuclear powers (for example, Germany and Japan) to acquire nuclear weapons.

(4) The principal objective of U.S. nuclear policy should be to deploy nuclear weapons solely as a deterrent to their use by others and to use them only in response to nuclear attack.

(5) Attempts to credibly extend the mission of nuclear weapons beyond the primary goal of deterring nuclear war, such as to deter massive nonnuclear attack on one's allies, at some level are in conflict with the primary goal. As a result of the immense changes in the world, the need for such extension is now greatly diminished.

(6) It is impossible to link specific deterrent objectives to well-defined requirements for nuclear forces and their control. Our ability to predict the political and security context for U.S. policy is limited. Deterrence is not an objective concept but depends on judgments about how national leaders

will respond. For all these reasons, the requirements for the future nuclear forces and their control cannot be established on an analytical basis but must be based on a combination of judgment and economic and political realities.

(7) Nuclear weapons constitute both assets to national security and liabilities. The latter stem from the enormity of the damage if deterrence fails, the impact of the size of nuclear arsenals on nuclear proliferation, the need to provide for safety and security, and the environmental and economic impact of the nuclear weapons infrastructure. Thus, more nuclear weapons do not necessarily imply an increase in national security, just as fewer nuclear weapons do not necessarily imply an increase in strategic stability. Requirements for nuclear forces and their control should therefore result from balancing the relevant factors.

(8) U.S. tactical nuclear forces in Europe are intended to deny incentives for nuclear proliferation and to provide a secure transition to whatever new nuclear configuration the European powers and security organizations adopt. But these objectives do not require the continuation of ground-based forces or numbers above the 1,000 to be specified in the NATO Strategy Review. The decision whether to maintain a U.S. nuclear presence in Europe in the long term should depend principally on whether it helps support European cooperation in security matters.

## SPECIFIC CONCLUSIONS ON STRATEGIC FORCE CONFIGURATIONS

(1) The survivability of U.S. nuclear forces and their command and control systems must continue to be improved even as reductions take place.

(2) It is not in U.S. security interests to counteract Soviet efforts to increase the survivability of their nuclear forces.

(3) As nuclear forces are reduced, the following criteria appear essential:

- Survivability of the remaining systems should be improved. Among other conditions, this means that the ratio of strategic weapons to the number of strategic aimpoints can be decreased.
- Stability must be maintained during the process of reductions.
- The pressure for rapid retaliation when one side believes itself to be under attack must be minimized. This implies a need to:

—reduce further the susceptibility of the command system to disruption by a relatively small number of weapons,
—avoid targeting time-urgent strategic retaliatory systems,
—improve the reliability of warning, and
—design a target allocation procedure to ensure adequate coverage of a small number of essential targets by a reduced force even if the command and control system is damaged.

(4) Security of command and control demands both increased confidence in nonrelease in peacetime and confidence that weapons could be released after attack. Permissive action links (PALs) or equivalent devices are highly desirable for all, including naval, nuclear forces. Other nuclear nations should be persuaded to implement such a provision.

(5) Cooperative measures can strengthen reliable warning of attack. These can range from sharing information based on national warning systems to cooperative management of devices installed on land-based systems to signal missile launches.

(6) It is neither necessary nor desirable for the United States and the Soviet Union to match strategic systems "in kind." Rather, each nation should provide the maximum survivability for its forces, taking into account its particular geographic and economic circumstances.

(7) At reduced force levels deterrent targets could still include military-related industry and energy sources, essential elements of conventional forces, "soft" bases of strategic nuclear operations, and military command and control. Even without anticity targeting, attacks against such military-economic targets would cause heavy civilian casualties.

(8) Once START is in force and initial experience is favorable, if no significant strategic defense systems are deployed, if China, France, or the United Kingdom have not built up their nuclear forces significantly, and if the decrease in the Soviet conventional threat is not reversed, then 1,000–1,600 targets held at risk in the Soviet Union should meet the deterrent objectives cited. The weapons-to-target ratio under these assumptions need not be higher than 3:1. The total number of nuclear warheads is estimated to be about 3,000–4,000, a reduction by a factor of 2 to 3 below START.

(9) A further step in reducing strategic systems should be possible provided favorable experience in U.S.-Soviet nuclear relations continues; security cooperation between the United States and the Soviet Union is established; and the remaining nuclear systems have attained a higher degree of survivability, availability, and reliability than they have at present. In addition, other nuclear powers should have accepted appropriate strategic arms limitations and the nuclear nonproliferation regime should be more firmly preserved or enhanced. Under these circumstances, the total number of targets adequate for deterrence might be in the 500–800 range, which, with a warheads-to-target ratio of 2–3:1, leads to a total requirement of 1,000–2,000 nuclear warheads.

(10) Many studies are available that provide specific designs for force configurations corresponding to numbers such as the ones cited. Which particular configuration should actually be adopted is not critical provided it meets the general criteria outlined. For economic reasons, wherever possible, reductions should be carried out by selective withdrawals rather than acquisition of new systems.

(11) The reduced strategic forces envisaged should preserve the "triad" concept. About one-half of U.S. weapons could be on submarines. Some land-based systems should be retained even at the lowest force levels considered. U.S.-based intercontinental bombers might retain about 25 percent of the warheads at each of the lower levels considered.

(12) If possible, the nuclear warheads should be destroyed whenever nuclear delivery systems are eliminated. This will require development of facilities and verifiable procedures for: dismantling warheads; destroying nonnuclear warhead components and placing the nuclear components in monitored storage; cutting off production of fissile materials for use in nuclear weapons; and placing the nuclear fuel cycles under "IAEA-like" safeguards, followed by transferring agreed amounts of fissionable materials from the military stockpile to the commercial fuel cycle.

(13) The ability to keep controlled quantities of highly enriched uranium for naval propulsion and for research and the continued production of the amounts of tritium needed to support the reduced weapons stockpile should be retained.

## SPECIFIC CONCLUSIONS ON NONSTRATEGIC NUCLEAR FORCES

(1) NATO has decided unilaterally to remove ground-based nuclear systems from its territory. The planned future deployment of French short-range nuclear missiles is meeting some resistance. It is assumed that the Soviets will remove their short-range nuclear systems from Europe as their troops withdraw.

(2) Fewer than 1,000 U.S. air-delivered nuclear weapons systems in Europe seems appropriate at present, and the level of any longer-term U.S. nuclear commitment there should be decided in cooperation with the European countries concerned.

(3) U.S. dual-purpose aircraft, without nuclear weapons under normal peacetime conditions, are likely to remain in Europe and on U.S. aircraft carriers.

(4) The unilateral U.S. withdrawal of many of the nuclear weapons on its surface ships as a result of changes in missions and threats is a stabilizing trend that should lead to agreements with the Soviet Union to eliminate them entirely.

# Appendix A

# Current U.S. and Soviet Strategic Forces and the START Limits

The Strategic Arms Reduction Treaty (START) between the United States and the Soviet Union will place limits on the number of each nation's strategic nuclear warheads and strategic nuclear delivery vehicles. Specific kinds of delivery vehicles are subject to particular limitations. START will permit:

(1) 1,600 deployed ballistic missiles and heavy bombers for each side;

(2) 6,000 "accountable" warheads on these 1,600 delivery vehicles (bomber-carried weapons are discounted [see items 4 and 5]; sea-launched cruise missiles [SLCMs] are not included in the treaty, although SLCMs are limited in a separate agreement [see item 6]);

(3) no more than 4,900 warheads on ballistic missiles, of which no more that 1,540 may be on heavy ICBMs and no more than 1,100 on mobile ICBMs;

(4) heavy bombers armed with long-range air-launched cruise missiles (ALCMs) will count at 50 percent of their loading. U.S. bombers may carry no more than 20 long-range ALCMs each, and 150 of these bombers will count as carrying only 10 warheads. Soviet bombers may carry no more that 16 ALCMs each, and 180 of these bombers will count as carrying only

The information in this appendix was provided by the Arms Control Association, Washington, D.C.

eight warheads. Any U.S. or Soviet bombers with ALCMs above the 150 and 180 limits will count as actually loaded.

(5) heavy bombers equipped with up to 20 or more gravity bombs and short-range attack missiles will count as carrying one warhead each;

(6) separate "politically binding" agreements will limit sea-launched cruise missiles (SLCMs) with ranges above 600 kilometers to 880 for each side and Soviet Backfire medium bombers to 500.

Under these terms, the total U.S. strategic warheads subject to the treaty will be reduced by 20–25 percent, while Soviet warheads will be reduced by 30–35 percent. The actual reductions will depend on the future force structures the two nations adopt. Soviet heavy missiles will be cut by 50 percent, and Soviet ballistic missile warheads will also be reduced by roughly 50 percent. The United States will reduce its ballistic missile warheads by about 35 percent. However, because bomber-carried weapons are discounted and sea-launched cruise missiles (SLCMs) are not included, the percentage of *total* strategic warheads reduced will be considerably smaller. Beyond this, if the two countries chose to exercise all the options available under the treaty, strategic arsenals could grow significantly, but the current political climate and the budget constraints on both sides make this very unlikely.

Figure A-1 shows current U.S. and Soviet forces and a projection of what the two forces might look like in the late 1990s after the implementation of START. Given that the range of choice for bomber-carried weapons is quite large, that reaching the outer limits of those choices is highly unlikely, and that both the United States and the Soviet Union face a number of significant procurement and modernization decisions whose outcomes are uncertain, the projections about future U.S. and Soviet forces make assumptions, described below, about the most probable choices based on the best available current knowledge. The U.S. force structure projection is taken from testimony given in March 1991 before the House Armed Services Committee by Undersecretary of Defense Paul Wolfowitz. The Soviet force projection is based on publicly available intelligence estimates of current Soviet forces and trends.

## EXPLANATION OF THE FIGURE

*U.S. ICBM/SLBM Breakdown*: START will limit the United States and the Soviet Union to 4,900 ballistic missile warheads. The chart assumes that the United States will have a total of 1,423 ICBM warheads, including 500 warheads on 50 MX missiles and 923 warheads on some combination of Minuteman III (both three-warhead and "downloaded" versions) and Midgetman missiles as the latter are deployed. The balance of the U.S.

ballistic missile force would consist of 3,456 submarine-launched ballistic missile (SLBM) warheads on 18 Trident submarines, each with 24 missiles carrying eight warheads apiece.

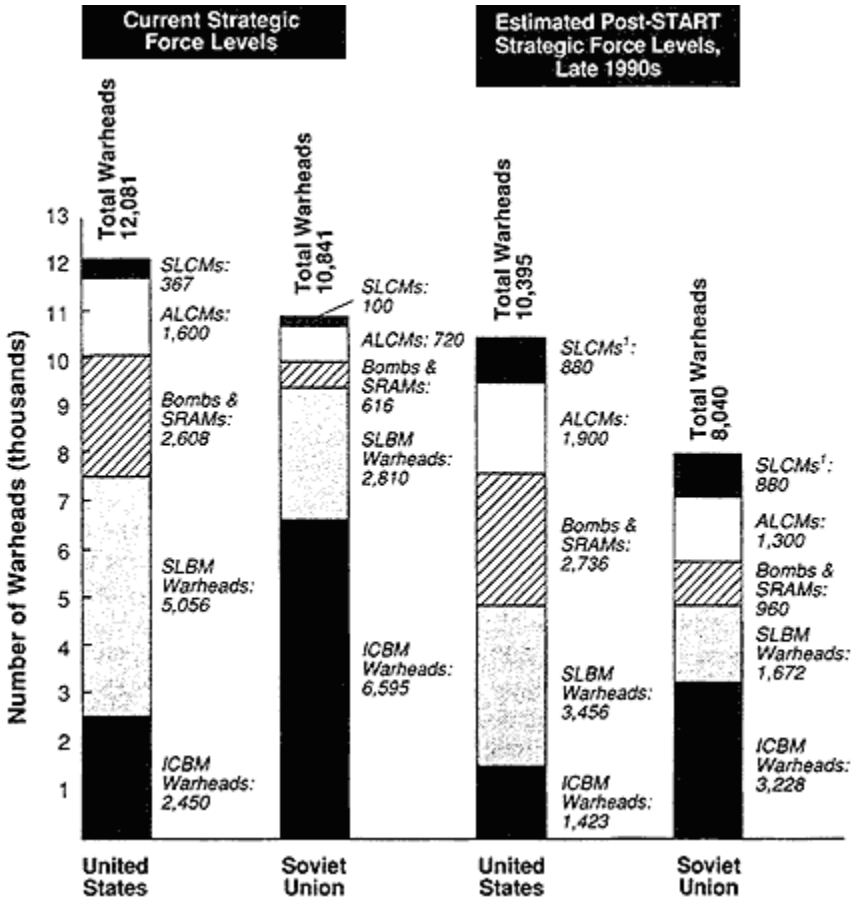


Figure A-1 Estimated strategic forces under START.

*Soviet ICBM/SLBM Breakdown*: The chart assumes 154 10-warhead SS-18s, the maximum permitted by START, and 60 silo-based SS-24s. Within the 1,100 sublimit on mobile ICBM warheads, the chart assumes 36 rail-based, 10-warhead SS-24s, and 728 single-warhead SS-25s. The chart also assumes 1,672 warheads on SLBMs deployed on 10 Delta IV submarines, each armed with 16 SS-N-23 missiles carrying four warheads apiece; six

Typhoon submarines, each with 20 SS-N-20 missiles carrying five war-heads apiece (downloaded from 10); and nine Delta III submarines, each armed with 16 SS-N-18 missiles carrying three warheads apiece (down-loaded from seven).

*Bombers*: The table assumes that the United States will deploy 75 B-2s, as the Bush administration has proposed, with 16 bombs and short-range attack missiles (SRAMs) each; 96 B-1Bs with 16 bombs and SRAMs each; and 95 B-52Hs with 20 air-launched cruise missiles (ALCMs) each. Fifteen operational B-2 bombers have already been authorized through fiscal year 1991. If the United States were to stop deployment at 15 B-2s, the number of its bomber weapons would be about 1,000 less.

For the Soviet Union, the chart assumes 130 Bear-Hs with 10 ALCMs each and 60 Blackjacks with 16 bombs and SRAMs each. The START limits will give the Soviet Union the flexibility to deploy more Blackjack bombers than the 60 assumed in the chart, a number based on recently reported U.S. intelligence estimates.

Bomber loading estimates for both sides are based on aircraft carriage capabilities and operational requirements. Actual operational loadings may differ from the assumptions used here. Both sides will be permitted to exempt 75 existing heavy bombers that have been converted to nonnuclear missions from the limit of 1,600 strategic nuclear delivery vehicles.

*SLCMs*: Through fiscal year 1991, Congress has appropriated funding for 399 nuclear SLCMs. The Navy currently plans to deploy a total of 637 nuclear SLCMs by the mid-1990s, but this number may be reduced due to budgetary constraints. The Navy also has a new "stealthy" SLCM under development called "Excalibur," which may be armed with a nuclear warhead.

Reportedly, roughly 100 Soviet long-range SS-N-21 SLCMs have been deployed, while the supersonic SS-NX-24 SLCM may remain in development. The Soviet Union also has 600–800 nuclear-armed antiship SLCMs with a range of 300–600 kilometers. These will not be limited by START, but will be subject to a confidential data exchange.

# Appendix B

# Target Allocation Issues

Any scheme to assign priorities to targets necessarily entails substantial judgment or arbitrariness in developing values for targets in a class and then deciding what fraction of the total value of that class to target to meet military needs. Developing a value scheme that spans the whole range of targets of very different character is even more difficult. How should one decide the relative value of a fighter airbase, a tank regiment, a naval base, a nuclear storage site, a "ball bearing" factory, or an oil refinery? However, it can be argued that practical value schemes can be developed for the usual categories of targets, and since much of the total value in many categories resides in the most valuable 50 or 100 targets, the total weapons requirements to do "unacceptable" damage to the full target system can be provided even by retaliation from a damaged force. A few examples make this assertion plausible:

(1) The CIA reported that in 1984 the Soviet Union had a total of 53 oil refineries distributed throughout 17 economic regions.[1] Destroying 50 percent of them, selected by capacity and geography, would require about 30–35 warheads and would devastate this industry.

(2) Figure B-1 shows the cumulative electrical generating capacity of the Soviet Union in 1984, again using CIA data, starting with the largest

The committee is grateful to George Bing and Roger Speed for their work on the analysis in this appendix.

stations and proceeding down to the smaller ones.[2] The 80 largest stations account for over 50 percent of total capacity. It seems plausible that destroying 50 of the largest and most strategically located stations would be very effective militarily.

(3) Figure B-2 shows an estimate of the cumulative destruction of Soviet industry of all kinds as a function of the number of attacking warheads, assuming the most valuable and concentrated targets are struck first.[3] By this estimate, successful detonation of about 130 warheads, each with a 500-kiloton yield, would destroy 50 percent of all industry. If the attacks were concentrated on primarily military-related industry, presumably fewer would be required to destroy 50 percent of those industries, although inevitably nonmilitary industries would still be destroyed.

(4) The Soviet Union has about 100 seaports of all kinds. Most are nonmilitary and some are ice-locked most of the year, so destroying perhaps 20 military ports would presumably cripple the Navy's shore facilities. Fifty detonations should be adequate for that task.

Examining the process of targeting Soviet ground forces provides a more complete example of this process. According to the most recent editions of *Soviet Military Power 1990* and *The Military Balance 1990–1991* ,[4] the Soviet Union has about 195 ground force divisions, mostly tank and motorized rifle with a few airborne. About 23 of these divisions are still in Germany, Poland, and Czechoslovakia, but they are expected to leave soon; the future size of the Soviet Army is uncertain, but it will probably decrease. *The Military Balance* reports that Soviet divisions currently fall into four categories: Category A divisions are at 75 percent strength or higher, B divisions are at 50 percent strength, Category C are at 20–50 percent, and Category D/E divisions are termed mobilization divisions and are at 5 percent strength or lower.

There are many questions about the effectiveness of attacking ground force units if they are on alert and dispersed to uncertain locations. However, assuming there is sufficient knowledge about the divisions' locations to make attack possible, it is clear that not all units should have equal priority as targets. As a very qualitative example, the following exercise assumes that each full-strength division presents six targets—a headquarters and $C^3I$ unit, and five fighting regiments. It assumes further that for a Category A division each headquarters unit is worth 2 "points" and each regiment 1 point, for the Category B divisions the points are 1 and 0.5 respectively, for Category C they are 0.5 and 0.25, and for the mobilization divisions 0.2 and 0.1. According to *The Military Balance*, there are 46 Category A, 47 B, 89 C, and 13 mobilization divisions. With these data and assumptions one can construct a value curve for Soviet ground force targets. Figure B-3 displays the curve. It appears that successful detonation

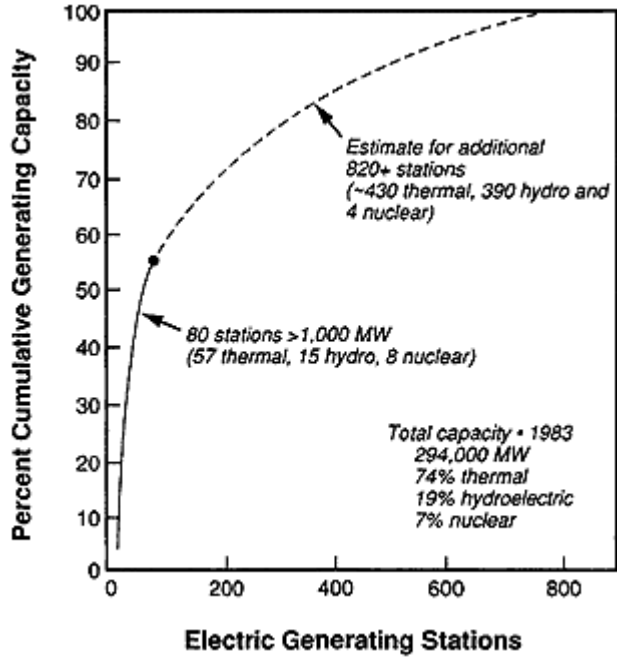


Figure B-1 Soviet electric generating capacity.


Figure B-2 Soviet industry.

of about 300 warheads against units whose location is reasonably well known could destroy 50 percent of current Soviet ground force capability. This example is only presented to suggest roughly the magnitude of the task of targeting this element of Soviet power.

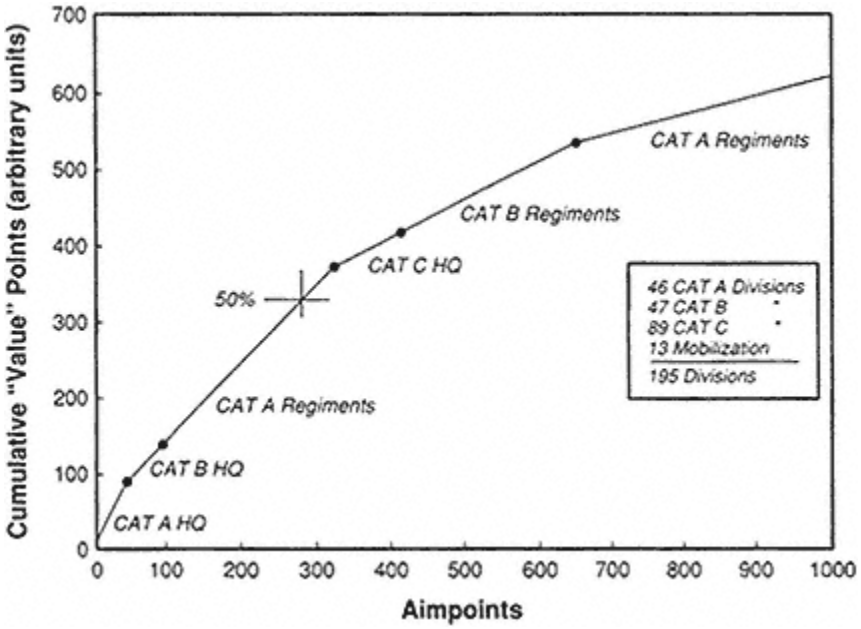


Figure B-3 Cumulative value of Soviet ground forces.

Similar arguments can be made to estimate the forces needed to attack substantial fractions—on the order of 50 percent—of the value of other militarily significant target categories, including airfields, logistic and transportation nodes, and command and control centers. We note that, in addition to the intended destruction of the target, tens of millions of people would be killed and injured, especially in attacks on military-related manufacturing targets in urban areas. Explicit anticity targeting would produce comparable casualties with far fewer weapons.

## NOTES

1. Central Intelligence Agency, *USSR Energy Atlas*. Washington, D.C.: U.S. Government Printing Office, 1985.
2. *Ibid.*
3. R.D. Speed, *Strategic Forces: Future Requirements and Options*. Livermore, Calif.: Lawrence Livermore National Laboratory, Report UCRL-ID-105336, November 1990, pp. 52–53.
4. U.S. Department of Defense, *Soviet Military Power 1990.* Washington, D.C.: U.S. Government Printing Office, 1990; International Institute of Strategic Studies, *The Military Balance 1990–1991*. London: IISS, 1990, pp. 28–43

# Appendix C

# The Sensitivity of Strike Results to Preattack Planning Factors[1]

The outcome of a strike against a set of targets depends not only on the capability of the weapons but also on the allocation of weapons to targets, which, in turn, depends on preattack planning factors. These factors include variables such as the reliability of weapons and delivery systems, the effectiveness of defenses in preventing weapons from reaching the target area, and the probability of damage to a target given that the weapon arrives in the target area. These factors can be combined into a single quantity $P_s$, which represents the survivability of a target if a single weapon is assigned to attack it. The "single-shot probability of kill" (SSPK) is $1\text{-}P_s$. The purpose of this appendix is to explore the sensitivity of strike results to prestrike assumptions about $P_s$.

A simple model is used to demonstrate that strike results are not very sensitive to misassumptions about attack planning factors. A specific case is considered in this appendix, where it is possible to derive analytic formulas for the optimal attack tactics, the value damaged, and the variance in value damaged. The case is one where values can be assigned to targets and the distribution of target value obeys a simple power law: $V_{cum} = (x/T)$ , where $V_{cum}$ is the cumulative value of the targets, $T$ is the total number of

This appendix is based on work done for the committee by Paul Chrzanowski of the Lawrence Livermore National Laboratory; it will appear in an extended form in an LLNL report now in preparation. We very much appreciate his assistance.

targets, $x$ is target number with installations ranked in order of decreasing value, and is in the range $0 < < 1$.

For example, if one has = 0.3, half of the value of the target base resides in the most valuable 10 percent of the targets [$V_{cum} = 1/2 = (0.1)^{0.3}$]. Sample results for this value of are plotted in Figures C-1 and C-2. In the figures, $Q_s$ is the anticipated value of the single-shot probability of target survival. whereas $P_s$ is the actual value. For various values of $Q_s$, attack efficiency is shown as a function of $P_s$ in Figure C-1. Figure C-2 shows the damage extracted as a function of attack size with perfect planning ($Q_s = P_s$). Notice that the total target damage depends strongly on $P_s$ (how well weapons perform) but that for a given value of $P_s$ the results are fairly insensitive to $Q_s$ (the preattack assumption about $P_s$). In short, accurate attack planning assumptions ($Q_s = P_s$) are important for understanding how well the strike will succeed but do not help one to devise a much more effective plan.

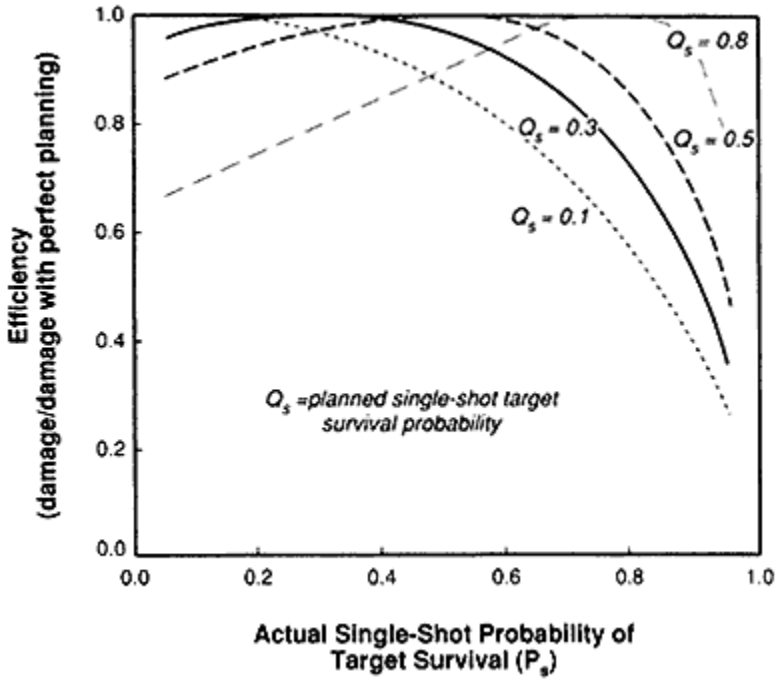


Figure C-1 Efficiency of attack plans with imperfect estimates of single-shot target probability of survival.
Note: $Q_s$ is the prestrike estimate of $P_s$ (and $P_s$ is the actual value). Efficiency (attack damage/attack damage with perfect planning [$Q_s = P_s$]) is shown for the case of a many weapon attack (W>>I).

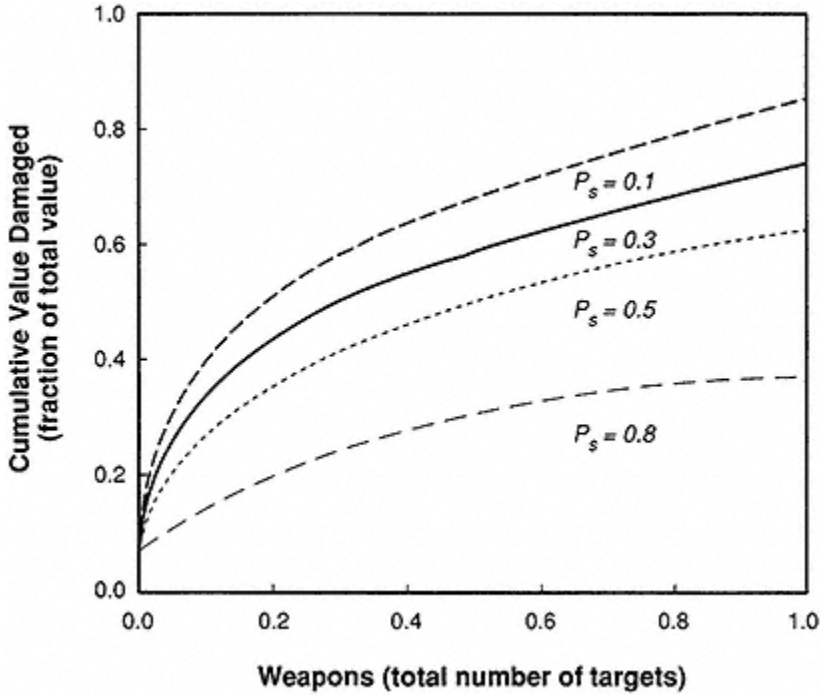


Figure C-2 Attack effectiveness as a function of attack size in the case of perfe ct planning ($Q_s = P_s$).

## NOTE

1. For a set of 1,000 targets with cumulative value growing as the 0.3 power of target number, and with perfectly planned allocation of weapons to targets (but without bomb-damage assessment or shoot-look-shoot), the fraction destroyed of total target set value may be calculated exactly: Case 1a is the allocation of Case 1, but with the single-shot probability of kill degraded to the equivalent of 0.20 by random destruction before launch, for example. Case 2 shows the potential benefit over la of statistical reassignment (factor 1.75 increase in damage realized). Case 3a illustrates the much larger initial force required (without statistical reassignment) to provide damage comparable with the statistical reassignment Case 2. For comparison, Case 4 shows that the ability to reallocate specific surviving weapons to the most valuable 21 targets would enable damage to be maintained with 22 surviving weapons rather than the 40+ of Cases la or 2 or the 220+ of Case 3a.

| *Case* | *SSPK* | *Weapons used* | *Fractional value destroyed* |
|---|---|---|---|
| 1 | 0.90 | 187 | 0.556 |
| 1a | 0.20* | 18 | 0.171 |
| 2 | 0.20 | 187 | 0.299 |
| 3 | 0.90 | 1,075 | 0.942 |
| 3a | 0.20* | 1,075 | 0.294 |
| 4 | 0.90 | 22 | 0.294 |

# Glossary

*Air defense.* Defense against air-breathing attacking weapons, such as manned bombers or cruise missiles.

*Antiballistic missile (ABM) system.* A weapon system for intercepting and destroying strategic ballistic missiles and their warheads in flight.

*Antiballistic Missile (ABM) Treaty.* A ratified treaty of "unlimited duration" between the United States and the Soviet Union, adopted in 1972 and amended in 1974, strictly limiting each side's antiballistic missile (ABM) systems in order to prevent the deployment of nationwide ABM defenses or a base for such a defense. Each country is restricted to a single deployment area incorporating 100 ABM interceptor launchers. The treaty prohibits the development, testing, and deployment of space-based, sea-based, air-based, and mobile land-based systems and components. Certain qualitative and quantitative limits regulate fixed land-based systems and restrain future improvements of ABM technologies. Specific provisions also restrain the upgrading of air-defense systems and radars for antiballistic missile defense. Compliance is monitored by national technical means of verification. A Standing Consultative Commission was established to resolve compliance issues.

*Ballistic missile.* A missile system that spends a large part of its flight in free flight in a "ballistic" trajectory.

*Conference on Security and Cooperation in Europe (CSCE).* Begun in 1972, the conference adopted a Final Act in 1975 (also called the Helsinki Final Act) that, among other provisions, contained agreements for confidence-building measures (CBMs) designed to reduce tensions and the possibility of misperception by making the military environment more predictable through the imposition of operational constraints on military movements and exercises. The 35 CSCE members include Eastern and Western Europe, the Soviet Union, the United States, and Canada.

*Confidence-building measures (CBMs).* Negotiated or unilateral measures undertaken to increase "transparency" and demonstrate a nation's lack of belligerent or hostile intent, as distinguished from measures that actually control or reduce military capabilities.

*Conventional Forces in Europe (CFE) Treaty.* An agreement signed by 22 countries (NATO, the Soviet Union, and Eastern Europe) in November 1990 that place limits on a range of conventional weapons. Within 40 months of the treaty's entry into force, all weapons above treaty limits must be destroyed or, in a few cases, converted to noncombat roles, under strict guidelines.

*Cruise missile.* A pilotless, jet-propelled guided missile flying in the atmosphere. Cruise missiles may be armed with conventional or nuclear warheads and launched from an aircraft (air-launched cruise missiles, ALCMs), a submarine or surface ship (sea-launched cruise missiles, SLCMs), or a land-based platform (ground-launched cruise missiles, GLCMs).

*Download.* Procedures for the removal of some of the warheads from multiple-warhead missiles so that missiles may be counted as carrying fewer warheads within certain prescribed limits.

*Dual-capable.* Weapons systems, such as fighter aircraft and cruise missiles, that may deliver either nuclear or conventional munitions.

*East-West Military Doctrine Seminar.* Seminar held in early 1990 as part of CSCE regime involving high-level military officers and officials from NATO, the Warsaw Pact, and other European nations. Additional seminars are planned.

*European Community.* The three organizations—the European Coal and Steel Community (1951), the European Economic Community (1957), and the European Atomic Energy Community (1957)—created to promote the political and economic integration of Europe. Now comprising 12 nations, the EC plans to abolish all trade barriers among members by 1992.

*Fissile material.* A material fissionable by neutrons of all energies, including fast neutrons; for example, uranium-235 and plutonium-239.

*Full-scope safeguards.* The requirement in the Nonproliferation Treaty that nonnuclear weapons states that are parties to the treaty submit all their peaceful nuclear activities to safeguards administered by the International Atomic Energy Agency. Safeguards are various procedures de
signed to detect and thereby deter the diversion of materials from civilian nuclear power activities for possible use in nuclear weapons.

*Harden.* To protect a potential target or warhead against the blast, heat, electromagnetic pulse, and radiation effects of nuclear explosions.

*Intercontinental ballistic missiles (ICBMs).* A fixed or mobile land-based rocket-propelled vehicle capable of delivering a warhead to intercontinental ranges of more than 5,500 kilometers. An ICBM consists of a booster, one or more reentry vehicles, possibly penetration aids, and, in the case of a MIR Ved missile, a postboost vehicle (see ballistic missile).

*Intermediate-Range Nuclear Forces (INF) Treaty.* Agreement between the United States and the Soviet Union that entered into force in June 1988 calling for the global elimination of U.S. Pershing II missiles and intermediate-range ground-launched cruise missiles and the elimination of all Soviet intermediate-range nuclear missiles. Verification is by national technical means, perimeter portal monitoring, and onsite inspection. It was the first agreement to eliminate an entire class of nuclear weapons.

*International Atomic Energy Agency (IAEA).* A United Nations organization, founded in 1956, whose purpose is to promote peaceful uses of nuclear technology, maintain health and safety standards for the nuclear industry and the environment, and detect and thereby deter any diversion of nuclear materials to a weapons program.

*London Declaration.* Statement on a "Transformed North Atlantic Alliance" released by the 16 heads of state attending a NATO summit in July 1990. Among other provisions, it proposed follow-up talks as soon as CFE was signed, announced that in the future NATO's forces would be smaller and restructured, announced that NATO would rely on a new nuclear weapons strategy that would be "truly weapons of last resort," and proposed measures to make CSCE more prominent.

*Multiple independently targetable reentry vehicle (MIRV).* A package of two or more reentry vehicles with nuclear warheads that can be carried by a single ballistic missile and independently delivered to separate designated targets.

*National technical means.* Technical means of collecting intelligence or verifying compliance that does not intrude on national sovereignty of other countries. Examples include imagery or signal collection by satellites, over-the-horizon or line-of-sight radar observation, and air sampling and geophysical (seismic, acoustic, ionospheric, hydroacoustic, etc.) observations outside another country's territory.

*NATO Strategy Review.* Plans for fundamental restructuring of NATO forces and revision of doctrine in response to changes in European security environment. Preliminary approval given by defense ministers of mem

ber nations in May 1991, subject to approval at 1991 NATO summit meeting.

*Nonproliferation Treaty (NPT).* Multilateral agreement to prevent the spread of nuclear weapons negotiated by the United States, the Soviet Union, and Great Britain and signed by over 140 nations. The treaty requires nonnuclear weapons states not to develop, manufacture, or acquire nuclear weapons and to accept IAEA full-scope safeguards on all of their nuclear facilities. In turn, the nuclear weapons states agreed to share "the applications of nuclear energy for peaceful purposes" with nonnuclear weapon

| | |
|---|---|
| | signatories on a "nondiscriminatory basis" and to negotiate in good faith an end to the arms race and toward nuclear disarmament. |
| *Permissive action links (PALs).* | A coded switch that serves as a technical supplement to the administrative controls exercised over the release of nuclear weapons. When installed, they make enabling the weapon, or access to the warhead itself, dependent upon receiving a code from a higher command. |
| *Plutonium.* | A man-made element produced by the irradiation of uranium-238 with neutrons in nuclear reactors. Plutonium has several isotopes, of which the fissionable isotope Pu-239 is used for nuclear weapons. |
| *Short-range nuclear forces (SNF).* | Land-based nuclear weapons delivery systems with ranges up to 500 kilometers; not limited by the INF Treaty. |
| *Strategic Arms Reduction Talks (START).* | Negotiations between the United States and the Soviet Union initiated in 1982 to seek substantial reductions in strategic nuclear weapons. Agreement signed by President Bush and President Gorbachev in July 1991 will reduce U.S. and Soviet strategic forces by approximately 20–35 percent. |
| *Strategic nuclear forces.* | Land-based missiles with ranges over 5,500 kilometers, modern submarine-launched ballistic missiles, and heavy bombers capable of intercontinental missions. |
| *Submarine-launched ballistic missile (SLBM).* | A ballistic missile carried in and launched from a submarine, thereby achieving survivability for a missile force (see ballistic missile). |
| *Survivability.* | The ability of a nation's forces and its command system to withstand a nuclear attack. This may be accomplished to varying degrees by hardening, mobility, or creating redundant systems to provide backup capabilities. |
| *Tactical nuclear weapons.* | Weapons developed for use in battlefield operations, in combat with opposing military forces, as opposed to those designed for use against an opponent's homeland. (See strategic nuclear forces.) |
| *Time-urgent target.* | A target whose value would be greatly diminished unless attacked promptly. |
| *Transparency.* | Systematic provision of information on specific aspects of activities in the military field under informal or formal international arrangements. Depending on the specific arrangements, information can be made available among nations or to a central repository. |

*Triad.* The traditional term applied to the three components of U.S. and Soviet strategic forces: long-range bombers carrying either gravity bombs or ALCMs, land-based ICBMs, and submarine-based ballistic missiles.

*Weapons-grade uranium.* Uranium with a sufficiently high concentration of the fissionable isotope U-235 to make it suitable for use in a nuclear weapon.

*Yield.* The energy released by the explosion of a nuclear weapon. It is generally measured in TNT equivalent, that is, the weight of a "conventional" trinitrotoluene explosion capable of producing the same energy release. Nuclear yield is usually measured in kilotons (KT) or megatons (MT). In physical units, 1 KT = 4 x $10^{12}$ joules.