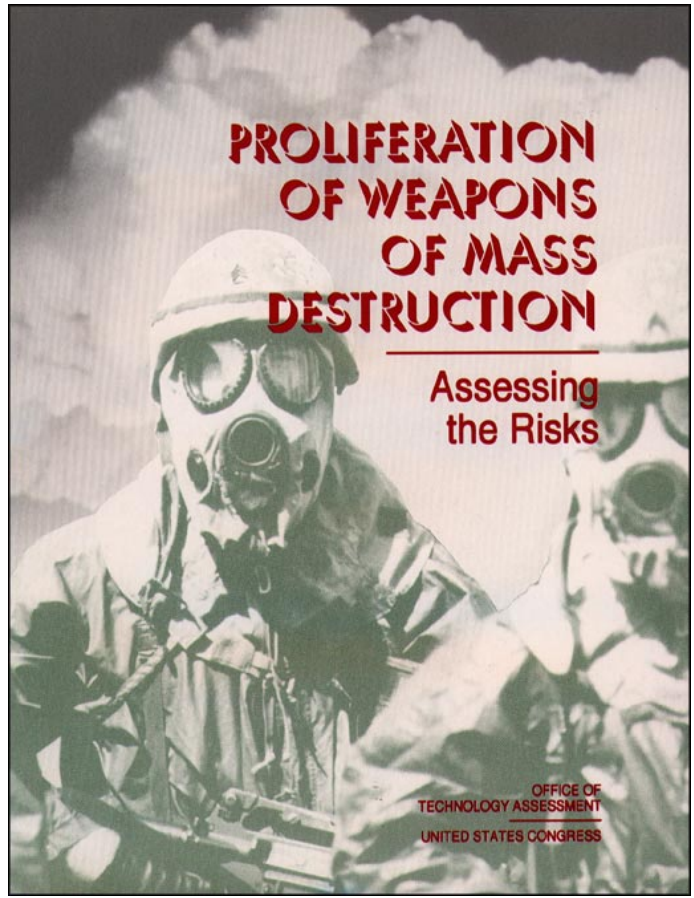
Proliferation of Weapons of Mass Destruction: Assessing the Risks

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Foreword

Throughout history, human beings have been able to annihilate each other without weapons of mass destruction. However, the development of such weapons has greatly reduced the time and effort needed to kill, giving small nations and even subnational groups the ability to destroy lives on a scale that few nations could otherwise manage. Such mass killing does not require state-of-the-art technology; the basic technologies underlying chemical, biological, and nuclear weapons date back to World Wars I and II. Now, modern technologies—and the ever-increasing flow of goods, information, and people across national borders-can place these deadly capabilities in many more hands.

Occasionally, the United States may directly influence another state's decision to pursue weapons of mass destruction. More often, nonproliferation efforts of the United States-together with other countries and international institutions such as the United Nations and the International Atomic Energy Agency—must operate indirectly. By establishing a system of obstacles, disincentives, rewards, and international norms or rules of behavior, nonproliferation measures are intended to lessen the desire for and increase the costs of acquiring these weapons. The challenge is to accomplish this objective in a world where states still threaten one another, and where military power is still viewed as the ultimate guarantor of national survival. Even so, several recent international trends offer us hope that proliferation might be slowed or even reversed.

OTA has been asked by the Senate Foreign Relations Committee and the Senate Committee on Governmental Affairs, with the endorsement of the House Committee on Foreign Affairs, the House Permanent Select Committee on Intelligence, and the Senate Committee on Banking, Housing, and Urban Affairs, to assist Congress in its efforts to strengthen and broaden U.S. policies to control the proliferation of weapons of mass destruction. This report describes what nuclear, chemical, and biological weapons can do, analyzes the consequences of their spread for the United States and the world, and summarizes technical aspects of monitoring and controlling their production. (A separate background paper analyzes the technologies underlying nuclear, chemical, and biological weapons and delivery systems in greater depth.) This report also explains the array of policy tools that can be used to combat proliferation, identifying tradeoffs and choices that confront policymakers. A forthcoming report will analyze specific sets of nonproliferation policy options in detail.

OTA gratefully acknowledges the contributions of many individuals, firms, and government agencies who assisted its research and writing for this report.



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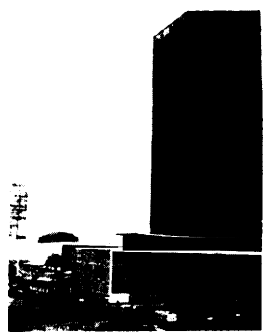
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Introduction and Summary 1

Since the end of the Cold War, the proliferation of weapons of mass destruction has become much more prominent in U.S. national security and foreign policy planning. Revelations about Iraqi, North Korean, South African, and Israeli nuclear weapon programs, the possibility of a nuclear arms race in South Asia, and the multidimensional conflicts in the Middle East all point to the immediacy of this problem. Adding a dangerous new twist is the dissolution of the Soviet Union, a superpower armed with nuclear, chemical, and biological weapons whose successor states are wracked by economic crises and political instability.

At least three main factors underlie this renewed emphasis on proliferation. First, the reduced military threat from the former Soviet Union has increased the relative importance of lesser powers, especially if armed with weapons of mass destruction. Second, certain international political and technological trends are increasing the threat to international security from proliferation. Third, new opportunities are opening for enhancing the current international regimes designed to stem proliferation.

Since at least as far back as the 1960s, when it sponsored the Non-Proliferation Treaty (NPT), the United States has recognized that proliferation is a global problem and combating it requires high levels of international cooperation. This country has also exerted unilateral influence, successfully in several cases, to discourage proliferation; it will no doubt continue to do so. Nevertheless, placing priority on nonproliferation will require the further development and enforcement of international norms and behavior supporting that objective. International conditions today offer significant opportunities for such cooperation.



UNITED NATIONS

INTRODUCTION

Frightening as they are, weapons of mass destruction-taken here to be nuclear, chemical, and biological weapons—represent only part of the world's post-Cold War security problems. Diffusion of militarily useful advanced technology, continuing conventional arms sales, and the resurgence of hitherto suppressed regional and ethnic rivalries are spurring a broader problem: the growth of advanced military capability among states and sub-national groups that are potentially hostile toward each other. Not only are weapons of mass destruction and their delivery systems spreading, but so are advanced conventional weapons (e.g., those other than nuclear, chemical, and biological), along with equipment needed to build a command, control, communication, and intelligence infrastructure. Even "low-technology' weapons can produce massive casualties, as shown by the Allied fire bomb attacks in World War II that caused up to 100,000 deaths in Tokyo and 200,000 in Dresden. Nevertheless, proliferation of nuclear, chemical, and biological weapons is of particular concern for at least two reasons:

- The large-scale and indiscriminate nature of their effects—particularly against unprotected civilians—differentiates mass-destruction from conventional weapons. Mass-destruction weapons make it possible for a single missile or airplane to kill as many people as thousands of planeloads of conventional weaponry. These weapons can give small states or subnational groups the ability to inflict damage that is wholly disproportionate to their conventional military capabilities or to the nature of the conflict in which they are used.
- Unlike most categories of conventional weapons, which will likely be considered legitimate instruments of national self-defense for the foreseeable future, weapons of mass destruction engender widespread revulsion. Some 150 nations have renounced nuclear weapons, formalizing their commitment by joining the Nuclear Non-Proliferation Treaty as non-nuclear-weapon states. Moreover, the United States and many other nations have forsworn chemical and biological weapons completely, even in retaliation for in-kind attack, by joining the Biological Weapons Convention (with 125 parties) and the Chemical Weapons Convention (with more than 140 signatories). These three treaties codify strong, if not yet universal, international norms against weapons of mass destruction. The states seeking these weapons today are generally pursuing them covertly, attesting to the reluctance states have to admit to such developments. Thus, controlling weapons of mass destruction may well be feasible despite the dubious track record of past attempts to regulate or ban other weapons of war.

This is the first report of OTA's project on the proliferation of weapons of mass destruction. It describes the various weapons of mass destruction, reviews the status of their proliferation worldwide, and discusses possible consequences of their spread. It also surveys the range of nonproliferation policy measures, offering a menu of tools from which a coherent nonproliferation policy could be constructed.

A separate background paper examines the technical bases for nuclear, chemical, and biological weapons, along with their delivery systems, and seeks to identify opportunities to control or to monitor their production. A forthcoming report will provide a more complete specification and analysis of selected nonproliferation policy options.

Weapons Described

Nuclear, chemical, and biological weapons are commonly lumped together under the term weapons of mass destruction, ' yet their effects, relative lethalities, and military applications are very different. Nuclear weapons, which can be more than a million times more powerful than the same weight of conventional explosives, create

shock waves, high pressures, flying debris, and extreme heat—the same mechanisms by which conventional explosives injure and kill, albeit at vastly increased scale. Unlike conventional explosives, however, nuclear blasts also create neutron and gamma radiation, which can kill or harm those exposed at the instant of detonation.[1] In addition, they can generate long-term radioactivity in the form of *fallout*, which can spread over an area much greater than that affected by the bomb's immediate effects. In addition to producing acute illness or death at considerable distances from the detonation, fallout can also lead to delayed medical problems such as cancer or genetic abnormalities.[2]

Chemical agents are poisons that incapacitate, injure, or kill through their toxic effects on the skin, eyes, lungs, blood, nerves, or other organs. Some chemical warfare agents can be lethal when vaporized and inhaled in amounts as small as a few milligrams. As potent as chemical agents are, however, biological agents-disease-causing microorganisms such as bacteria, rickettsia, and viruses-can be many times deadlier, pound-for-pound. Laboratory tests on animals indicate that, if effectively disseminated and inhaled, 10 grams of anthrax spores (a form of disease-inducing bacteria) could produce as many casualties as a ton (one million grams) of nerve agent. Toxins--defined as toxic substances made by biological organisms, or their synthetically produced versions—are banned by both the Biological and the Chemical Weapons Conventions.

Delivery Systems

To do their deadly work, agents of mass destruction have to be integrated into weapons (e.g., an aerial bomb, a ballistic missile warhead, or even a suitcase) and delivered to their targets. Such weapons can be highly threatening without sophisticated delivery systems. A nuclear device planted by a terrorist or commando squad, or delivered by a disguised cargo ship, civil aircraft, or even a small pleasure boat, can kill just as many people as one delivered by intercontinental ballistic missile; a given quantity of certain lethal microorganisms would probably kill even more people if spread effectively by human agents than if by a missile. In the cases of rival states bordering each other, weapons of mass destruction mounted on even short-range means of delivery can pose a major threat. Nevertheless, states able to couple weapons of mass destruction to delivery systems with longer range or greater ability to penetrate defenses can threaten more nations with higher levels of destruction, and with greater likelihood of success. At the same time, since such delivery systems—taken here to be ballistic missiles, cruise missiles, and combat aircraft—generally pose greater technical challenges, they are more amenable to international controls than are less sophisticated delivery systems.

Of these three delivery systems, ballistic missiles have attracted the most attention, both because they are difficult to defend against and because they appear to be particularly suited for weapons of mass destruction. (They generally do not have much military value in proportion to

[1] Nuclear weapons detonated at high attitude can also generate powerful radio waves (called ''electromagnetic pulse' that can wreak havoc with electronic equipment, but do not pose a direct human health risk.

[2] In principle, nations or groups could develop *radiological* weapons whose effects are similar to those of fallout from a nuclear weapon (albeit over a far smaller area) without any of the blast effects or extreme temperatures that make nuclear weapons so devastating. Radiological weapons disseminate highly radioactive material over an area using mechanical means or conventional explosives. They resemble chemical weapons much more than nuclear weapons in their effects, since they contaminate territory and poison living organisms but do not destroy physical structures. Conventional attacks on nuclear power plants could be tantamount to radiological warfare, as the accident at Chernobyl suggests. The amount of fallout from such an attack could be massive, far greater than that from a "traditional' radiological weapon that disperses radioactive material directly.

Although there are as yet no documented cases of anyone trying to acquire radiological weapons, the Geneva-based Conference on Disarmament has an ad hoc committee charged with concluding a convention on them. Sweden has proposed that attacks on nuclear facilities be included, while the United States, France, and Germany favor dealing only with traditional radiological weapons.

their cost when armed with conventional warheads, although they can have considerable political significance.) Combat aircraft also pose a potent threat for delivery of mass-destruction weapons. They are much more widely available than missiles, and efforts to control their spread are greatly complicated by the multiple roles that aircraft play. Cruise missiles and other unmanned aerial vehicles could also be used as delivery methods, although such vehicles with the range and payload of typical combat aircraft or ballistic missiles are not yet widely available.

MAJOR FINDINGS

The Proliferation Threat

Those states most actively working to develop weapons of mass destruction, although limited in number, are for the most part located in unstable regions of the world—the Middle East, South Asia, and the Korean peninsula. For at least the next decade, few if any of these states will be able to deliver such weapons more than a thousand kilometers or so in a reliable and timely manner. Therefore, the greatest threat posed by these states is to their neighbors and to regional stability. Despite their current limitations in long-range military delivery systems, however, proliferant states-at least in principle--can threaten any country on earth using unconventional means (e.g., covert or disguised delivery systems such as a ship or truck).

Proliferation poses dangers to all nations. It poses particular problems for the United States. As a global power, the United States will almost certainly retain allies and vital interests overseas that might be threatened by states possessing weapons of mass destruction. Should the United States need to defend its interests with military force--whether acting unilaterally or under multilateral auspices such as those of the United Nations--U.S. armed forces, and possibly U.S. territory, might become targets for weapons of mass destruction.

The breakup of the Soviet Union presents immediate threats to the global nonproliferation regimes. One possibility is that Ukraine, Kazakhstan, or Belarus will renege on their commitments to return the nuclear weapons stationed within their borders to Russia and, in the case of Ukraine and Kazakhstan, to join the Non-Proliferation Treaty as non-nuclear-weapon states. (Belarus has already ratified the WT.) Such actions would seriously undermine the nonproliferation regime. Another danger is the leakage of nuclear weapon materials or actual weapons to potential proliferants elsewhere in the world if the nuclear custodial system in Russia itself were to break down. Yet another concern is the export from former Soviet republics of equipment, technology or expertise relevant to producing weapons of mass destruction.

Prerequisites to Effective Nonproliferation Policy

If nonproliferation policy is to succeed, it must receive substantial international cooperation. Cooperation is *necessary* because no nation or small group of nations by themselves can prevent proliferation or contain its consequences. Cooperation is *possible* because many countries have come to recognize that the proliferation of nuclear, chemical, and biological weapons poses a genuine threat to all nations. However, since states will not always agree on nonproliferation measures, maintaining and acting on an effective consensus will require each participating country to give up some freedom to act independently.

Some analysts argue that containing proliferation in the long run will require a far deeper level of international cooperation than has been achieved to date, one that builds international institutions for a much more cooperative global security regime. Others argue that the international political system is inevitably anarchic and that as a

result, the degree of cooperation needed to contain proliferation cannot be achieved.

Whether or not either of these views proves correct, the end of the Cold War has opened up new opportunities for cooperative nonproliferation policies. One promising sign is the revitalization of the United Nations Security Council. Progress has also been made with the signing of the Chemical Weapons Convention and the strengthening of various multilateral groups that have formed for the purpose of controlling the spread of proliferation-sensitive technology: the Nuclear Suppliers Group, to control exports of nuclear technology; the Australia Group, to control materials useful for chemical and biological weapons; and the Missile Technology Control Regime, to restrict traffic in missile systems and missile technology.

If U.S. nonproliferation policy is to succeed, the United States must give it high priority. With its leadership role in the world community, the United States has the opportunity and the ability to mobilize international nonproliferation efforts. Free of previously overriding Cold War security concerns, the United States can now attach greater priority to nonproliferation. Doing so, however, is not without costs. Nonproliferation may conflict with economic goals, as export promotion is balanced against export controls. Promoting openness, transparency, and verification of nonproliferation commitments, on the one hand, conflicts with maintaining the secrecy of national-security or proprietary information, on the other. Nonproliferation will also likely conflict with other foreign policy objectives such as maintaining relations with individual states. For example, would the United States be willing to sacrifice its relationship with Israel-and possibly risk Israeli national survival-to pressure that state to give up a nuclear arsenal it believes essential to its security? How prominently should nonproliferation figure in U.S. relations with China, a regional power whose cooperation the United States seeks in other diplomatic or economic arenas?

Strategies for inhibiting proliferation have four broad elements, all of which contribute to existing nonproliferation regimes and form the basis for future ones. For the most part, these elements are mutually supportive, although as described later in this chapter, tensions between them can arise. By emphasizing these elements in different proportion, nonproliferation policies can be tailored to particular situations. These elements include:

- obstacles to impede those working to acquire weapons of mass destruction, ranging from protection of weapon-related information, to export controls, possibly all the way to preemptive military attack against production or storage facilities;
- punitive measures to deter or punish proliferants, including economic sanctions or diplomatic isolation imposed on countries developing these weapons, and on states, firms, or individuals who assist in such developments;
- rewards to increase the attractiveness of voluntarily forgoing these weapons, such as development assistance (financial or technical) that is tied to nonproliferation; and
- global or regional security improvements to reduce the perceived needs for the weapons.

The increasing international flow of technical knowledge, high-technology goods, and trained specialists is eroding the ability of the United States and its allies to withhold technologies relevant to producing weapons of mass destruction from states of proliferation concern. Nevertheless, although technical capability is necessary to develop weapons of mass destruction, it is not sufficient, and it is certainly not causal. A host of nontechnical factors such as the diplomatic, political, organizational, and economic costs and benefits bear on a state's decision to pursue such weapons.

In the long run, the most effective nonproliferation measure is to convince states that it is

in their own best interest to forgo weapons of mass destruction. Reducing the incentives for seeking such weapons and raising the costs of doing so are both important. External obstacles and disincentives can play an important role in raising the costs of proliferation to a state considering it, possibly tipping the balance towards nonproliferation. Such coercive measures can also buy time for other diplomatic or political measures to forestall the development of weapons of mass destruction. However, they may not always be sufficient to stop states determined to acquire weapons of mass destruction.

Technical Aspects of Nonproliferation Policy

Trying to control proliferation through controlling exports or placing other obstacles in the way of potential proliferants requires technical analysis of the production pathways for making these weapons. Controls will not work if the target state can readily make controlled items indigenously, find uncontrolled sources of supply, or develop alternatives. Technical analysis also underpins measures to monitor the production of weapons of mass destruction, measures that are needed to evaluate potential threats as well as to formulate verification regimes by which states can assure each other that they are not pursuing such weapons.

ISSUES FOR CONTROLLING PROLIFERATION

- Obtaining fissionable nuclear weapon material (enriched uranium or plutonium) today remains the greatest single obstacle most countries would face in the pursuit of nuclear weapons. For this reason, theft or black market purchase of nuclear material or warheads from the former Soviet arsenal—or collaboration between potential proliferants whereby one provides nuclear materials to another-would be extremely troubling. Although nuclear material production, weapon fabrication, and testing require specialized equipment, in many cases this equipment can be fabricated indigenously by proliferants using equipment (e.g., machine tools) that also has civilian applications.
- Most of the equipment needed to produce chemical weapons has civilian applications. Moreover, most of the same chemicals, or *precursors,* used to make chemical-warfare (CW) agents are also used in commercial products. Some agents (e.g., sulfur mustard and the nerve agent tabun) could be produced with widely available chemical-industry equipment. The most potent nerve agents (e.g., sarin, soman, VX) involve a process step--the alkylation of phosphorous—that is less common, but that nevertheless is used in a handful of commercial products such as some pesticides and fire retardants.
- Virtually all the equipment underlying production of biological and toxin agents has civil applications and has become widely available as fermentation technology, and the pharmaceutical and biotechnology industries more generally, have spread worldwide. Since militarily significant quantities of biological agents could be produced in a short time in small facilities, they could be used offensively without the need for long-term stockpiles. Crude dissemination of biological agents in an aerosol cloud can be performed with commercially available equipment, such as an agricultural sprayer mounted on a truck, ship, or airplane. However, developing reliable, efficient projectile or missile warheads for precision delivery of organisms over a target requires surmounting major technical hurdles. Even so, the United States overcame these hurdles by the 1960s.

MONITORING PROLIFERATION AND VERIFYING COMPLIANCE WITH NON PROLIFERATION AGREEMENTS

- All facilities for producing weapon-grade nuclear material have unique features amenable to detection by intrusive onsite

inspection. Many have distinctive signatures that are detectable remotely, although facilities needed for some approaches to material production might not be readily detectable.

- Production of chemical-warfare agents can be detected through analysis of samples taken during an onsite inspection. However, considerable access to production facilities is required to collect appropriate samples. Moreover, highly sensitive analytical chemistry techniques that are decisive under laboratory conditions might be less so under some circumstances in the field, particularly if the proliferant has been producing related legitimate chemicals (e.g., pesticides) in the same facility and is willing to expend time, effort, and resources to mask, obscure, or otherwise explain away chemical agent production activities. Such efforts, while not likely to eliminate grounds for suspicion, could create ambiguities or otherwise complicate detection of chemical agent production during an inspection.

  Identifying where to look for evidence of covert production is probably the greatest challenge for monitoring chemical weapon proliferation, since highly reliable technologies to detect chemical agent production from outside a facility are not currently available. Information on plant design and purchase of precursor chemicals may suggest a chemical agent production capability, and may therefore lead to challenge inspections under the Chemical Weapons Convention.
- Detection of biological and toxin agent production is particularly challenging because clandestine production sites need not be large or distinctive, because the equipment involved has legitimate civilian applications, and because offensive work can be conducted under the guise of defensive preparations. Identifying where to look for evidence of biological agent production is even harder than for chemical agents. Several suggestive signatures of biological weapon production do exist, and, if integrated effectively with each other and with other sources of intelligence, they might make it possible to infer a weapon production capability. However, the evidence supporting such an inference may not be sufficient to justify claims of treaty violation before the international community, either because it cannot be publicly released or because public allegations of treaty violation typically require a substantially higher burden of proof than intelligence assessments. Sensitive techniques exist to identify biological or toxin agents if access to a suspect site is made available. However, such techniques alone do not ensure that an effective onsite inspection regime can be established to detect production of biological or toxin weapons.

WEAPON CHARACTERISTICS AND COMPARISONS

Lethality and Military Utility

One motivation for developing nuclear, chemical, or biological weapons is their ability to destroy or interfere with military targets. More generally, however, these weapons may also be sought for symbolic, deterrent, intimidating, or terrorist purposes that may not be simply related to their value from a purely military perspective.

Nuclear weapons, particularly at large yields (hundreds of kilotons or higher) are the most potent means of mass destruction.[3] In addition to killing tens or hundreds of thousands of people or more, a nuclear weapon can obliterate the entire

[3] One *kiloton is* the explosive blast generated by 1,000 tons of high explosive.

physical infrastructure of a large city and contaminate a much larger area with radioactive fallout. Given this destructive power, nuclear weapons have been developed for strategic use against a nation's military infrastructure, its economic base, and even its population. In addition, the nuclear powers have developed many tactical nuclear weapons for a variety of battlefield missions. These weapons are particularly threatening to concentrations of military force such as tightly clustered naval groups, port or depot facilities, troop concentrations, or massed forces of tanks and other armored vehicles.

Unlike nuclear weapons, chemical and biological agents-if detected-can be defended against through use of gas masks, protective clothing, shelters, and decontamination procedures. Although these weapons can contaminate territory, they do not destroy infrastructure. If protective measures are taken in time-which requires adequate warning-they can dramatically reduce casualties, and hence the military and political implications, of a chemical or biological attack. Nevertheless, such weapons can still have military value against protected troops, since forcing troops to don protective gear impairs their ability to function on the battlefield and lowers their military effectiveness. Means for penetrating protective gear would have serious implications for the military utility of chemical or biological weapons. Although such means have been examined, they have operational shortcomings; moreover, defensive equipment is being improved to mitigate that threat.



Gas masks and protective clothing can shield against chemical and biological weapons, but they impair military @activeness.

Biological weapons are so potent that under conditions favorable to the attacker, they can kill as many people as comparably sized nuclear weapons, potentially making them extremely dangerous as a strategic or terrorist weapon against dense population centers. However, their characteristics make them particularly difficult to use on the battlefield. Except for some toxins, biological agents act more slowly than chemical or nuclear weapons, taking days or weeks to achieve full effect. In addition, their effects are much harder to control or predict than those of nuclear weapons, since 1) individuals differ markedly in their sensitivity to biological agents; 2) the lethal areas created by such agents, which depend on wind and other weather conditions, are hard to predict (indeed, such agents may even be blown back upon the attacker by an unexpected shift in wind direction during a battlefield engagement); and 3) biological agents must be kept alive through the dissemination process and long enough afterward to infect the target personnel, but not so long as to impede future use of the area.

On a pound-for-pound basis, chemical weapons are much less lethal than either nuclear or biological weapons, and correspondingly greater amounts would have to be delivered to have

comparable results. Indeed, it may not even be appropriate to consider them to be weapons of ''mass destruction. ' Yet they can still induce terror, particularly among troops or civilians without protective gear.

In some battlefield scenarios, chemical weapons might be no more effective than the same weight of conventional high-explosive munitions, even when used against unprotected people. Like biological weapons, their effects depend on variable factors such as weather and terrain, limiting their predictability. Nevertheless, chemical weapons do have tactical applications. Persistent chemical agents cart create local "no-man' s-lands' in which restrictions would be imposed on military operations of either side. Attacks using nonpersistent agents could disrupt enemy defenses but still permit attacking troops to overrun the territory soon afterwards. Some chemical agents can be used as incapacitants, either in lieu of lethal force or in conjunction with it.

Ease of Acquisition

Barring a shortcut, such as the direct acquisition of nuclear materials usable in weapons, the infrastructure required to produce nuclear weapons is considerably more difficult and expensive to develop than that for either biological or chemical weapons. It is also the most amenable to limitation through control of international technology transfers. Mass production of lethal chemical agents requires a greater investment than that of biological weapons, but is not nearly as expensive or challenging as production of nuclear materials.

Table 1-1, drawn from the technical analyses in a separate OTA background paper, compares the relative difficulties involved in trying to produce nuclear, biological, or chemical weapons in several categories.[4] Note that the table differentiates between producing materials (nuclear materials, chemical warfare agents, and biological pathogens) and building the munitions and delivery systems needed to make those materials militarily functional.

Since international norms remain and are being strengthened against proliferation of these weapons, proliferants may very likely try to acquire them secretly. Concealing potential indicators of the necessary activities adds to the expense and difficulty of acquisition. With enough effort and resources, the magnitude and scope-and possibly even the existence-of a covert weapon program might well be successfully concealed; the burden will be on the suspecting parties to detect relevant indicators and to interpret their meaning accurately. The background paper exties various ''signatures' that might indicate the presence of a clandestine weapon program.

Probability of Use

Nuclear weapons have been detonated on adversaries only twice-against Hiroshima and Nagasaki in World War II. Biological weapons, despite their apparent ease of manufacture and their devastating effects, have not played a



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Kurdish victims of an Iraqi chemical attack on *the Iraqi town of Halabja during the Iran-Iraq war.*

[4] OTA background paper on technologies underlying weapons of mass destruction in press.

Table I-1—Technical Hurdles for Nuclear, Biological, and Chemical Weapon Programs

	Nuclear	Biological	Chemical
Nuclear materials or lethal agents production			
Feed materials	Uranium ore, oxide widely available; plutonium and partly enriched uranium dispersed through nuclear power programs, mostly under international safeguards.	Potential biological warfare agents are readily available locally or internationally from natural sources or commercial suppliers.	Many basic chemicals available for commercial purposes; only some nerve gas precursors available for purchase, but ability to manufacture them is spreading.
Scientific and technical personnel	Requires wide variety of expertise and skillful systems integration.	Sophisticated research and development unnecessary to produce commonly known agents. Industrial microbiological personnel widely available.	Organic chemists and chemical engineers widely available.
Design and engineering knowledge	Varies with process, but specific designs for producing either of the two bomb-grade nuclear materials can be difficult to develop: . Separation of uranium isotopes to-highly enriched uranium; . Reactor production and chemical processing to produce plutonium.	Widely published; basic techniques to produce known agents not difficult.	Widely published. Some processes tricky (Iraq had difficulty with tabun cyanation, succeeded at sarin alkylation; however, sarin quality was poor).
Equipment	Varies with different processes, but difficulties can include fabrication, power consumption, large size, and operational complexity: ● Electromagnetic separation equipment can be constructed from available, multiple-use parts; ● Equipment for other processes is more specialized and difficult to buy or build.	Widely available for commercial uses. Special containment and waste-treatment equipment may be more difficult to assemble, but are not essential to production.	Most has legitimate industrial applications. Alkylation process is somewhat difficult and is unusual in civilian applications. Special containment and waste treatment equipment may be more difficult to assemble, but are not essential to production.

prominent role in wartime.[5] Chemical weapons, on the other hand, were heavily used in World War I and have been employed several times since then in regional conflicts. Most recently, Iraq used chemical weapons during the 1980-1988 war with Iran, resulting in some 50,000 Iranian casualties, with Iran belatedly retaliating in kind.[6] Iraq also used chemical weapons against its own Kurdish population. Although the threat of Iraqi chemical weapons loomed large over coalition military forces and civilians in surrounding countries during Operation Desert Storm, they were not in fact used during that conflict. Nevertheless, if the past is any guide, chemical

[5] In World War II, Japan used biological agents including bubonic plague on an experimental basis in occupied China, reportedly killing some hundreda of Chinese civilians but also causing thousands of illnesses among its own troops (see ch. 2). Biological weapons were not used in any other theater of the war.

[6] 'R@mony of R. James Woolsey, Director of Central Intelligence, before the Senate Committee on Governmental Affairs, Feb. 25, 1993.

Table I-l-(Continued)

	Nuclear	Biological	Chemical
Plant construction and operation	Costly and challenging. Research reactors or electric power reactors might be converted to plutonium production.	With advent of biotechnology, small-scale facilities now capable of large-scale production.	Dedicated plant not difficult. Conversion of existing commercial chemical plants feasible but not trivial.
Overall cost	Cheapest overt production route for one bomb per year, with no international controls, is about $200 million; larger scale clandestine program could cost 10 to 50 times more, and even then not be assured of success or of remaining hidden. Black-market purchase of ready-to-use fissile materials or of complete weapons could be many times cheaper.	Enough for large arsenal may cost less than $10 million.	Arsenal for substantial military capability (hundreds of tons of agent) likely to cost tens of millions of dollars.
Weaponization			
Design and engineering	Heavier, less efficient, lower-yield designs easier, but all pose significant technical challenges.	Principal challenge is maintaining the agent's potency through weapon storage, delivery, and dissemination. Broad-area dissemination not difficult; design of weapons that effectively aerosolize agents for precision delivery challenging (but developed by U.S. by '60s).	Advanced weapons somewhat difficult, but workable munition designs (e.g., bursting smoke device) widely published.
Production equipment	Much (e.g., machine tools) dual-use and widely available. Some overlap with conventional munitions production equipment.	Must be tightly contained to prevent spread of infection, but the necessary equipment is not hard to build.	Relatively simple, closely related to standard munitions production equipment.

SOURCE: Office of Technology Assessment, 1993.

weapons are considerably more likely to be used in the future than either nuclear or biological weapons.

IMPLICATIONS OF PROLIFERATION

Mass killing of human beings is not new to warfare, or even to this century. Nevertheless, weapons of mass destruction compress the time and the effort needed to kill. Wars lasting only a few days could now devastate populations, cities, or entire countries in ways that previously took months or years. Particularly ominous is the fact that the states now working hardest to develop weapons of mass destruction (see following section) are for the most part located in unstable regions of the world, where bitter and unresolved rivalries have erupted into war in the recent past and hold the prospect of doing so again. Not only might future wars lead to the actual use of weapons of mass destruction, but the deployment of such weapons in these regions could increase tensions still further.

Even if these weapons are not used, they cast shadows that can affect interstate relations and

international balances of power. A few analysts, pointing to the role that nuclear weapons seem to have played in preventing war between the United States and the Soviet Union, argue that their spread will actually increase international stability. Most, however, consider such a view to be dangerously misguided. The Cold War was not without serious crises and close calls, such as the Cuban Missile Crisis. In the Middle East, South Asia, and the Korean peninsula, hostile powers share common borders, contest core values and vital national interests, and lack both the mutual learning experience and the technical safeguards that have helped the superpowers come to live with the mortal threat each poses the other.

Proliferation, therefore, poses real dangers from the point of view of international security and human welfare. Moreover, in addition to its global consequences, it poses particular problems for the United States. As a global power, the United States will almost certainly retain allies and vital interests overseas that might be threatened by states possessing weapons of mass destruction. Should the United States need to defend its interests and principles with military force—whether acting unilaterally or under multilateral auspices such as those of the United Nations—U.S. armed forces or territory might become targets for weapons of mass destruction.

The threat of nuclear attack is nothing new to the United States. Having faced a massive Soviet nuclear arsenal for decades, the United States has shown itself willing at least to contemplate the loss of many U.S. cities, and millions of American lives, to ensure its own survival and the survival of the states under its nuclear umbrella. (Granted, this posture has always posed problems for many who questioned what "national survival' means in the context of tens, let alone hundreds or thousands, of nuclear weapons detonating on U.S. territory.) At the same time, however, the existence of the Soviet nuclear arsenal strongly tempered U.S. views of which ''vital national interests' were worth risking nuclear war to defend. If additional countries acquire the means to threaten U.S. allies, U.S. forces overseas, or even U.S. territory with nuclear weapons, the United States will be forced to reevaluate the conditions under which it is willing to risk nuclear attack. Even though it might retaliate with its own nuclear arsenal, U.S. retaliation may not compensate for U.S. or allied losses.

Plausible scenarios for the current set of suspected proliferants to threaten U.S. territory with nuclear or other weapons of mass destruction are difficult to devise. None possess missiles or aircraft with sufficient range to reach the United States, nor are potentially hostile powers likely to develop such systems in the next 10 years (see next section). Nevertheless, a state that badly wanted to wreak destruction on a U.S. city could probably do so, whether it had advanced delivery systems or not—and whether the United States had effective defenses against such advanced delivery systems or not.

PROLIFERATION THREATS AND PROSPECTS

Only five countries (the United States, Russia, the United Kingdom, France, and China) acknowledge possessing nuclear weapon stockpiles.[7] Three more-Ukraine, Kazakhstan, and Belarus--have former Soviet strategic nuclear weapons located within their borders (although as yet they do not control them), and it is not yet certain that they will give them up. Only three states (United States, Russia, and Iraq) say they have chemical weapon arsenals, and all of these weapons are in the process of, or are slated for, destruction. No countries admit to active offen-

[7] South Africa has acknowledged having assembled six nuclear weapons but says it has since destroyed them.

sive biological weapon programs.[8] Few countries, therefore, are overtly deploying or preparing to deploy weapons of mass destruction. The difficulty in assessing the extent of the proliferation threat lies in determining which states are doing so secretly. Merely counting the states that today are *capable* of mounting a program to produce weapons of mass destruction inflates the proliferation threat considerably, just as counting only the states *acknowledging* such production errs in the opposite direction.

This report names countries commonly cited in the public literature as having nuclear, chemical, or biological weapons, or as having programs to acquire them. Consistent with the unclassified nature of this report, the estimates given here are not based on classified sources and should in no way be considered authoritative or indicative of official U.S. Government assessments. Therefore, the tables in this report may well disagree in some respects with the best intelligence information available to the U.S. Government, which itself can be uncertain and incomplete. If an incomplete public understanding of the current extent of proliferation poses problems for U.S. nonproliferation policy, it behooves U.S. policymakers to ensure that the open literature better reflects the actual state of affairs.

Keeping Score

Besides the five acknowledged nuclear powers and the three non-Russian former Soviet republics that still have nuclear weapons on their territory, only three "threshold states" appear to possess nuclear weapons or have the ability to deploy them on short notice: Israel, which is widely believed to have a clandestine arsenal; India, which tested a nuclear device in 1974 and probably has stockpiles of nuclear weapon material available, but has made no overt moves to develop a nuclear arsenal; and Pakistan, which is cut off from U.S. military aid because the President cannot certify that it does not possess a nuclear explosive device.[9] None of these countries is a member of the Nuclear Non-Proliferation Treaty. South Africa has admitted to mounting a nuclear weapon program that culminated in the construction of six nuclear weapons, confirming suspicions that had included it in this threshold category. However, stating that it has destroyed those weapons, it has since joined the Nuclear Non-Proliferation Treaty as a non-nuclear-weapon state and opened up its nuclear facilities to international inspection. Little information has been released so far on the results of those inspections, but to date (June 1993) they have not resolved 'serious questions' that the United States has concerning South Africa's compliance with its NPT obligations.[10]

A few other states reputed to have nuclear weapon programs are apparently not as far advanced as the above four: Iran and Libya, both NPT members; North Korea, which has given and then retracted notice of its intent to withdraw from the NPT, and possibly Algeria, which is not an NPT member. North Korea appeared to have taken steps to back away from its nuclear weapon program, permitting inspection (after years of delay) of facilities that clearly seem to have been intended for nuclear weapon production. However, after having been caught attempting to mislead international inspectors as to the extent of its nuclear program, it refused to open other suspicious facilities for inspection. Rather than comply with its commitment under the NPT to

8 Russia has admitted that the Soviet Union's offensive biological weapon program persisted after the U.S.S.R. signed the Biological Weapon Convention banning such work but insists that this program has since been halted.

9 In 1992, Pakistan's Foreign Secretary was quoted as declaring that Pakistan had all the p@ for a nuclear weapon. He subsequently retracted this statement, with the Ministry of Foreign Affairs claiming he had been misquoted.

10 "Adherence to and Compliance with Arms Control Agreements and the President's Report to Congress on Soviet Noncompliance with Arms Control Agreements," prepared by the U.S. Arms Control and Disarmament Agency, Jan. 14, 1993, p. 18.

cooperate with such inspections, it gave notice of its intent to withdraw from the NPT, becoming the first nation ever to do so. To many observers, such actions confirm that North Korea not only had been pursuing nuclear weapons all along, but seeks to preserve the capability to do so.

Iraq is a special case. Although the 1991 Gulf War and its aftermath arrested and reversed Iraq's nuclear weapon program before it could come to fruition, United Nations inspections showed the program to have been much broader and more advanced than Western intelligence agencies had suspected. Few observers doubt that the program will resume in the absence of the extraordinarily international monitoring efforts imposed upon Iraq by the United Nations Security Council.

Argentina and Brazil in the past had been thought to be pursuing nuclear programs, albeit ones that were less advanced than those of the threshold states. In recent years, however, they have agreed to open up their nuclear facilities to bilateral and international inspection to assure each other and the rest of the world that they are not developing nuclear weapons.

Public reports of the extent of chemical and biological proliferation differ with each other more than do assessments of nuclear proliferation. OTA has reviewed several compilations of states suspected of pursuing chemical or biological weapons; those states appearing in a preponderance of these lists are identified in figure 1-1, together with the states mentioned above as still suspected of pursuing nuclear weapons. (See ch. 2.)

In all, 14 countries are listed in figure 1-1 as widely believed to possess or to be pursuing nuclear, chemical, or biological weapons. Given official U.S. Government statements that ''more than 25 countries . . . may have or may be developing" weapons of mass destruction and their delivery systems, figure 1-1 may understate the number of countries pursuing such systems.[11] Part of the discrepancy may be states that are pursuing delivery systems but not nuclear, chemical, or biological weapons, which would not be included in figure 1-1; the remainder might indicate countries suspected by U.S. intelligence of pursuing such weapons but not yet identified in open sources.

Most of the states listed in figure 1-1 have bought or developed simple ballistic missiles with at least the capability of Scud missiles. All have combat aircraft with characteristics that make them candidates for delivering weapons of mass destruction. None seems to have cruise missiles adapted to this purpose, but the spread of applicable technologies makes cruise missiles a threat to be concerned about in the future.

Three features stand out in the combined perspective offered by figure 1-1. First, the estimate for the current number of states actively pursuing nuclear weapons is small, and smaller than it might have been a few years ago. Second, the set of countries trying to acquire nuclear weapons overlaps considerably with the set suspected of having chemical and biological weapon programs. Third, the most immediate and serious threats (beyond the potential threat posed by former Soviet republics) are concentrated in three regions of international rivalry: the Koreas, India-Pakistan, and the Middle East.

Longer term assessments of the extent of proliferation are harder to make, although some trends are clear. For example, for 'at least another decade," only China, Russia, and possibly Ukraine, Kazakhstan, and Belarus--all possessing weapons that have long been capable of being targeted at the United States—will pose a ballistic missile

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11 Testimony of R. James Woolsey, Director of Central Intelligence, before the Senate Committee on Governmental Affairs, Feb. 24,1993. Although he gave some information on the activities of some countries, his testimony did not identify all of the states believed by the United States to be pursuing weapons of mass destruction and their delivery systems, much less specify which ones are pursuing which weapons.

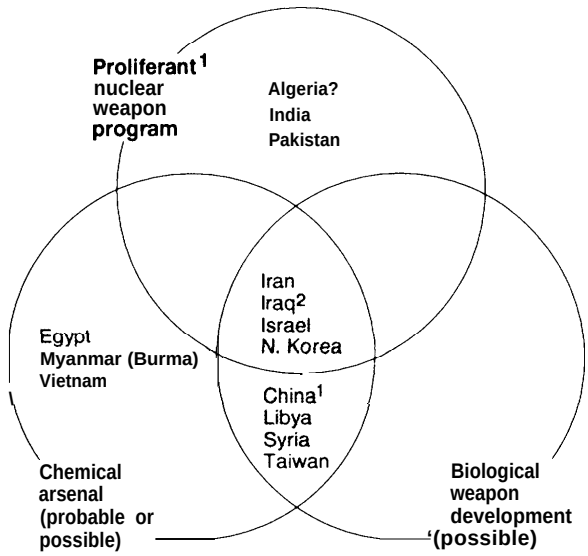
threat to the territory of the United States.[12] Projections of the future number of nuclear, chemical, or biological powers are more elusive. It is hard to determine even the present status and anticipated progress of existing programs. Even with the wealth of information that has been uncovered about the Iraqi nuclear weapon program, for example, experts disagree over how long it would have taken the Iraqis to assemble a working weapon. Moreover, extrapolating from current trends can be misleading. We have already noted several examples of apparent 'roll-back" in nuclear weapon programs. Further changes in the world situation, including those that nonproliferation policies seek to bring about, will affect the extent of future proliferation.

Trends Fostering Proliferation

RISKS FROM THE BREAKUP OF THE SOVIET UNION

The breakup of the Soviet Union-and the shakiness of governmental authority in its successor republics-could contribute to proliferation problems. The threat is potentially great, but hard to predict. One set of problems could arise from the emergence of Ukraine, Kazakhstan, or Belarus as new nuclear powers and the ramifications such actions would have on the nuclear nonproliferation regime. Another concerns the future integrity of Russia itself, or at least of the system of controls over Russian nuclear weapons and nuclear weapon materials. A third issue, perhaps the most immediate risk posed by the Soviet breakup, is the possible leakage to potential proliferants of people, critical information, equipment, materials, or even complete weapons. Such assistance could be of great value not only to nuclear but also to chemical or biological weapon programs. Finally, in the longer term, various former Soviet republics may choose to develop weapons of mass destruction indigenously, perhaps drawing on facilities that had once contributed to Soviet weapon programs.

Figure I-l-Suspected Weapon of Mass Destruction Programs



[1] The United States, Russia, United Kingdom, France, and China are nuclear-weapon states party to the Nuclear Non-Proliferation Treaty and therefore are not considered nuclear "proliferants." However, China is suspected of pursuing chemical and biological weapons and is included in this figure for that reason.
[2] Iraqi programs have been reversed under UN Security Council Resolution 687.

SOURCE: Tables 2-6, 2-7, 2-8; Office of Technology Assessment, 1993.

THE END OF THE COLD WAR

Apart from the acute crises posed by the collapse of the Soviet Union, the end of the Cold War has the potential for weakening restraints against proliferation. Countries that had formerly enjoyed Soviet or U.S. security guarantees may now feel more exposed and insecure, increasing

12 Robert M. Gates, Director of Central Intelligence, before the Senate Governmental Affairs Committee, Jan. 15, 1992. See "Weapons Proliferation in the New World Order," S. Hrg. 102-720, 102d Cong., 2d Session, Jan. 15, 1992, p. 7. Britain and France, with submarine-launched ballistic missiles capable of reaching the United States, are not considered to pose a threat.

the motivation to develop their own weapons of mass destruction. Moreover, controls that the Soviet Union had formerly exerted over its allies no longer exist, or at least have been considerably weakened given the reduced role that Russia is playing in international affairs. As the United States reshapes its own security relationships in recognition of the Cold War's end, in particular by withdrawing overseas forces, it too may lose some leverage over its allies.

PERSISTENCE OF REGIONAL CONFLICTS

Outside the sphere of the former Soviet Union, the most serious drivers for proliferation of weapons of mass destruction remain the seemingly intractable regional conflicts in South Asia and the Middle East, where most of the current proliferants are located. In South Asia, India and Pakistan are unable to resolve their ethnic and territorial dispute over Kashmir, while India also--or perhaps even primarily--feels threatened by China, the nuclear power to the northeast. In the Middle East, the current peace process does not promise early resolution of the Arab-Israeli conflict. In addition, the Iraqi invasion of Kuwait illustrates that, even independent of Israel, the Arab and other Islamic countries (e.g., Iran) would probably continue to arm against one another.[13]

Proliferation of conventional arms, fueled by these regional conflicts as well as by the glut of military industrial capacity and weapon stockpiles in the wake of the Cold War, can stimulate the quest for weapons of mass destruction as ''equalizers. ''14At the same time, continued sales of high-performance combat aircraft and the spread of missile technology bolster states' ability to deliver weapons of mass destruction.

SPREADING TECHNOLOGY AND INDUSTRIALIZATION

Economic and technological development will, in general, enhance national wealth, technical skill, and industrial capabilities useful for indigenous production of weapons of mass destruction and their delivery systems. It will also increase the number of potential foreign suppliers of skill and technology to proliferant nations. Consequently, it will be increasingly difficult for a small number of industrially advanced countries to control weapon proliferation by denying access to key technologies or materials.

Indeed, the dissemination of technologies that have at least some relevance to producing weapons of mass destruction might need to be not only tolerated but encouraged if populations in developing nations are to improve their health, environment, and standards of living. This is especially true for chemical and biological technologies. Technologies that can contribute both to military and civil objectives, often referred to as ''dual-use" technologies, are actually multi-use, providing basic capabilities that can be used in a host of applications (e.g., computing, metal-forming, and diagnostic testing). Controls on some dual-use technologies will prove to be infeasible (if the technologies involved have already disseminated too widely) or undesirable (if too many non-weapons-related activities would be constrained as well).

These difficulties notwithstanding, export controls will remain an important nonproliferation tool. For example, although Iraq's indigenous industrial base was more capable than most outsiders realized, it still had to import much of the equipment used in its weapon facilities. This level of importation was made feasible only by Iraqi oil revenues.

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13 Arab and Iranian disputes with Turkey, a NATO member, have the potential to involve the United States directly.

14 For discussion of the spread of conventional military technology, see U.S. Congress, Office of Technology Assessment, *Arms Trade*, OTA-ISC-460 (Washington, DC: U.S. Government Printing Office, June 1991).

RESISTANCE TO DISCRIMINATORY REGIMES

A few developing countries, most notably India, object to external attempts to deny them nuclear and missile-related technologies that are accepted as legitimate for certain other countries, Nevertheless, most nations of the world have been willing to live with the two-tiered, nuclear/non-nuclear structure of the NPT. This factor is not an issue with the Chemical Weapons Convention or the Biological Weapons Convention, both of which apply to all states without distinction.

WEAKENED TABOO AGAINST CHEMICAL WEAPON USE

The 1925 Geneva Protocol prohibits the use of chemical and biological agents in warfare. This ban was observed in most of the conflicts following its entry into force, including World War II (except the use by Japan, then a non-party, of chemical and biological weapons in China). However, more recent instances of chemical weapon use have weakened this international norm. In particular, Iraqi use against Iran in the 1980s may have demonstrated to some defense planners that chemical weapons can be a useful military tool.

Trends Favoring Nonproliferation Efforts

GENERALLY RISING NORM AGAINST PROLIFERATION

An international consensus seems to be growing that further proliferation of weapons of mass destruction should be stopped, and that chemical and biological weapons should be eliminated completely. Governments around the world have declared renewed commitments to nonproliferation. Strengthened nonproliferation norms might help deter potential proliferants. More importantly, they also improve the prospects of strong, coordinated world action to deter and punish violators.

The past few years have brought a significant increase in the number of signatories to the Nuclear Non-Proliferation Treaty, rising from 138 at the end of 1989 to 157 by January 1, 1993. Two of the nuclear weapon states that did not originally join the NPT (China and France) have joined in the last two years, as did a hold-out state that has admitted having produced nuclear weapons outside the NPT (South Africa). Although three non-signatories are believed to have actual or potential nuclear weapon capabilities (Israel, India, and Pakistan), no states have declared themselves to be nuclear powers since China in 1964. No non-nuclear members of the NPT have ‘‘gone nuclear,’ although a few have been trying.

The deep reductions in nuclear forces undertaken by the United States and Russia mean that both countries are finally making visible progress on their NPT obligation to ‘‘pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race, ’ even though they seem unlikely to seriously pursue the NPT goal of “general and complete disarmament. ” Progress in superpower nuclear arms reductions could undermine longstanding complaints about the discriminatory nature of the NPT that might otherwise have hurt the treaty’s chances for renewal when it comes up for extension in 1995. On the other hand, North Korea would deal the nonproliferation regime a serious blow if it proceeds to withdraw from the NPT

END OF THE COLD WAR

In part, the end of the Cold War has allowed the strengthening of this norm against proliferation. Besides fostering a new level of cooperation between the United States and Russia (as successor to the Soviet Union in the U.N. Security Council), the cessation of the U.S.-Soviet conflict has also made possible changes in national priorities and policy emphases. Although nonproliferation policies may continue to conflict with other policy goals, they need no longer be subordinated to Cold War objectives. In addition, foreign policy and intelligence resources are being redirected from Cold War efforts to deal with proliferation.

Should Russia revert to a foreign policy that is seriously threatening to Western interests, nonproliferation will be set back. Granted, even during the Cold War, the Soviet Union took a strong stance against nuclear proliferation, and an anti-Western Russia would likely do the same. But future efforts to contain the spread of all types of weapons of mass destruction will require significant Russian-United States cooperation in support of nonproliferation norms, not just parallel policies in limited areas (see ch. 3).

RECENT REVERSALS OF NATIONAL POLICIES

Reversals in the nuclear weapon programs of Argentina, Brazil, South Africa, and (albeit involuntarily) Iraq follow decisions in earlier decades by Sweden, South Korea, and Taiwan to halt programs that had seemed directed at nuclear acquisition. Such reversals, however, are themselves reversible: despite some moves by North Korea to open up to international inspection, its subsequent actions have given rise to serious doubts.

GROWING COOPERATION IN EXPORT CONTROL REGIMES

Several multilateral groups have formed to control the export of equipment or materials that might be used in the production of weapons of mass destruction or of missiles. These control regimes have been strengthened in the past few years, both by covering additional items and by expanding their membership. Particularly notable is the April 1992 decision of the 27-member Nuclear Suppliers Group to require importers of nuclear technology to accept international monitoring (through the International Atomic Energy Agency's system of safeguards) over their entire nuclear programs, not just over the particular facilities built with imported technology. This action leaves China as the only supplier of nuclear technology that does not require such 'full-scope safeguards' as a condition of sale. By requiring full-scope safeguards, exporters prevent states from acquiring expertise in safeguarded facilities and using it to build and operate other facilities that are not open to international inspection or controls.

U.N. ACTIONS IN IRAQ

Besides reversing Iraqi mass destruction weapon programs, recent U.N. Security Council resolutions make approving references to international nonproliferation and disarmament treaties, setting useful precedents in demonstrating international resolve against weapons of mass destruction. The Security Council has also taken on both short- and long-term onsite monitoring tasks to assure that its decisions mandating elimination of Iraqi weapons of mass destruction are carried out.

CHEMICAL WEAPONS DISARMAMENT AND THE CHEMICAL WEAPONS CONVENTION

The two largest chemical weapon powers, the United States and Russia, have committed themselves to the destruction of their chemical arsenals, together with their development and production facilities. The Iraqi chemical arsenal is being dismantled under U.N. supervision. Most significantly, the Chemical Weapons Convention (CWC), signed by more than 140 states in early 1993, bans for the first time the development, production, and possession of chemical weapons (in addition to their use) and reinforces the international norm against chemical weapons. Regardless of any doubts that may remain as to whether the CWC's verification regime is adequate to the task and whether it will be stringently implemented, the Convention strengthens the international consensus that chemical weapons are illegitimate. If some nation were to use chemical weapons in the future, the international community may feel committed to react more strongly than it did against Iraq's use in the 1980s.

BIOLOGICAL WEAPONS CONVENTION VERIFICATION

In the wake of the Russian admission that the Soviet Union had violated the Biological Weapons Convention, the United States, the United

Kingdom, and Russia have agreed on a program to inspect each other's biological facilities.[15] Although states that have joined the Convention disagree over the feasibility or desirability of a formal verification regime, an international Ad Hoc Group of Governmental Experts on Verification (VEREX) is considering potential verification measures.

In sum, despite some dangerous trends and many uncertainties, the world community has significant new opportunities to curtail, and perhaps roll back, the spread of weapons of mass destruction.

THE NONPROLIFERATION POLICY CONTEXT

The United States and other countries concerned about the proliferation of weapons of mass destruction have instituted measures seeking to impose obstacles to the acquisition of weapons of mass destruction; to create disincentives in order to deter states from developing such weapons or to persuade them to reverse course; to offer benefits to states that agree to forgo such attempts; and to develop **security** improvements to reduce the perceived needs for the weapons. These measures have been implemented to date through three primary mechanisms: national policies and laws governing states' actions with respect to others that are developing or assisting in the development of weapons of mass destruction; multinational agreements to restrict exports of certain technologies or to take action against those states found to be violating international nonproliferation norms; and international treaties and institutions open to all states who agree to subscribe to their principles.

Imposing Obstacles to Proliferation

Obstacles that can be put in the way of states trying to acquire weapons of mass destruction include using secrecy to restrict the flow of knowledge; adopting export controls; taking diplomatic or other action to stop exports by third parties; and acting to stop or discourage experts from providing assistance. Since the United States is not the only source of technology, knowledge, or other support that might be useful to a proliferant, such measures must be imposed multilaterally to be effective. At the same time, however, U.S. leadership is necessary to mobilize effective international cooperation.

If, despite these barriers, a proliferant nation manages to acquire facilities for a weapon program that another country or countries deem to pose an intolerable security threat, the ultimate recourse might be to impose another kind of obstacle: destroying the facilities by military attack. However, such an approach is fraught with legal, political, and operational difficulties, and must be considered at most as a last resort.

EXPORT CONTROLS

Export controls are intended to block the most straightforward paths to developing weapons of mass destruction and to raise the price and the time required for alternate approaches. They can also provide information valuable for monitoring programs to develop weapons of mass destruction. Export controls will remain an important component of nonproliferation policy for years, especially in the nuclear area. However, control regimes can be defeated if their targets can "invent around" restricted technologies or products, if controls are attempted on goods that are too widely available, or if some potential suppliers are not included. Moreover, it is very difficult to control the education of scientists and engineers in one country who may later return or migrate to another to develop weapons of mass destruction.

In the United States, export controls are established by a number of public laws and regulations

15 "Joint U.S./U.K./Russian Statement on Biological Weapons," Sept. 14, 1992, reproduced in *The Arms Control Reporter* (Cambridge, MA: Institute for Defense and Disarmament Studies, 1992), vol. 11 (1992), p. 701.D.1

(see ch. 3), and they are also formally or informally coordinated with those of other states. They now cover a range of technologies related to nuclear, chemical, and biological weapons, as well as ballistic missiles and conventional armaments.

SANCTIONS AGAINST SUPPLIERS

The United States can impede weapon programs in proliferant states by helping foreign governments block aid that their own citizens or corporations may be providing such programs. If U.S. intelligence uncovers foreign plans to provide such assistance, the United States can request the government having jurisdiction over such activities to stop them. In addition, U.S. laws can impose sanctions directly against foreign individuals or companies, including criminal penalties, debarment from U.S. Government procurement, and denial of access to the U.S. market (see ch. 3). Should a foreign government itself be aiding proliferation, the United States can take diplomatic measures against it such as denial of trade preferences, arms transfers, or financial assistance.

MILITARY ACTION

In extreme cases, the United States, another nation, or a multinational coalition might feel compelled to attack facilities, equipment, or materials believed to be connected to weapons of mass destruction. However, if not authorized by the United Nations Security Council, such an action would generally be viewed as contrary to international law unless it could be shown to be required for national self-defense, and unless other means short of attack had been exhausted. (Although they made precisely those arguments, the Israelis were unable to convince the world community that their 1981 raid against Iraq's Osirak nuclear reactor was justified.)

Military action involves very high risk. Operationally, the attacking country or group of countries must contend with questions about the quality of its intelligence, how well the attack can be executed, and how badly the attack will damage the proliferant state's weapon program. As the Israeli raid showed, military attack is not a permanent solution. Strategically, a potential attacker must consider the degree of international backing it is likely to expect and the prospect of retaliation (military, diplomatic, or terrorist). Military action that is not explicitly sanctioned by the international community risks damaging consensus on future cooperative nonproliferation policies and might even build sympathy for the victim of the attack.

Disincentives and Sanctions Against Proliferants

Mechanisms exist in U.S. law—but are not laid out in international law—to punish states found to have used weapons of mass destruction or to have engaged in activities related to their development (see ch. 3). At the international level, enforcement of international nonproliferation commitments falls to the United Nations Security Council, which has the authority to respond to ''threats to international peace and security" by imposing measures such as sanctions, severance of travel and communication links, diplomatic isolation, or even military action under Chapter VII of the United Nations charter.[16] Actions of the Security Council are binding upon all U.N. members. Security Council enforcement of existing nonproliferation commitments such as the Nuclear Non-Proliferation Treaty and the 1925 Geneva Protocol could deter further proliferation and

16 By themselves, international organizations involved with nonproliferation such as the International Atomic Energy Agency, typically can take no punitive action stronger than expelling members found to have violated their commitments to the organization. However, the IAEA can refer evidence of violations to the United Nations Security Council for further action. It did so for the first time in April 1993, when it found North Korea in violation of its safeguards agreement.

strengthen global nonproliferation norms.[17] Conversely, inaction in such cases will weaken the nonproliferation regime.

Any United Nations efforts to enforce treaty commitments will not directly affect those states that have not acceded to these commitments in the frost place. However, in January 1992, the Security Council declared the proliferation of weapons of mass destruction to be a threat to international peace and security, opening up at least the possibility of taking action even against proliferants who are not party to global nonproliferation regimes.

Within the United States, current laws and regulations to deter or punish proliferants stress economic sanctions. However, other measures could be taken, many of which serve not only to deter further proliferation but to help address the consequences of proliferation if it occurs. These measures include:

- embarrassment by disseminating intelligence or other information exposing illicit activities;
- provision of technical or military assistance to states threatened by weapons of mass destruction;
- development and deployment of active defenses (e.g., missile or air defenses) or passive measures (e.g., gas masks and protective clothing) to protect against the weapons;
- diplomatic isolation of proliferants or formation of countervailing military alliances; and
- withdrawal of U.S. security guarantees.

The effectiveness of these measures will depend, like other nonproliferation measures, on the degree of international cooperation behind them. The presence of strong international norms against acquisition and use of these weapons will be important to getting that cooperation.



UN PHOTO, E. DEBEBE

The United Nations Security Council, which has primary responsibility for the enforcement of international nonproliferation obligations,

Benefits for Forgoing Weapons of Mass Destruction

Coercive measures by themselves may not always be sufficient to stop states from acquiring weapons of mass destruction. The best hope for nonproliferation in the long term lies in building a consensus among potential proliferants that they should jointly refrain from acquiring these weapons. However, several factors make such a consensus difficult to achieve. States seeking weapons of mass destruction may want them for military purposes (including intimidation or deterrence), for political influence, for national pride, or for international status. The presence of nearby nuclear powers is a powerful incentive to develop nuclear weapons, and a cascading one. (China acquired them because of the United States and the Soviet Union; India because of China; Pakistan worries about India, etc.) To forgo weapons of mass destruction, potential proliferants must come to see that their

17 The 1925 Geneval Protocol bans use, but not development, production or stockpiling, of chemical and ‘ ‘bacteriological’’ weapons. Many states ratifying it reserved the right to retaliate in kind against chemical or biological attack, or considered it binding only with respect to other signatories. Therefore, it effectively became a ‘‘no first use” agreement. Moreover, no attempts have ever been made to enforce it against violators. Signatones who have since acceded to the Chemical and the Biological Weapons Conventions, which unconditionally ban those weapons, have rescinded their reservations to the Geneva Protocol.

political or military needs can be met in some other way.

Although it is not likely to sway a determined proliferant, financial, technical, and other development assistance can be offered to states forgoing the development of weapons of mass destruction.[18] Exemptions from export controls on dual-use items, or preferential access to international aid organizations, might also be offered. The Nuclear Non-Proliferation Treaty (NPT), for instance, promises technical assistance in the peaceful uses of atomic energy, including medical and agricultural applications. Note, however, that such assistance can be a double-edged sword, since familiarity with nuclear technology can contribute to military as well as peaceful goals. The Chemical Weapons Convention (CWC) offers more in the way of incentives than the NPT, promising not only access to chemical technology but also various assurances to parties who find themselves threatened or attacked with chemical weapons. Members of the CWC envisage that chemical weapon-related export controls will be relaxed against member-states judged to be in compliance. The Biological Weapons Convention (BWC) makes similar provisions for promoting transfers of biotechnology to member-states, although these have never been implemented.

Security Benefits To Reduce the Demand for Proliferation

Technical assistance notwithstanding, the central bargain of consensual nonproliferation agreements is that states give up their own rights to acquire weapons of mass destruction on the condition that they will not be needed to deter the weapons of others. This deal underlies regional or global arms control arrangements such as the Nuclear Non-Proliferation Treaty, the Chemical Weapons Convention, the Biological Weapons Convention, the Latin American Nuclear-Free Zone (Treaty of Tlatelolco), and the South Pacific Nuclear-Free Zone (Treaty of Rarotonga). These treaties codify the international norms against weapons of mass destruction and have value for that reason alone. Beyond that, however, most of them are also associated with verification regimes intended to permit parties to assure each other that they are in compliance (see box l-A).

Nonproliferation treaties involve a "free-rider" problem: states that remain outside the regime can sometimes enjoy the benefit of reducing the threat to themselves without having to pay the price of giving up their own weapon options.[19] Moreover, the NPT—which permits the United States, Russia, Britain, France, and China to retain their nuclear arsenals--does not eliminate the potential nuclear threat that member-states may believe these nations to pose. (It does, however, commit the nuclear weapons states to pursue nuclear disarmament and to assist non-nuclear states in their peaceful nuclear programs.)

The long-run success of nonproliferation policy is likely to depend, at least in part, on the reduction of the security threats used to just@ acquisition of weapons of mass destruction. The security problems in each region of proliferation concern are different; each will require specially tailored arrangements if parties are to trust one another enough to halt or reverse their military competitions. Such arrangements may consist of combinations of political accommodations, eco-

18 Instead of serving primarily as an incentive to adopt other nonproliferation policies, development assistance could itself be a nonproliferation measure to the extent that lack of development, economic deprivation, and competition for economic resources are a source of conflict. Similarly, policies that alleviate international tensions resulting from demographic trends, differing political systems, ideology, and resource pressures can also be considered nonproliferation measures. Analysis of such policies, however, goes outside the scope of this assessment.

19 For this reason, the Treaty of Tlatelolco contains a provision that keeps it from coming into force until all states in the region become members. Twenty-three of the Treaty's parties have waived this provision accepting the Treaty's obligations. Brazil and Chile, which had not previously waived the provision, and Argentina and Cuba, which had not entered the Treaty at all, have recently said they will join the Treaty or permit it to enter into force for them.

Box 1-A-International Nonproliferation Treaties and Their Verification Regimes

Nuclear Non-Proliferation Treaty (NPT)

The NPT prohibits all member-states except the five acknowledged nuclear powers from acquiring nuclear weapons. It also requires ail non-nuclear-weapon member-states to implement a safeguards agreement with the International Atomic Energy Agency (IAEA) covering ail nuclear materials that might be useful for weapons. IAEA safeguards are intended to detect, and therefore to deter, the diversion of materials from peaceful nuclear programs to military use, although they cannot by themselves prevent such diversion.

Under the NPT, non-nuclear-weapon member-states must declare to the IAEA all facilitiesthat handle nuclear materials, and these facilities then become subject to safeguards. But the IAEA has had little ability to monitor whether states were conducting nuclear weapon activities in undeclaredfacilities. The limitations of this approach became clearafterthe 1991 Gulf War, when Iraq was revealedto have mounted a major nuclear weapon program outside of its declared nuclear program. Although monitoring declared nuclear facilities will continue to be crucial to verifying compliance with the NPT, it addresses only half the problem. Some means must also be found to allay suspicions that nuclear weapon activities might be undertaken in covert or undeclared facilities.

The IAEA has always had the formal abilityto undertake "special inspections" of undeclared fadiities if it had reason to suspect illicit activities there. However, it did not exercise this authority until February 1993, when it attempted to inspect suspicious sites in North Korea. (in response, North Korea refused access to IAEA inspectors and announced its withdrawal from the NPT.) To carry out such inspections, the IAEA must be able to receive and act on information identifying suspect facilities, and it must have the backing of the U.N. Security Council in case the target state refuses to cooperate.

Since the NPT entered into force in 1970 for a 25-year period, a review conference will be held in 1995 at which member-states must decide whether to extend the treaty, and for how long. consequently, successful extension of the NPT, preferably for an indefinite term, is one of the most important issues facing the nuclear nonproliferation regime.

Treaties of Tlatelolco and Rarotonga

Both of these nuclear-weapon-free zone treaties create regional organizations to monitor compliance and also require that member states submit to IAEA safeguards.

Chemical Weapons Convention (CWC)

The newly signed Chemical Weapons Convention bans the development, production, possession, and use of chemical weapons and establishes the most comprehensive verification scheme yet formulated in an international treaty. When it comes into force, it will create a new international institution-the Organization for the Prohibition of Chemical Weapons (OPCW)--that will receive routine declarations from member states and conduct routine inspections of declared chemical facilities. More significantly, it will also have the ability to conduct "challenge inspections" at any site--government or private-suspected of illegal activity. Far more facilities produce, ship, or use chemicals than are involved in peaceful nuclear activities, making the routine notification and inspection activities of the OPCW much more complicatedthan those of the IAEA. Moreover, the CWC's challenge inspection provisions are much more rigorous than the IAEA's provisions for ''special inspections.'' The final treaty text--and the implementation procedures now being negotiated among treaty signatories-are based on the principal of "managed access," in which the state being searched has the right to limit the access of treaty inspectors in order to protect information not germane to the treaty. An important challenge in implementing the CWC's inspection provisions will be balancing the need to monitor treaty compliance with the need to protect proprietary and national-security information unrelated to the CWC.[1]

[1] See Office of Technology Assessment, *The Chemical Weapons Convention: Effects on the U.S. Chemical Industry*, OTA-BP-ISC-1O6 (Washington DC, U.S. Government Printing Office, August 1993).

(Continued on next page)

Box 1-A—International Nonproliferation Treaties and Their Verification Regimes—(Continued)

Biological Weapons Convention (BWC)

Signed in 1972, the Biological Weapons Convention bans development, production, and stockpiling of biological agents or toxins for purposes other than "prophylactic, defensive, and other peaceful activities."[2] Unlike the NPT or the CWC, however, it makes no explicit provisions for verification. The Treaty text requires only that member states are to "consult one another" and "cooperate in solving any problems which may arise in relation to the objective" of the treaty. States believing other states to be in breach of the treaty may lodge a complaint with the UN Security Council, and states are obligated to cooperate with any Security Council investigation.

Pursuant to the Third Review Conference of the BWC in 1991, an expert working group has been considering means by which a verification regime for the BWC might be instituted. Under the Bush administration, the United States opposed implementation of such a regime on the grounds that development and production of biological weapons—much more so than chemical or nuclear weapons—are easy to hide. Therefore, a formal verification regime would not prove to be much of a deterrent to cheating, nor would it provide sufficient confidence in other states' compliance to be worth the costs of conducting and submitting to highly intrusive inspections. Moreover, the United States argued that ineffective verification measures could instill a false sense of confidence and prove to be worse than no verification regime at all. Other states, including many U.S. allies, countered that even a modest verification regime has some prospect of catching violations and that any state contemplating cheating would have to take that risk into account. Moreover, the verification regime would mandate declarations of all activities relevant to the Biological Weapons Convention. These declarations, when combined with onsite inspections, would make it easier to detect anomalies indicative of a violation.

Under the Clinton administration, the United States is reassessing its position on the value of establishing a BWC verification regime. Balancing the degree of intrusiveness needed to detect or deter cheating with the need to protect proprietary and national-security information will be even more difficult for the Biological Weapons Convention than it is for the Chemical Weapons Convention.

SOURCE: Office of Technology Assessment, 1993.

[2] The formal name of the Biological Weapons Convention is the "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction."

nomic measures, military confidence-building measures, and arms control. They may also involve security guarantees provided to regional states by powers outside the region (positive security assurances), or assurances from extra-regional powers that military force-or weapons of mass destruction-will not be used against regional states (negative security assurances).

Regional security measures and nonproliferation policies have to proceed in tandem. States lacking confidence in regional security arrangements may be unwilling to forgo development of weapons of mass destruction, thus posing a potential threat to their neighbors that will make it harder to resolve the regional security situation.

Some analysts go so far as to assert that a transformation of the whole basis of global security will be required to have any chance of inducing restraint among many of the states that might otherwise turn to weapons of mass destruction. Proliferation cannot be controlled, they argue, unless the international political system is fundamentally changed from one in which states assure their own security through their military forces and alliances, to a "cooperative security" regime in which states do not maintain forces

sufficient to conduct aggression in the first place. With the Cold War over, these analysts believe it is now possible to move towards such a world.

When Nonproliferation Fails

The United States cannot assume that all those states now acquiring or possessing weapons of mass destruction will soon renounce them, nor that future nonproliferation policies will be 100 percent effective. It must therefore consider measures to mitigate the consequences of proliferation for U.S. and international security.

Modifying U.S. military force structure and operational planning to cope with proliferation is unquestionably an important task for U.S. policy makers. If they prove technically feasible, actions such as improving intelligence capabilities or adopting passive and active defenses might improve U.S. military capabilities without interfering with nonproliferation objectives. Indeed, by lessening the military value of an opponent's weapons of mass destruction, such actions can simultaneously serve to deter an opponent from acquiring such weapons, and to deter or militarily counter their use if acquired anyway.

Other preparations to mitigate the conse-quences of proliferation, however, might exacerbate the process of proliferation. For example, the existing nuclear powers might wish to deter or even to prevent chemical or biological attack by holding out the prospect of using nuclear weapons. Giving nuclear weapons this mission, however, could increase their perceived utility and status, weakening nuclear nonproliferation efforts. Moreover, advertising a willingness to use even conventional force to preempt or to respond to proliferation may persuade some countries not to forgo weapons of mass destruction, but instead to seek them as a counter-deterrent.

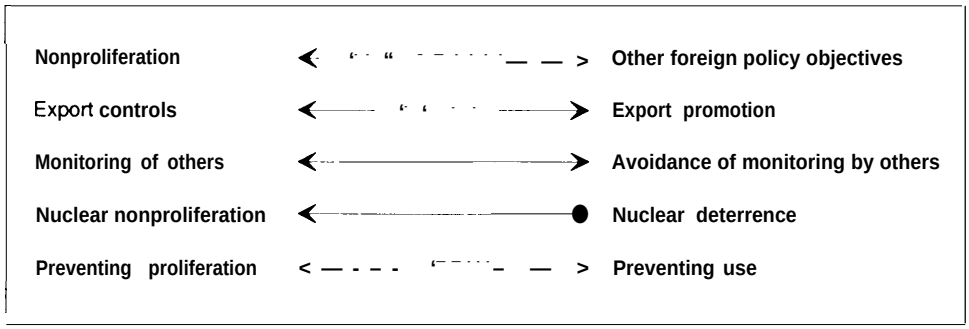
Other measures short of military force might lessen the chances that proliferation will lead to use of nuclear weapons, but these pose serious dilemmas. The established nuclear powers may conclude that if additional states are going to develop and deploy nuclear weapons anyway, it would be prudent to minimize the risk that those weapons might actually be used. Therefore, they might wish to help the emerging nuclear powers develop stabilizing doctrines of deployment and deterrence, and implement appropriate technical safeguards against accidental or unauthorized use. However, this would be tantamount to admitting these states into the nuclear club, showing that proliferation can lead not to international condemnation but to legitimacy and even enhanced status.

CONFLICTING OBJECTIVES

Many of the choices to be made in designing and implementing nonproliferation policies are between potentially *conflicting objectives;* that is, the extent to which nonproliferation should take precedence over other objectives of U.S. policy when they cannot both be pursued simultaneously. Certainly the end of the Cold War has removed one such conflict, eliminating what had been an overriding concern and permitting nonproliferation to take much greater priority. Yet tensions between nonproliferation and other policy objectives continue to force tradeoffs.

Many conflicts between competing goals are mirrored in the organizational structure of the U.S. Government, with particular agencies pursuing missions that at times conflict with each other. With the possible exception of the Arms Control and Disarmament Agency, whose complete agenda in the post-Cold War organization of the U.S. Government is still evolving, no single agency has nonproliferation as its primary mission. The other agencies that have the greatest roles in nonproliferation policy-the Departments of State, Defense, Energy, and Commerce—are all charged with pursuing other goals that can compete with nonproliferation, some of which are described below.

Figure 1-2—Potentially Conflicting Objectives



SOURCE: Office of Technology Assessment, 1993.

The pairings depicted in figure 1-2 and summarized below are not discrete alternatives, but rather opposite poles of a continuum. Intermediate positions are certainly possible, but seeking one goal will generally imply lessening emphasis on the other. These choices must be made on a case-by-case basis, since the appropriate balance between conflicting objectives varies depending on the individual situation.

Nonproliferation v. Other Foreign Policy Objectives

U.S. relationships with other states involve a host of objectives, both generic and country-specific. For example, the U.S. Government may wish to maintain favorable relations with other states, encourage them to support U.S. positions in international fora, restrain their conventional arms buildups, promote exports, support human rights, and work towards common environmental goals. Expending limited U.S. influence to stress nonproliferation goals may mean losing a target state's cooperation on other matters, or even provoking its hostility.

Consider the cases of Israel and China. Israel has a very strong, longstanding relationship with the United States, one in which nonproliferation has never figured prominently. Ensuring the security of a democratic ally threatened by hostile neighbors has outweighed whatever concern the United States has had over Israel's apparent nuclear and ballistic missile arsenal. Even if Israeli weapons of mass destruction are not themselves deemed to threaten the United States or U.S. interests, however, their implicit acceptance complicates nonproliferation policy. Other states condemn U.S. policy as reflecting one standard for friends and another for all other countries, hampering attempts to build international consensus behind nonproliferation policies.

U.S. policy towards China also illustrates tensions among conflicting objectives. U.S. policymakers have sought to stop Chinese sales of nuclear and missile technology. At the same time, they must also take note of China's overall strategic importance in the Pacific region, its growing economic clout, the need to gain China's agreement (or at least its acquiescence) in U.N. Security Council actions, and the desire to promote human rights and democratization within China. Threatening to revoke China's "most-favored-nation" (MFN) status potentially provides the United States considerable leverage over China, just as threatening to withhold the U.S. commitment to Israeli security provides leverage over Israel. In both cases, however, other factors that outweighed nonproliferation have so far kept these threats from being executed.

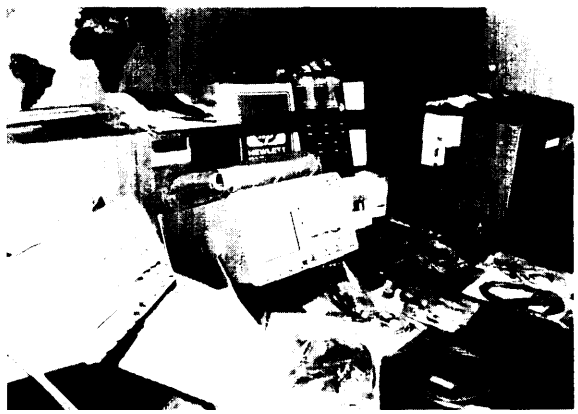
Export Controls v. Export Promotion

The push to improve U.S. economic performance, increase jobs, and rectify the trade imbal-

ance makes it a major national priority to increase exports. Tightening the export-control system for nonproliferation purposes may sometimes conflict with this goal. No respectable exporter deliberately seeks the business of those developing weapons of mass destruction, although too many disreputable ones apparently do. However, some exporters may unwittingly assist proliferants if they do not know by whom and for what purpose their products will be used, or if their goods are diverted after sale.

Tightening export controls and applying sanctions against foreign violators have economic and political costs that must be weighed against their return in international security. These costs may be deemed worth paying, but they should be acknowledged. First, controls can somewhat restrict international trade. Although the number of export denials is a small fraction of all international transactions, many transactions must be screened in order to detect those that ultimately are denied. Consequently, a wide range of businesses must keep informed about and comply with complex regulations and licensing procedures. Individual companies may find themselves losing legitimate sales and the other business opportunities that might have followed those sales. More seriously in terms of U.S. jobs and exports, U.S. firms may also find that foreign competitors under less stringent controls are moving in to take over their markets. Although U.S. policymakers may be willing to hold U.S. firms to a higher standard, such a policy would interfere with U.S. export performance without generating any nonproliferation benefits if other countries do not follow suit.

In addition to their costs to exporters, controls also impose costs on legitimate foreign users of advanced technology. During the Cold War, damage to the Soviet civil sector resulting from Western export controls was seen as a "fringe benefit" of a policy already justified on security



Dual-use *electronic equipment seized by the U.S. Commerce Department's Office of Export Enforcement while in the process of being exported illegally to Iran. The equipment was intended for Iran's Ministry of Defense and its Atomic Energy Organization.*

grounds. In a nonproliferation context, however, exporting states may seek to restrict the spread of weapon-related technology without placing unnecessary obstacles in the way of an importing state's legitimate economic and technological development—a much tougher assignment.[20] By the same token, however, the greater the dependence of a developing country's civil economy on imported technology, the more leverage would be provided by making access to that technology contingent upon acceptable nonproliferation behavior.

Policies governing export controls must address two sets of issues. The frost involves the internal structure, implementation, and enforcement of U.S. export controls. U.S. export-control procedures have been the source of bureaucratic and political controversy for decades, a situation that is likely to be aggravated as nonproliferation replaces the Cold War as the primary driver of export control policy. The second set of issues involves the coordination of export control policies among different nations, and the role that

20 M. Granger Morgan and Mitchel B. Wallerstein, "controlling *the* High Technology Militarization of the Developing World," James Goodby, cd., ***Bipolarity Revisited: Problems in North-South Security Relations After the Cold War,*** (Oxford University Press, in press).

unilateral initiatives play in shaping multilateral consenses. Multilateral control regimes aimed at different weapons of mass destruction and delivery systems have evolved separately; they have differing memberships, procedures, and objectives. Participating governments may wish to examine the existing structure of these multilateral regimes to see if tighter coordination, or consolidation, is desirable or feasible.

Monitoring Others v. Avoiding the Costs of Being Monitoring

Nonproliferation regimes are strengthened by empowering international nonproliferation organizations to make intrusive onsite inspections of suspect activities (see box l-A). Yet states will not easily accept such inspections unless other states do likewise.[21] If the United States expects other states to provide access to outside inspectors, it may have to open itself up to inspection as well. Such inspections have costs that must be weighed against their nonproliferation benefits. In addition to the disruption of normal activities, U.S. Government or industrial facilities exposed to foreign inspections must incur costs to protect classified or proprietary information unrelated to the purpose of the inspection. Even greater costs might be incurred by failing to protect such information, or by inadvertently disclosing secrets that might actually aid a proliferant's own weapon programs.

Nuclear Nonproliferation v. Nuclear Deterrence

One way to reduce the appeal of nuclear weapons is to reemphasize the role they play in international relations. But to do so would mean that the nuclear powers must rely on them less, weakening the credibility and utility of U.S. nuclear deterrent threats--especially those intended to deter military actions short of nuclear attack. Conversely, to the extent that nuclear weapons are given a prominent role in ensuring the security of the United States and its allies--particularly against threats from non-nuclear powers-it becomes harder to make the case that other countries should not be able to address their security concerns in similar ways. Granted, retention by the United States of its nuclear arsenal is very unlikely to be the sole factor inducing another state to pursue nuclear weapons. However, U.S. decisions involving continued nuclear weapon development and testing, continued production of nuclear weapon materials, or reliance on nuclear threats against nonnuclear attack, will certainly influence nuclear nonproliferation norms.

Some argue that in the long run, there is no way to sustain a stable world order in which some states possess nuclear weapons but all others are forbidden to acquire them. In such a view, stopping nuclear proliferation is impossible without a universal prohibition against national nuclear arsenals, with all nuclear weapons either placed in the hands of a supranational organization or banned entirely. However, such a world still seems remote.

Preventing Proliferation. Preventing Use

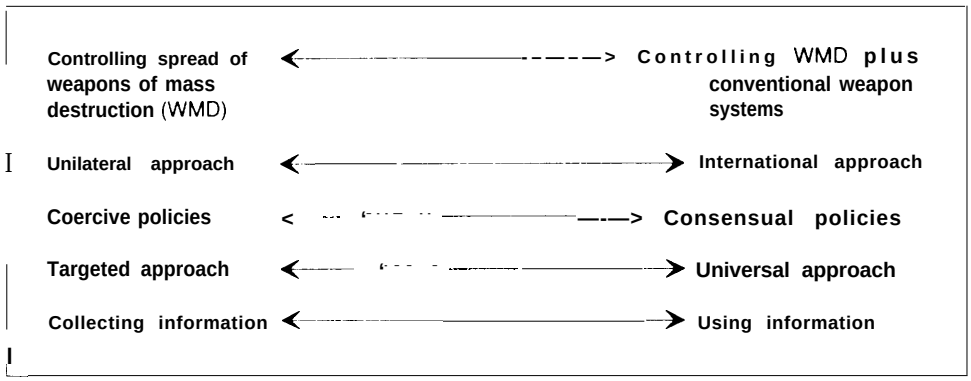
As discussed above, some measures to reduce the risk that nuclear weapons might be used—measures that would require the acknowledgement of new nuclear powers—would actually conflict with controlling proliferation by other states in the longer term.

This conflict arises only in the case of nuclear weapons, since the Nuclear Non-Proliferation Treaty prohibits not their existence but their spread beyond the five acknowledged nuclear powers. Although it would be extremely controversial, one could imagine a change to the nuclear nonproliferation regime that legitimized nuclear arsenals in additional states. The challenge would be to assure that such a change would not lead to further proliferation, and further admissions to the

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21 The United Nations inspections of Iraq, which have the right to go anywhere at any time, are part of a regime imposed upon a defeated power and cannot be considered a precedent for inspection provisions that states would accept voluntarily.

Figure 1-3—Potentially Conflicting Approaches



SOURCE: Office of Technology Assessment, 1993.

nuclear club, in future years. In the case of the Chemical and Biological Weapons Conventions, which impose global bans, exceptions that legitimized the chemical or biological arsenals of one or more countries would be totally incompatible with the treaties themselves.

CONFLICTING APPROACHES

In addition to choices between nonproliferation and other policy objectives, balances must also be struck between conflicting approaches to nonproliferation policy. Like the preceding set, these approaches--summarized in figure 1-3--do not represent diametrically opposed positions, but rather indicate opposing tensions that must be balanced against each other.

Scope of Control Efforts

As noted in the beginning of this chapter, the proliferation of weapons of mass destruction takes place within the context of the proliferation of military capability more generally. Low-technology weapons, advanced conventional weapons, and the command, control, communications, and intelligence infrastructure needed to use these weapons most effectively are all spreading around the world. From the point of view of a military planner, all such weapons in the hands of potential adversaries-mass destruction or conventional-make it more difficult to deter war or to prevail should war erupt. Elements within the Pentagon now define proliferation as "the destabilizing spread, especially to countries of concern in key regions, of a wide array of dangerous military capabilities, supporting capabilities, allied technologies, or know-how," placing weapons of mass destruction at one end of a considerably broader spectrum of concerns.[22] Such a view argues for an integrated strategy in response.

Other linkages between weapons of mass destruction and conventional weapons also exist. A given delivery system might be adapted to carry either class of weapon, linking a state's conventional military power with its capability to deliver weapons of mass destruction. Similarly, one state's conventional forces can motivate an opponent to seek nuclear, chemical, or biological weapons in response, linking a state's conventional military forces with its *opponent's* mass-destruction weapons. As stated earlier, some analysts go so far as to argue that weapons of mass destruction cannot be controlled in the long run without effective limitations on other aspects of military power as well.

22 Under Secretary of Defense for Policy-Transition Working Papers, "Special Transition Proposal—Counterproliferation Strategy," Counterproliferation Initiative, Feb. 2, 1993.

A contrasting view notes that weapons of mass destruction differ markedly from other military systems in terms of international legitimacy. Whereas the pursuit of nuclear, chemical, and biological weapons can be deemed violations of international norms, conventional arms have long been accepted as legitimate and necessary to a state's self-defense. No objective standards exist to differentiate acceptable levels of conventional military capability from levels that pose threats to "international peace and security. " Therefore, those extending nonproliferation policy to include conventional armed forces cannot avoid basing their decisions at least in part on their individual national interests-interests that may not be shared by other nations. Mobilizing effective international nonproliferation efforts will therefore become that much harder. Moreover, those who see the proliferation of weapons of mass destruction as far more dangerous than the spread of conventional, or even advanced conventional, weapons, would not wish to divert effort away from the more serious threat.

The linkages between conventional arms and weapons of mass destruction can give rise to paradoxes. In the past, one policy measure employed by the United States to reduce a state's (e.g., Pakistan's) motivation to acquire nuclear weapons had been to provide it with conventional arms (e.g., F-16 aircraft) in order to address its security needs. However, such planes can serve multiple roles, conceivably including the delivery of Pakistan's purported nuclear weapons. Thus, conventional arms transfers intended to reduce a state's demand for weapons of mass destruction may actually have the effect of increasing its capability to deliver them.

Balancing Unilateral and International Approaches

International cooperation is necessary for nonproliferation to be successful. However, other nations will not always agree with the United States on either the problem or the solution. In such cases, the United States will have to decide whether to preserve consensus, at the risk of not taking what it sees to be appropriate action, or to proceed unilaterally, at the risk of disrupting international consensus.

Those analysts emphasizing consensus typically stress that proliferation should be treated as a violation of international norms of behavior. They argue that nonproliferation policies with widespread international legitimacy will be much more effective than ones viewed primarily as furthering the objectives of the United States or any other single power. This approach emphasizes the role of international institutions, as opposed to individual states, because such institutions provide a greater degree of international support. However, a drawback of this approach is that unless each nation places high priority on nonproliferation, each will have reason to downplay it at times (see above discussion on conflicting objectives). Therefore, the cases in which consensus for international action can be reached might be considerably fewer than many states individually might wish. At the same time-and largely for the same reason-nations have traditionally been reluctant to cede authority to international bodies that might later act in opposition to their own interests. Thus, even when an international institution is able to identify a consensus position, it may not be able to do much.

Proponents of an ''internationalist' approach envision a world in which civilized nations agree on strong norms against the development, acquisition, production, threat, or use of weapons of mass destruction, possibly excepting some residual nuclear capability in the nuclear weapon states. States unwilling to subscribe to these norms, or found to be violating them, would be considered by the others as pariahs. Such norms can come about if-and only if-a very large number of individual nations see them as compatible with their own national interests. In that case, states may be willing to use international institutions for real enforcement, based on information

submitted by individual states or acquired directly.

Proponents of a more unilateral approach see proliferation as a threat to U.S. national interests against which the United States must take its own steps, whatever other nations may think or do. Although they would agree that nonproliferation policies are more effective if implemented multilaterally, they argue that the United States should not restrict its actions to cases where consensus can be reached. In this view, international regimes strong enough to implement a consistent multilateral approach are unlikely to emerge; at any rate, the United States should not put itself in the position of having to rely on them. Through the use of ad hoc coalitions, such as that assembled for the Gulf War, the United States could gain the benefit of a group response while still preserving some freedom of independent action. The drawback of U.S. action in the absence of international backing, however, is that it may antagonize other states whose cooperation will be needed to implement a more effective multilateral policy. Moreover, if a proliferant state can portray itself not as an international pariah but instead as a victim of superpower bullying, it can encourage other countries to withhold support from--or even to undermine--U.S. nonproliferation policy.

Balancing Coercive and Consensual Policies

Nonproliferation policies include both *coercive* measures, imposed to frustrate efforts by **states to** develop weapons of mass destruction, and *consensual* ones that invite states to voluntarily forgo such developments. Coercive measures tend **to be** directed against particular states. Consensual ones, on the other hand, typically involve actions—such as joining **treaty regimes—that any state** is free to take, and they therefore avoid the need to single out targets. In the near term, coercive measures can impede progress towards developing weapons of mass destruction; in the long run, they can help raise the costs of such programs and so discourage states from pursuing them. In the near term, consensual policies may not be accepted by those states most likely to develop or deploy weapons of mass destruction. In the long run, however, the most effective nonproliferation measures are those in which states decide that it is in their own best interest to forgo weapons of mass destruction.

Like the case of unilateral and multilateral approaches, coercive and consensual measures can be mutually supportive. Yet states may respond to coercion with defiance, refusing to join nonproliferation regimes. Conflicts between coercive and consensual measures may become particularly relevant in cases where potential proliferants are in a position to export proliferation-sensitive technology. Punitive measures aimed at discouraging the development of weapons of mass destruction in such states may make it difficult to elicit their cooperation in forgoing proliferation-sensitive exports.

Balancing Targeted and Universal Approaches

The targets of coercive U.S. nonproliferation policies such as export controls and sanctions can be chosen in one of two ways. In a *targeted* approach, the United States applies these measures to specific countries determined to be of particular proliferation concern. In a *universal* approach, the target countries are not specified by name, but rather consist of all states that meet given criteria such as violation of, or refusal to join, international nonproliferation treaty regimes.

Given that the motivations for and the consequences of developing weapons of mass destruction vary greatly from country to country, the targeted approach provides greater flexibility and discretion for tailoring nonproliferation policy. In particular, it permits the United States to treat states not considered security threats differently from states judged to be particularly dangerous to their neighbors or hostile towards U.S. interests.

For exactly this reason, however, targeted policies are harder than universal ones to justify and implement multilaterally. Identifying some states and not others as causes for concern unavoidably leads to charges of discrimination and double standards.[23] Moreover, the states implementing multilateral nonproliferation policies will probably not agree on who the problem countries are.

Balancing Collection and Use of Intelligence

Much of the information available to the U.S. Government pertaining to proliferation is classified. Acting on classified information+. g., by exposing a state's actions to international attention, or by shutting down a covert supplier network-risks compromising the sources and methods by which the information was originally collected, possibly shutting off access to such information in the future. Therefore, tensions exist between collecting intelligence information and making effective use of it.

A related problem is that to the extent that relevant information must remain classified, public debate and discussion—and to some extent, international negotiations and actions-will be conducted on the basis of incomplete information.

TECHNICAL BASIS FOR MONITORING AND CONTROLLING PROLIFERATION

The various weapons of mass destruction addressed in this report are based on very different technical principles and require distinct sets of industrial capabilities. A separate background paper explores the technical pathways by which states might acquire nuclear weapons, chemical weapons, biological weapons, and delivery systems. Those analyses are intended to identify opportunities for monitoring and, if possible, controlling proliferation, as well as to note the potential implications of certain old and new technologies. They also describe the level of effort, commitment, and resources required for any state to mount such developments, thereby indicating the relative effects of increasing these costs, for example, by export controls. Nevertheless, a country-by-country analysis of potential proliferants' indigenous technical expertise and industrial infrastructure is beyond the scope of this study. So, too, is a political assessment of the incentives facing each of these states, or a thorough discussion of the many other nontechnical factors that would influence their ability to pursue weapons of mass destruction.

The bottlenecks or 'chokepoints' identified in the background paper—steps that are particularly time-consuming or difficult for proliferants to master without outside assistance-might be exploited to control proliferation. Conversely, steps that are relatively easy, or that make use of widely available know-how and equipment, make poor candidates for control efforts. It is important to understand the extent to which "dual-use" technologies or products, which also have legitimate civil applications, are involved in the development of weapons of mass destruction, since both the feasibility of controlling dual-use items and the implications of doing so depend on the extent of their other applications.

Monitoring the proliferation of weapons of mass destruction, or conversely monitoring compliance with nonproliferation agreements, depends on detecting and identifying various indicators or *signatures* associated with the development, production, deployment, or use of weapons of mass destruction. Unilateral intelligence collection efforts can seek to exploit these signatures with the use of remote or covertly placed instruments; multilateral verification regimes—typically operating within the framework of a negotiated treaty-can make provision for states to voluntarily open their facilities to cooperative

23 The U.S. State Department's list of states supporting terrorism, for example, is often accused Of reflecting political tilts, rather than firm intelligence analysis.

onsite inspection in addition to sanctioning the use of remote instrumentation.[24]

Both unilateral and cooperative approaches have their strengths. A cooperative regime might offer direct access to facilities that would be difficult to inspect in any other way. However, strict limitations may be put on that access. Moreover, since the inspected party knows the type of instrumentation and procedures to be used by inspecting parties, it may be able to defeat those inspections. Intelligence collection efforts conducted outside the framework of a negotiated agreement would probably not have the degree of access to any specific site that would be provided by a cooperative onsite inspection regime, but they might have other advantages such as breadth of coverage. Moreover, they would not be constrained by prenegotiated procedures, and they might be able to gather information about sites where onsite inspection would be denied. However, if unilateral intelligence efforts involved covert placement of sensors in the territory of the inspected party, such efforts would probably be viewed as a violation of sovereignty, creating political tensions if detected.

Unilateral and multilateral approaches are not mutually exclusive. Indeed, they will be most effective if used synergistically: unilateral intelligence efforts might trigger a challenge inspection. However, many of the signatures discussed below are likely to be ambiguous, if they are detected at all. Deciding on appropriate responses in the face of incomplete or ambiguous information will pose great challenges for nonproliferation policy, as will mobilizing effective domestic and international support for those responses.

Nuclear Weapons

MATERIAL PRODUCTION

In terms of costs, resources required, and possibility of discovery, the difficulty of obtaining nuclear weapon materials—plutonium or highly enriched uranium—today remains the greatest single obstacle most countries would face in pursuing nuclear weapons. Even straightforward methods of producing such material indigenously (such as building a small reactor and a primitive reprocessing facility to produce plutonium and recover it from irradiated reactor fuel) would require at least a modest technological infrastructure and hundreds of millions of dollars to carry out. Moreover, once such a facility became known, it could generate considerable pressure from regional rivals or the international community. The costs of a full-scale indigenous nuclear weapon program-especially if clandestine--can be substantially higher than for a program largely aimed at producing just one or two bombs and carried out in the open. Iraq spent 10 to 20 times the cost of such a minimal program-many billions of dollars-to pursue multiple uranium enrichment technologies, to build complex and sometimes redundant facilities, to keep its efforts secret, and to seek a fairly substantial nuclear capability. Few countries of proliferation concern can match the resources that Iraq devoted to its nuclear weapon program. (Iran, however, probably could.)

Since production of nuclear materials is generally the most difficult and expensive part of producing a nuclear weapon, the leakage of significant amounts of weapon-grade material from the former Soviet Union would provide a great advantage to potential proliferants. In-

24 In the strategic arms control process between the United States and the Soviet Union, each side agreed not to impede the other side's "national technical means of verification," in effect legitimizing the collection of intelligence pertinent to the treaty.

deed, the possibility of black-market sales of weapon-usable materials may represent one of the greatest proliferation dangers now being faced. Even the covert acquisition of low-enriched uranium, which can fuel nuclear reactors but is not directly usable for nuclear weapons, could be advantageous to a proliferant by enhancing the capacity of its isotope separation plants.

This ominous prospect notwithstanding, nuclear materials suitable **for weapon purposes have to date been extremely difficult to obtain from countries that already possess them.** There is no reliable evidence that any militarily significant quantities of nuclear weapon material have been smuggled out of the former Soviet Union. The vast majority of nuclear material in nonnuclear weapon states is safeguarded by a comprehensive system of material accountancy and control administered by the International Atomic Energy Agency (IAEA). These safeguards are not perfect, but they provide high levels of confidence that significant quantities of nuclear material have not been diverted from safeguarded nuclear reactors. Diversion would be more difficult to detect from facilities such as fuel fabrication plants, uranium enrichment plants, and plutonium reprocessing facilities that process large quantities of nuclear material in bulk form, as opposed to handling it only in discrete units such as fuel rods or reactor cores. At present, however, there are no large facilities of this type under comprehensive IAEA safeguards in countries of particular proliferation concern.[25] At least in the short run, the diversion of safeguarded materials poses less of a threat to the nonproliferation **regime than the black-market purchase or covert indigenous production of** nuclear materials.

Under current European and Japanese plans for reprocessing and limited reuse of plutonium from commercial reactor fuel, the current worldwide surplus of some 70 tomes of safeguarded, separated *reactor-grade* plutonium-the type produced by commercial nuclear reactors in normal operation-will likely continue to grow through the 1990s by more than 10 tonnes per year. Reactor-grade plutonium is more radioactive and more difficult to handle than *weapon-grade* plutonium, which is produced specifically for use in nuclear weapons, but it can still be used to make a crude nuclear weapon of significant (though probably less predictable) yield. Nevertheless, the states that have sought nuclear weapons have gone to great lengths to produce weapon-grade materials--either highly enriched uranium or weapon-grade plutonium-rather than reactor-grade plutonium. (Note that some types of nuclear power reactors, including ones in India, South Korea, and North Korea, can produce either reactor-grade or weapon-grade plutonium, depending on how they are operated.)

OTHER TECHNICAL BARRIERS

Unlike chemical and biological weapons, whose lethality is roughly proportional to the amount of agent dispersed, nuclear weapons will not produce any yield at all unless certain conditions are met: a minimum ‘‘critical mass’ of nuclear materials must be present, and that material must be brought together with sufficient speed and precision for a nuclear chain reaction to take place. A proliferant must master a series of technical hurdles in order to produce even a single working weapon.

Nuclear weapons are so destructive that they place few requirements on the accuracy of delivery systems for any but the most protected targets. Most proliferants would likely be able to design first-generation nuclear weapons that were small and light enough to be carried by Scud-class missiles or small aircraft. Given additional technical refinement, they might be able to reduce

[25] Brazil has a medium-sized fuel fabrication facility under IAEA safeguards, and South African enrichment facilities are coming Waler safeguards with South Africa’s announced destruction of its nuclear weapons and its accession to the NPT. Neither state is considered an active proliferation threat at present.

warhead weights to the point where the 500 kg (l,100 pound) delivery threshold originally established by the Missile Technology Control Regime no longer provides a reliable barrier to nuclear-capable ballistic or cruise missiles.[26]

Although nuclear weapons were first developed 50 years ago and the basic mechanisms are widely known, much of the detailed design information, and particularly the knowledge gleaned by the nuclear weapons states from decades of design and testing, remains classified. Much of this information can be reconstructed by a dedicated proliferant, but it will take time and money. Moreover, "weaponizing" a nuclear warhead for reliable missile delivery or long shelf-life creates additional hurdles that could significantly increase the required development effort. Therefore, having access to key individuals--such as those from the former Soviet nuclear weapon program--could significantly accelerate a nuclear program, primarily by steering it away from unworkable designs. Specific individuals could fill critical gaps in a given country's knowledge or experience, adding greatly to the likelihood that a program would succeed.

High-performance computers (so-called "supercomputers '' in the 1980s) are *not required* to design first-generation fission weapons. Thus, placing strict limits on their exports would be of minimal importance compared with limiting technologies for nuclear materials production.

MONITORING NUCLEAR PROLIFERATION

Production of nuclear materials provides many signatures and the greatest opportunity for detecting a clandestine nuclear weapon program. Even so, a large part of the Iraqi program was missed. Since members of the Nuclear Non-Proliferation Treaty (other than the acknowledged nuclear-weapon states) are not permitted to operate unsafeguarded facilities handling nuclear materials, the existence of any such facilities would probably indicate an illegal weapon program.[27]



LOS ALAMOS NATIONAL LABORATORY

Iraqi electromagnetic isotope separation (EMIS) equipment, uncovered after having been buried in the desert to hide it from United Nations inspectors. Iraq's EMIS program to enrich uranium for nuclear weapons had not been detected by Western intelligence agencies prior to the Gulf War.

Nuclear tests at kiloton yields or above would probably be detectable by various means, especially if multiple tests were conducted. However, such tests are not necessary to field a workable weapon with reasonably assured yield. Similarly, the deployment of a small number of nuclear weapons might not be easily detected.

IMPLICATIONS OF OLD AND NEW TECHNOLOGIES

Low- and medium-level *gas centrifuge technology* for enriching uranium may become increasingly attractive to potential proliferants for a variety of reasons, including availability of information about early designs, difficulty of detec-

26 Broadening its focus, the Missile Technology Control Regime now covers missiles capable of delivering chemical and biological weapons as well as those that could be used (o deliver nuclear weapons. Consequently, the payload threshold of 500 kg has been removed.

27 The exception t. this statement would be unsafeguarded facilities dedicated to military purposes unrelated to nuclear weapons, such as naval nuclear propulsion. Such uses are not prohibited by the Nuclear Non-Proliferation Treaty. They fall outside IAEA jurisdiction however, since IAEA safeguards pertain only to peaceful-e. g., nonmilitary-applications of nuclear power. See Ben Sanders and John Simpson, *Nuclear Submarines and Non-Proliferation: Cause for Concern,* PPNN Occasional Paper Two (Southampton England: Centre for International Policy Studies, University of Southampton for the Programme for Promoting Nuclear Non-Proliferation 1988).

tion, ease of producing highly enriched uranium, and potential availability of equipment from the former Soviet Union. Modem, state-of-the-art centrifuges could lead to even smaller, more efficient, and relatively inexpensive facilities that would be most difficult to detect remotely.

In the longer run, *laser isotope separation* techniques and *aerodynamic separation* may have serious proliferation potential as means of producing highly enriched uranium for nuclear weapons. Openly pursued by more than a dozen non-nuclear-weapon states, *laser enrichment* technologies use precisely tuned laser beams to selectively energize the uranium-235 isotope most useful for nuclear weapons and separate it from the more common uranium-238 isotope. Laser facilities would be small in size and could enrich uranium to high levels in only a few stages. They could therefore prove to be difficult to detect and control if successfully developed as part of a clandestine program. Nevertheless, considerable development work remains to be done before this method can be made viable or can compete with existing enrichment technologies. Even for the advanced industrialized countries, constructing operational facilities will remain very difficult. Some *aerodynamic techniques*—which use carefully designed gas flows to separate the lighter uranium-235 from the heavier uranium-238-require fairly sophisticated technology to manufacture large numbers of precision small-scale components, but they do not otherwise pose technical challenges beyond those of other enrichment approaches.

Chemical Weapons

The technology used to produce chemical weapons is much harder to identify unambiguously as weapons-related than is that for nuclear materials production technology, and relevant know-how is much more widely available. Although production techniques for major chemical weapon agents involve some specialized process steps, detailed examples can be found in the open literature and follow from standard chemical engineering principles. Unlike nuclear proliferation, where the mere existence of an unsafeguarded nuclear facility in an NPT member state is often sufficient evidence of intent to produce weapons, many legitimate chemical facilities could have the ability to produce chemical agent. Intent cannot be inferred directly from capability.

AGENT AND WEAPON PRODUCTION

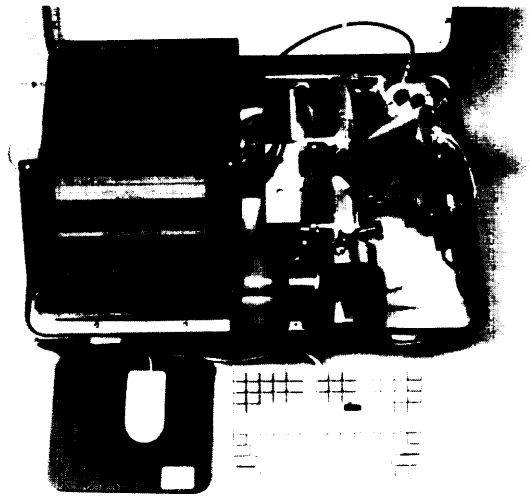
Certain chemical agents such as mustard gas are very simple to produce. Synthesis of nerve agents, however, includes some difficult process steps involving highly corrosive or reactive materials. A sophisticated production facility to make militarily significant quantities of one class of nerve agents might cost between $30 and $50 million, although dispensing with modem waste-handling facilities might cut the cost in half. Some of the equipment needed may have distinctive features, such as corrosion-resistant reactors and pipes and special ventilation and waste-handling equipment, but these can be dispensed with by relaxing worker safety and environmental standards and by replacing hardware as it corrodes. Moreover, production is easier if a proliferant country is willing to cut comers on shelf-life, seeking only to produce low-quality agent for immediate use.

Chemical-warfare agents can be produced through a wide variety of alternative routes, but relatively few routes are well suited for large-scale production. Just because the United States used a particular production pathway in the past, however, does not mean that proliferant countries would necessarily choose the same process.

In general, commercial pesticide plants lack the precursor chemicals (materials from which chemical agents are synthesized), equipment, facilities, and safety procedures required for nerve-agent production. Nevertheless, multipurpose chemical plants capable of manufacturing organo-phosphorus pesticides or flame retardants could be converted in a matter of weeks or months

to the production of nerve agents. The choice between converting a commercial plant in this manner and building a clandestine production facility would depend on the urgency of a country's military requirement for a chemical weapon stockpile, its desire to keep the program secret, its level of concern over worker safety and environmental protection, and the existence of embargoes on precursor materials and production equipment.

Agent production, however, is several steps removed from an operational chemical weapon capability. The latter requires design and development of effective munitions, filling the munitions before use, and mating them with a suitable delivery system.



Portable gas chromatograph/mass spectrometer (GC/MS) developed to support onsite analysis for the Chemical Weapons Convention. This equipment can detect and identify minute quantities of organic chemicals controlled by the CWC.

MONITORING CHEMICAL WEAPON PROLIFERATION

Direct detection of chemical warfare agents in samples taken from a production facility would be a clear indicator of weapon activity, since these agents have almost no civil applications.[28] However, considerable access to production facilities is required to ensure that appropriate samples have been collected. Moreover, some of the substances produced when chemical agents break down in the environment are also produced when legitimate commercial chemicals break down, so detection of final degradation products does not necessarily indicate agent production. Nevertheless, the suite of degradation products associated with a given chemical agent production process would provide a clear signature.

Other than the agent itself, or an ensemble of degradation products, chemical agent production has few unequivocal signatures. Moreover, highly reliable technologies to detect chemical agent production from *outside the* site are not currently available. Unlike nuclear weapon facilities, which generally exhibit fairly clear signatures, civilian chemical plants have multiple uses, are hundreds of times more numerous than nuclear facilities, and are configured in different ways depending on the process involved. Moreover, many of the same chemicals used to make chemical agents are also used to make pharmaceuticals, pesticides, and other commercial products. Since many different types of equipment are suitable for chemical agent production, plant equipment per se does not provide a reliable means of distinguishing between legitimate and illicit activities. Nevertheless, some potential signatures of chemical weapon development and production exist, and a set of multiple indicators taken from many sources may be highly suggestive of a production capability.

Indicators at suspect locations that may contribute to such an overall assessment include: visual signatures such as testing munitions and delivery systems; distinctive aspects of plant design and layout, including the use of corrosion-resistant materials and air-purification systems; presence of chemical agents, precursors, or degradation products in the facility's production line or waste stream; and biochemical evidence of chem-

28 Nitrogen mustards have some use in cancer chemotherapy, and phosgene and hydrogen cyanide have industrial applications.

ical agent exposure (including that due to accidental leaks) in plant workers or in plants and animals living in the vicinity of a suspect facility. Nevertheless, the utility of specific signatures depends on how a given weapon program operates, including the choice of production process and the extent of investment in emission-control technologies. Detection capabilities that are decisive under laboratory conditions may be rather inconclusive in the field—particularly if the proliferant has been producing related legitimate chemicals (e.g., organophosphorus pesticides) in the same facility and is willing to expend time, effort, and resources to mask, obscure, or otherwise explain away chemical agent production activities. Testing of chemical agents and training troops in their use might be masked by experiments with or training for the use of smoke screens. A robust inspection regime must therefore comprise an interlocking web of inspections, declarations, notifications, and data fusion and analysis, all of which a cheater must defeat in order to conceal his violations. Focusing monitoring efforts at a single point--even one thought to be a crucial chokepoint--would allow the cheater to focus his efforts on defeating them.

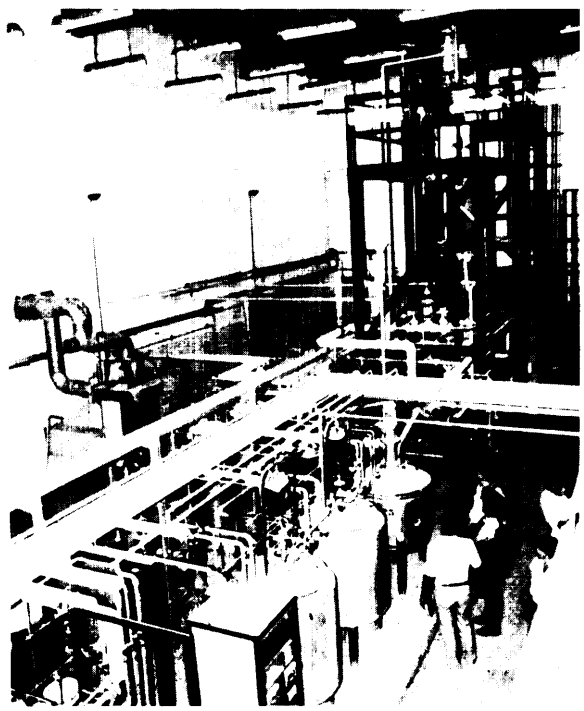
Keeping a production program covert forces other tradeoffs. Some of the simplest production pathways might have to be avoided since they use known precursors or involve known production processes. Purchasing equipment from multiple suppliers to avoid detection, or jury-rigging facilities from used equipment, might increase hazards to the workforce and nearby populations.

Biological Weapons

Biological-warfare agents are easier to produce than either nuclear materials or chemical-warfare agents because they require a much smaller and cheaper industrial infrastructure and because the necessary technology and know-how is widely available. Moreover, it would not be difficult to spread biological agents indiscriminately to produce large numbers of casualties, although it is much more difficult to develop munitions that have a predictable or controllable military effect.

AGENT AND WEAPON PRODUCTION

The global biotechnology industry is information-intensive rather than capital-intensive. Much of the data relevant to producing biological agents is widely available in the published literature and virtually impossible for industrialized states to withhold from potential proliferants. A widespread support infrastructure of equipment manufacturers has also arisen to serve the industry. Therefore, producing biological agents would be relatively easy and inexpensive for any nation that has a modestly sophisticated pharmaceutical industry. Moreover, nearly all the equipment needed for large-scale production of pathogens and toxins is dual-use and widely available on the international market.



United Nations inspectors assessing the biological weapon potential of Iraqi fermenters and other bioprocess equipment.

One technical hurdle to the production of biological weapons is ensuring adequate containment and worker safety during agent production and weapons handling, although the difficulty of doing so depends on the level of safety and environmental standards. A government that placed little value on the safety of plant workers or the civilian population might well take minimal precautions, so that a biological weapon production facility would not necessarily be equipped with sophisticated high-containment measures. Another challenge is ''weaponizing' the agents for successful delivery. Since microbial pathogens and toxins are susceptible to environmental stresses such as heat, oxidation, and dessication, to be effective they must maintain their potency during weapon storage, delivery, and dissemination.

A supply of standard biological agents for covert sabotage or attacks against broad-area targets would be relatively easy to produce and disseminate using commercially available equipment, such as agricultural sprayers. In contrast, the integration of biological agents into precise, reliable, and effective delivery systems such as missile warheads and cluster bombs poses complex engineering problems. Nevertheless, the United States had overcome these problems by the 1960s and had stockpiled biological warfare agents.

MONITORING BIOLOGICAL WEAPON PRODUCTION

Detection and monitoring of biological and toxin agent production is a particularly challenging task. Even use of biological weapons could in some cases be difficult to verify unambiguously, since outbreaks of disease also take place naturally. Thanks to advances in biotechnology, including improved fermentation equipment as well as genetic engineering techniques, biological and toxin agents could be made in facilities that are much smaller and less conspicuous than in the past. Moreover, the extreme potency of such agents means that as little as a few kilograms can be militarily significant. Since large amounts of agent can be grown up from a freeze-dried seed culture in a period of days to weeks, large stockpiles of agent are not required, although some stocks of the munitions to be filled with these agents would be.

There are no signatures that distinguish clearly between the development of offensive biological agents and work on defensive vaccines, since both activities require the same basic know-how and laboratory techniques at the R&D stage. Moreover, almost all the equipment involved in biological and toxin weapon development and production is dual-use and hence will not typically indicate weapons activity. Indeed, the capacity to engage in illegal military activities is inherent in certain nominally civilian facilities. Some legitimate biological facilities can also convert rapidly to the production of biological warfare agents, depending on the degree of sophistication of the plant and on the required scale of production, level of worker safety, and environmental containment. At the same time, however, legitimate applications of biological or toxin agents (e.g., vaccine production and the clinical use of toxins) are relatively few at present. With the exception of a few vaccine production plants, such activities are largely confined to sophisticated biomedical facilities not normally found in developing countries, and these facilities generally do not engage in production except on a small scale. Moreover, given that the global biotechnology industry is still in its infancy, the number of legitimate activities--from which the illegitimate ones would have to be distinguished-is still relatively small.

Sensitive analytical techniques such as polymerase chain reaction (PCR) analysis or use of monoclinal antibodies can identify trace quantities of biological agents and might be able to do so even after the termination of illicit activities. However, the existence of such sensitive laboratory techniques does not necessarily translate into a negotiated verification regime that might be instituted to monitor compliance with the Biolog-

ical Weapons Convention. Other factors that must be assessed in establishing such a regime include the likelihood of detecting clandestine production sites, the ability to distinguish prohibited offensive activities from permitted defensive efforts, and the risk of divulging sensitive national-security or proprietary information during inspections of U.S. facilities.[29]

Because of the difficulty of detecting clandestine biological and toxin weapon development and production, effective tracking of such programs will require integrating data from many sources, with a particular emphasis on human intelligence (agents, defectors, and whistleblowers). Some weaponization signatures (storage of bulk agents, preparation of aerosol dispensers, field testing, etc.) would probably be easier to detect than production signatures, but many such signatures could be concealed or masked by legitimate activities such as biopesticide R&D or use. Production and storage of components for BW munitions might also be masked by activities associated with conventional weapons, such as production of high explosives, bomb casings, or artillery shells. Since excessive secrecy might itself be indicative of offensive intent, greater transparency would tend to build confidence in a country's lack of offensive intentions.

IMPLICATIONS OF NEW TECHNOLOGY

Genetic engineering is unlikely to result in ''supergerms" significantly more lethal than the wide variety of potentially effective biological agents that already exist, nor is it likely to eliminate the fundamental uncertainties associated with the use of microbial pathogens in warfare. However, gene-splicing techniques might facilitate weaponization by rendering microorganisms more stable during dissemination (e.g., resistant to high temperatures and ultraviolet radiation). Biological agents might also be genetically modified to make them more difficult to detect by immunological means and insusceptible to standard vaccines or antibiotics. At the same time, genetic engineering techniques could be used to develop and produce protective vaccines more safely and rapidly.

Cloning toxin genes in bacteria makes it possible to produce formerly rare toxins in kilogram quantities. Moreover, molecular engineering techniques could lead to the development of more stable toxins. Even so, for the foreseeable future, toxin-warfare agents are unlikely to provide dramatic military advantages over existing chemical weapons. It is possible that bioregulators and other natural body chemicals (or synthetic analogues thereof) might be developed into powerful incapacitants, but means of delivering such agents in a militarily effective manner would first have to be devised. Moreover, if warning of their use were provided, chemical weapon protective gear would blunt their impact.

Delivery Systems

Although military delivery systems such as ballistic missiles, cruise missiles, and combat aircraft are not essential to deliver weapons of mass destruction, they can do so more rapidly, more controllably, and more reliably than rudimentary means such as suitcases, car bombs, or civilian ships or planes. Controlling the spread of advanced delivery systems by no means would eliminate the dangers posed by weapons of mass destruction, particularly in terrorist applications. However, limiting the availability of these delivery systems would make it harder for states to use weapons of mass destruction for military purposes, particularly against well-defended, forewarned adversaries.

29 The United States has already determined that inspection procedures under the Chemical Weapons Convention which allow the inspected party to negotiate the level of access to be provided to international inspectors, are sufficient to protect national-security information and trade secrets. However, it is not necessarily the case that the same inspection procedures would be suitable for the Biological Weapons Convention should a formal verification regime be instituted.

Unlike nuclear, chemical, or biological weapons themselves, which are not traded openly due to treaty constraints or international norms, delivery systems such as aircraft and short-range antiship cruise missiles are widely available on international arms markets, Since the late 1980s, the United States and other Western industrialized countries have had some success at delegitimizing the sale of longer range ballistic and cruise missiles by creating the Missile Technology Control Regime (MTCR), the participants in which refrain from selling ballistic or cruise missiles with ranges over 300 kilometers, or with any range if the seller has reason to believe that they may be used to carry weapons of mass destruction. However, missiles with ranges up to 300 km-and to a lesser extent, up to 600-1,000 km-are already deployed in many Third-World countries. Combat aircraft are possessed by almost all countries of proliferation concern. Cruise missiles or other unmanned aerial vehicles with ranges much over 100 km are not yet widespread outside the acknowledged nuclear weapon states, but large numbers of cruise missiles, including antiship missiles, are available at lesser ranges.

In terms of payloads that can be carried to specified ranges, the combat aircraft of virtually all countries of proliferation concern far surpass their missile capabilities. However, aircraft and missiles have different relative strengths—particularly in their ability to penetrate defenses—and the two systems are not fully interchangeable. Piloted aircraft have significant advantages over other delivery systems in terms of range, payload, accuracy, damage-assessment capability, and dispersal of chemical or biological agents. They can be used many times, usually even in the presence of significant air defenses. Missiles, however, are harder to defend against, and they offer distinct advantages for a country wishing to deliver a single nuclear weapon to a heavily defended area. Since missiles are not restricted to operating from airfields, they are also easier to hide from opposing forces. The wide range of motivations for acquiring ballistic missiles-prestige, diversifying one's forces, their psychological value as terror weapons, lack of trained pilots, and technology transfer and export opportunities-will continue to make missile technology very attractive for several countries of proliferation concern.

BARRIERS TO MISSILE AND AIRCRAFT PROLIFERATION

The spread of ballistic missiles around the world was greatly facilitated by the export in the 1970s and 1980s of Scud-B missiles from the former Soviet Union. With an increasing number of countries abiding by the MTCR, the number of potential missile suppliers has declined dramatically. Of the principal missile exporters, only North Korea has not agreed to comply. However, Ukraine poses future export concerns, since it contains much of the former Soviet missile production infrastructure, yet has not agreed to comply with the MTCR. Moreover, additional countries have learned to copy, modify, extend the range of, and produce their own missiles, and a small number have developed long-range systems-often in conjunction with space-launch programs and foreign technical assistance. Even so, MTCR constraints can slow the acquisition by developing countries of technologies associated with more advanced missiles-those having ranges


UN PHOTO, H. ARVIDSSON

United Nations inspector measuring an Iraqi Al-Husayn (modified Scud) missile in Baghdad.

in excess of 1,000 km or guidance errors of less than roughly 0.3 percent of their range.

Given the complex set of technologies and expertise used in advanced aircraft, especially high-performance jet engines, it remains virtually impossible for developing countries to acquire these systems without assistance. However, no internationally binding restrictions limit trade in combat aircraft, and such arms transfers continue to be used as an instrument of foreign policy. Moreover, overcapacity in Western defense industries, and the economic difficulties facing newly independent Soviet republics and Eastern European states, provide great incentive to develop arms export markets. Therefore, states can and probably will continue to acquire high-performance aircraft easily without having to build them. Moreover, other options short of buying aircraft or building them from scratch are available to states wishing to acquire or modify combat aircraft, such as engaging in licensed production.[30]

If they have sufficient payload and range-and if they can be procured despite export controls—commercially available unmanned aerial vehicles can be adapted to deliver weapons of mass destruction without much difficulty. Developing cruise missiles requires greater technical capability. Even so, technologies for guidance, propulsion, and airframes are becoming increasingly accessible, particularly with the spread of licensed aircraft production arrangements to many parts of the world. The most difficult technical challenges to developing cruise missiles—propulsion and guidance--do not pose much of a hurdle today. The highest performance engines are not required for simple cruise missiles, and many sources are available for suitable engines. Guidance requirements can be met by satellite navigation services such as the U.S. Global Positioning System (GPS), possibly the Russian Glonass system, or commercial equivalents. Inexpensive, commercially available GPS receivers are becoming available to provide unprecedented navigational accuracy anywhere in the world. Although GPS receivers would have only limited utility to emerging missile powers for ballistic missile guidance, they could be used to reduce uncertainty in the launch location of mobile missiles.

MONITORING DELIVERY VEHICLES

Although individual missiles can be very difficult to detect, a program to develop ballistic missiles is much more visible. Test firing and launching ballistic missiles can be readily seen. Development of intermediate and long-range ballistic missiles requires extensive flight testing, making it particularly noticeable. Although states pursuing both military and civil space technology may wish to hide their military programs, civilian space-launch programs are usually considered a source of national prestige and proudly advertised.

Even a purely civilian space-launch program provides technology and know-how useful for ballistic missiles. The most important aspects of a missile capability for weapons of mass destruction—range and payload-can usually be inferred from a civil program. (A civil space-launch booster does not need to have high accuracy, but neither does a missile carrying weapons of mass destruction for use against populations.) On the other hand, certain attributes desired for military applications, such as reliable reentry vehicles, mobility, and ease of operation in the field, suggest distinct technical approaches for military and civil applications. Although solid-fueled boosters are in some ways more difficult to develop and build than liquid-fueled boosters, they are easier to use in mobile and time-urgent applications. Liquid-fueled boosters were the first

30 The routes various states around the world have taken to develop defense industries, including aircraft industries, are discussed in U.S. Congress, Office of Technology Assessment, *Global Arms Trade*, OTA-ISC-460 (Washington, DC: U.S. Government Printing Office, June 1991).

used in military applications and are still more common. (The seemingly ubiquitous Scud missile and its modifications, such as were launched by Iraq against targets in Israel and Saudi Arabia, are liquid-fueled.)

Since combat aircraft are widely accepted as integral to the military forces even of developing countries, there is no reason to hide their existence. Individual planes, however, can be hidden. Moreover, modifications made to aircraft to carry weapons of mass destruction, or training given to pilots for their delivery, might be difficult to detect without intrusive inspections.

Of the three delivery systems, cruise missile development and testing will be the hardest to detect. Several types of unmanned aerial vehicles are being developed and marketed for civil purposes, and without inspection rights it will be difficult to discern whether such vehicles have been converted to military purposes. **Therefore, monitoring of delivery systems capable of carrying weapons of mass destruction will continue to be an uncertain exercise, having most success with missiles and highly capable aircraft. Nevertheless, the risk posed by other delivery systems cannot be dismissed. The full range of delivery technology must be taken into account when evaluating a country's overall proliferation capabilities and behavior.**

Assessing the Risks

2

All weapons kill and maim, but those commonly referred to as "weapons of mass destruction ''-nuclear, chemical, and biological-an do so on an especially large scale. What is more, many of these weapons can cause not just instant death or mutilation, but lingering disease and suffering. This chapter begins with a review of the basic characteristics of the devices of mass destruction. It also identities various ways these weapons might be delivered. The next section of the chapter then compares the destructive effects and possible military uses of these weapons. This overview of the weapons, their effects, and their uses serves two purposes. First, it illustrates why the weapons have been singled out for particular opprobrium and special efforts at control. Second, it indicates why states (and sometimes nonstate organizations) might come to believe that the weapons would be useful additions to their arsenals.



U.S. DOE

The proliferation of weapons of mass destruction is both a general and a particular problem. In the long term, dealing with the problem will require strengthening international norms against the weapons and fostering a political order that makes them unattractive. In the nearer term, however, proliferation problems are particular: the weapons are spreading to specific nations that have decided, for one reason or another, that the existing international norms against further proliferation should not apply to them. The third part of this chapter identifies states suspected of trying to acquire one or more types of weapon of mass destruction. This discussion leads to the conclusion that the immediate proliferation threats, as now understood, are serious but still limited in scope. Many more nations are economically and technically capable of building weapons of mass destruction than are actually trying to do so. All this is not to suggest

complacency about the dangers of proliferation: rather, it suggests that national and international nonproliferation policies actually have some prospect of containing the problem.

The fourth part of ch. 2 discusses what differences it may make to the international community in general, and to the United States in particular, when weapons of mass destruction spread. This analysis underscores the strong interest in containing the threat of proliferation that the United States shares with all civilized nations.

With ch. 1 having reviewed trends in the international arena that nonproliferation policies must take into account, the final section of this chapter calls special attention to the multifarious problems posed by the breakup of Soviet Union.

WEAPONS OF MASS DESTRUCTION

"Mass destruction" is a relative term. Allied fire bomb attacks on Dresden during World War II killed between 130,000 and 200,000 people with 1,400 aircraft sorties over 2 days.[1] A single atomic bomb killed about 68,000 people and injured another 76,000 in Hiroshima.[2] A 1-megaton hydrogen bomb exploding over Detroit might kill 470,000 and injure 630,000 more.[3] Thus, a single weapon of mass destruction can do damage equivalent to that of hundreds or thousands of 'conventional' high explosive or incendiary weapons. This report addresses the spread of three broad types of weapon meeting that criterion of killing more with less: nuclear, biological, and chemical. How do these weapons injure and kill?

Table 2-1 surveys the destructive agents discussed in this report. Table 2-2 identifies factors that can affect just how lethal these agents may be when used. To do their deadly work, these agents of mass destruction have to be incorporated into weapons (e.g., an aerial bomb, a ballistic missile warhead, an artillery shell, or a even a suitcase) and then delivered. Table 2-3 lists the kinds of weapons that have been, or in principle could be, designed for nuclear explosives or chemical or biological agents. During the Cold War, the United States and the Soviet Union developed every type of nuclear weapon listed in the chart.[4]

The easiest course for nuclear proliferant nations would be to try to build aerial bombs first, because these need not be as light or compact as other weapon types. The bomb dropped on Hiroshima weighed about 4,400 kg (9,700 lb), but proliferants should be able to do much better than that on their first try.[5] The countries currently suspected of nuclear weapon ambitions also have ballistic missile programs; even if they succeed in developing heavier aerial bombs sooner, they seem likely to pursue missile-capable nuclear explosives in the longer run. Iraq appears to have been trying to make its first nuclear weapon light enough for a missile warhead.

Chemical weapons were frost used extensively in World War I. Initially, gaseous agents, such as chlorine and phosgene, were released from ground-based tanks as airborne clouds; later, liquids such as sulfur mustard were delivered in artillery shells. Aerial bombing and spraying methods appeared between the two World Wars. During the Cold War, the United States and the Soviet

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[1] Science Applications Inc., *Evaluations of Collateral Damage* (La Jolla, CA: SAIC, Nov. 15, 1976), p. 131,

[2] Samuel Glasstone and Philip J. DoIan, (eds.), *The Effects of Nuclear Weapons, Third Edition (Washington DC:* U.S. Department of Defense and U.S. Department of Energy, 1977), p. 544.

[3] U.S. Congress, Office of Technology Assessment *The Effects of Nuclear War* (Washington, DC: U.S. Government Printing office, 1979), p. 37.

[4] In the aftermath of the Cold War (and even before), both superpowers began to withdraw from service most of their so-called tactical nuclear weapons.

[5] The United States and the Soviet Union had already deployed much lighter weapons by the 1950s.

Table 2-I—Weapon Agents of Mass Destruction

Type of weapon agent	Examples	Mechanism	Effects on human beings
Nuclear:			
fission and fusion	Hiroshima fission bomb= 12.5 kt (1 kt = 1,000 tons TNT); fusion bomb, e.g., largest U.S. test = 17 Mt (1 Mt = 1,000,000 tons TNT)	Blast (overpressure)	Bleeding and rupture; violent displacement; blows or crushing by debris
		Thermal radiation	flash burns, blinding, burning or suffocation from building fires
		Nuclear radiation (immediate)	Vomiting, diarrhea fever, bleeding, infection, circulatory failure, respiratory failure, brain swelling
		Nuclear radiation (delayed effects and fallout effects)	Above effects at high doses; contact burns, cataracts, leukemia, other cancers, birth defects at lower doses
Biological:			
viruses	Venezuelan equine encephalitis	Inhaled or ingested infectious diseases	A variety of debilitating or potentially fatal illnesses
bacteria	Anthrax, brucellosis, plague	(same)	(same)
rickettsiae	Q fever, typhus	(same)	(same)
Toxins:[2]	Botulin, ricin, animal venoms	Inhaled or ingested poisons	A variety of toxic effects, often fatal
Chemical:			
Blistering (Vesicants)	Mustard, lewisite	Skin and tissue destruction on contact or inhalation	Skin blistering, blindness, potentially fatal lung damage
Choking	Chlorine, Phosgene, PFIB	Lung damage on inhalation	Fluid build-up leading to fatal choking
Blood	Cyanogen chloride, hydrogen cyanide	Blocking of blood oxygen on inhalation	Anoxia (severe oxygen starvation of body tissues)
Nerve	Tabun (GA), Sarin (GB), Soman (GD), GF, VX	Nervous system disruption on contact or inhalation	Convulsions, paralysis leading to death

[1] Some chemical and biological agents may cause irritation, illness, or behavior changes, but may not normally be fatal; weapons using these agents may incapacitate people for hours, days or weeks, but cannot be accurately said to inflict mass destruction. Other agents can destroy livestock or crops, having great potential for economic warfare but (except for the possibility of causing mass starvation) not leading immediately to widespread human injury.

[2] Toxins are nonliving, posionous chemicals, first produced in biological processes. It was therefore reasonable to consider them to& biological weapons, and they are covered in the international treaty banning biological weapons. However, as toxic chemical (nonliving) substances, they are also categorized as "chemical' 'weapon agents—and they are so considered in the Chemical Weapons Convention banning chemical weapons.

SOURCE: Office of Technology Assessment, 1993.

Table 2-2—Factors Affecting Lethality of Nuclear, Biological, and Chemical Weapons

Factor	Nuclear	Biological	Chemical
Delivery modes	Higher altitude burst increases lethal area, decreases fallout; Lower altitude increases central blast and fallout	Aerial spraying produces wider lethal area than explosive bomb or missile warhead Explosive dispersion may also kill agent organisms	Aerial spraying produces wider lethal area than explosive bomb or missile warhead Persistent agents can injure or kill additional victims as they pass through a contaminated area
Terrain			
Open, flat	Increases exposure to thermal and ionizing radiation Decreases injuries from debris, collapsing structures	Maximizes lethal dispersion of agent	Maximizes lethal dispersion of agent
Hilly	Redirects blast effects May shield from thermal and ionizing radiation	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties
City	Supplies material for injurious debris Masonry may shield from blast, debris, and radiation Building collapses increase injuries Wood buildings and petrochemicals burn, may produce lethal firestorm	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties Buildings partially shelter from agent	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties Buildings partially shelter from agent
Weather	Wind, rain patterns may either increase or decrease lethal distribution of radioactive fallout	Wind may blow agent away from or toward targets Air temperature and temperature gradient affect dispersal	Wind may blow agent away from or toward targets Air temperature and temperature gradient affect dispersal

Union deployed the gamut of chemical delivery systems from spray tanks[6] to chemical warheads for short-range ballistic missiles, rockets, land mines, bombs, and artillery. The Iraqi chemical arsenal included artillery shells, bombs, and some ballistic missile warheads.

If any live biological weapons have been used in the twentieth century, their characteristics for the most part have been well concealed.[7] But apparently weapon designs have included spray-tanks, bombs, cluster bombs, and bomblet dispensers.[8] Like chemical weapons, biological agents are best dispersed as low-altitude aerosol clouds. (Moreover, explosive methods of dispersion may destroy the organisms.) Ballistic missile warheads that can effectively generate aerosols are

[6] Chemical agent is most efficiently delivered as a spray at low altitudes.

[7] As noted in table 2-1, from the delivery and effects standpoints, toxins are closer to being chemical than biological weapons. Japan seems to have attempted limited biological agent attacks in China during World War II-apparently with inconclusive effects. See below, footnote 23.

[8] World *Health Organization Health Aspects of Chemical and Biological Weapons* (Geneva: World Health Organization, 1970), p. 84. See also Stockholm International Peace Research Institute, *The Problem of Chemical and Biological Warfare: Vol II, CB Weapons Ted@ (New* York, NY: Humanities Press, 1975), pp. 83-89.

Table 2-2--(Continued)

Factor	Nuclear	Biological	Chemical
Weather (continued)		High winds disperse farther, but may dilute lethal concentrations sooner	High winds disseminate farther, but may dilute lethal concentrations sooner
		Rains may clear air, wash away deposited agent	Rains may dear air, wash away some types of deposited agent
		Sunlight or drying rapidly destroys some agents	Cold weather prevents evaporation, reducing concentrations in air but lengthening period of ground contamination
Defensive measures	Shelters offer varying degrees of protection outside central destructive area of bomb	Immunization possible if agents known in advance, but massive exposures can overwhelm immunity	Antidotes for some agents can be effective if administered soon enough after exposure; limited preventive treatment also possible for nerve agents
	With ample preparation and warning, evacuation the best protection	Depending on agent, early medical treatment can reduce mortality rate	Early decontamination and medical treatment can reduce mortality
		With adequate detection and warning, special masks and clothing or buildings or vehicles with filtered, positive internal air pressure can protect effectively	With adequate detection and warning, special masks and clothing or sealed buildings or vehicles with filtered, positive internal air pressure can protect effectively
		Surfaces can be decontaminated	Surfaces can be decontaminated
		With ample preparation and warning, evacuation the best protection	With ample preparation and warning, evacuation the best protection

SOURCE: Office of Technology Assessment, 1993.

technically challenging to design, although the United States had done so by the 1960s. Long-term storage of missile or artillery warheads filled with live or freeze-dried biological or toxin agent is difficult (except for anthrax spores); even if refrigerated, most of the organisms have a limited lifetime. Small, unmanned aerial vehicles carrying spray tanks might become an appealing option for third-world countries seeking inexpensive weapons of mass destruction.[9]

The biological agents usually considered for warfare have been infectious (multiplying within the infected person) but not contagious (spreading from one person to another). A nation contemplating the military use of contagious agents would have to consider the following problems:

- the spread of the disease might be so slow as to dilute the military impact;
- there would be a risk that the disease would spread back to the attacker; thorough vacci-

[9]See W. Seth Carus, " 'The Poor Man's Atomic Bomb?' Biological Weapons in the Middle East" (Washington DC: The Washington Institute for Near East Policy, Policy Papers No. 23, 1991), p. 11.

Table 2-3--Weaponizing Agents of Mass Destruction: Actual and Possible Methods of Delivery

Weapon	Nuclear	Biological	Chemical
Aerial bomb	J	√	√
Bomb subminitions		√	√
Aerial spray tank		√	√
Ballistic missile warhead, nonseparating	√	√	√
Ballistic missile warhead, separating	√	(poss.)	(poss.)
Reentry vehical			
Artillery Shell	√	√	√
Rocket Shell	√	√	√
Mortar shell	√		√
Cruise missile warhead	√	(poss.)	(poss.)
Mine (land)	√		√
Mine (sea)	√		
Antiaircraft missile warhead	√		
Torpedo	√		
Transportable Clandestine Bomb	√	(p0ss)	(poss.)
Actual Cases	√		
Theoretical possibility	(poss.)		

SOURCE: SIPRI, 1975 and Office of Technology Assessment, 1993.

nation of one's own troops and population would be very difficult; and

. many nations not at war with, and perhaps even allied to, the attacker might also suffer from the epidemic, exposing the attacker to unnecessary sanctions or retaliation.

A clandestine terrorist might not care about these problems. A nation with an advanced biotechnology program might try to create a contagious organism that was both difficult to treat and susceptible to a vaccine uniquely available to the nation's own population. These conditions would be difficult to achieve, as well as to implement covertly on a nationwide scale, but cannot be dismissed as impossible (see the OTA background paper on technologies underlying weapons of mass destruction, in press).

Means of delivery

How nuclear, biological, or chemical weapons are incorporated into weapons will depend both on their purposes and on the available means of delivery. This section introduces the primary kinds of vehicles by which these weapons might be delivered. Following sections address possible uses. As table 2-2 illustrates, properly configured weapons of mass destruction can be delivered by many kinds of military delivery systems, and at ranges from a few to thousands of kilometers. Depending on the scenario, such weapons can be highly threatening even without sophisticated military delivery systems. A nuclear device planted by terrorists or commando squads, or delivered by disguised cargo ships, aircraft, or even small pleasure craft, could kill just as many people as one delivered by an ICBM; a given quantity of lethal microorganisms effectively spread by human agents might kill even more than one delivered by missile.

Thus, the absence of advanced delivery systems does not mean that states or sub-national groups could not use weapons of mass destruction. Even though few proliferant states (with the

possible exceptions of India, Israel, and China)[10] have---or are likely soon to acquire-military delivery systems capable of directly reaching the United States, unconventional delivery methods could still put U.S. territory at risk. U.S. allies abroad or deployed U.S. forces are already threatened by shorter range systems. In the cases of rival states bordering one another, nuclear, biological, or chemical weapons mounted on even very short-range means of delivery can pose a major threat.

Nevertheless, states possessing considerable numbers of advanced longer range systems equipped with these weapons can more reliably threaten more nations with higher levels of destruction than those only possessing short-range systems. Every state currently of proliferation concern has combat aircraft in principle capable of delivering weapons of mass destruction; most of those states also own or have programs to acquire ballistic missiles.

Partly for these reasons, the discussions of delivery systems in this OTA report and its associated background paper deal primarily with advanced systems.[11] Another reason is a more practical one: because advanced systems designed to penetrate enemy defenses are in many cases technically more demanding, there is greater hope (than there is for short-range systems) of imposing international controls on their further proliferation.

The three principal types of advanced delivery vehicle are aircraft, ballistic missile, and cruise missile. Aircraft (in the sense used here) are piloted, air-breathing (usually jet) airplanes; the combat aircraft of many of the world's air forces can deliver payloads of several thousand pounds to distances of hundreds of kilometers (or more, if they are equipped for aerial refueling) 12; they may fly at speeds of 1,000 to **2,000 km/hr or** more.

Ballistic missiles carry both fuel and oxidizer and (except for very short-range systems) fly part of their trajectory outside the atmosphere. They usually reenter the atmosphere hypersonically, at speeds of thousands of km/hr, and carry smaller payloads than aircraft. They are likely to delivery weapons less accurately than aircraft, but high accuracy is unnecessary for delivering nuclear weapons on many kinds of missions.

Cruise missiles or other unpiloted aerial vehicles share some characteristics with piloted aircraft and some with ballistic missiles. Like airplanes, these missiles fly nonballistic trajectories within the atmosphere and are powered throughout their flight. (Ballistic missiles, in contrast, are powered only at the beginning of their trajectories, coasting to their targets once their final rocket motor stages burn out.) Unpiloted aerial vehicles range from simple, unmanned drone aircraft used for target practice, to short- and medium-range (10 to 100 km) antiship missiles widely available around the world, to highly sophisticated, longer range, autonomously guided missiles such as the U.S. Tomahawk. Like ballistic missiles, they do not require as extensive a training and support infrastructure as do piloted aircraft.

Since cruise missiles can be launched from air, sea, and underwater as well as from land, their own range is extended by that of their carrier (airplane, ship, or submarine). Like other aircraft, they can be shot down once detected and identified. However, small size (and radar cross-section), low-altitude flight, and circuitous courses can make them hard to find. Like ballistic missiles, they are expendable, eliminating the need to risk a pilot (and avoiding the possibility

10 Declared nuclear-weapon states are not considered nuclear "proliferants." China, although a declared nuclear-weapon state, is suspected of being a chemical and biological weapon proliferant.

11 Background paper on technologies underlying weapons of mass destruction, in press.

12 Converted cargo aircraft or long-range bomber aircraft (if available) can fly thousands of kilometers without refueling.

of pilot error while forfeiting the potential for pilot improvisation if something goes wrong).

With the worldwide availability of high-precision navigation services such as that provided by the U.S. Global Positioning System (GPS), a simple cruise missile can in principle be made more accurate than even a sophisticated ballistic missile. A piloted aircraft, on the other hand, has abetter chance than a cruise or ballistic missile of delivering chemical or biological weapons onto mobile military targets and of adjusting bombing or spraying patterns to the weather.

An analysis comparing the relative advantages of aircraft and ballistic missiles for nuclear weapon delivery concludes:

> Ballistic missiles are of principal concern to the degree they are coupled to the delivery of nuclear and, to a somewhat lesser extent, chemical weapons. But advanced-strike aircraft can be effective in delivering nuclear weapons and can be more effective than ballistic missiles for delivering conventional or chemical ordnance.[13]

On the other hand, to deliver weapons at intercontinental range, developing and building intercontinental ballistic missiles may be easier than acquiring long-range bombers and refueling capabilities.[14]

Since biological warfare agents are, like chemical ordnance, best disseminated in an aerosol over a wide area, aircraft and cruise missiles are better for delivering them than are ballistic missiles. In addition, it is more difficult (but not impossible) to develop ballistic missile warheads in which live biological agents can survive the stresses of space flight and atmospheric reentry.

WEAPON EFFECTS COMPARED

Destructive Effects

Figures 2-1 and 2-2 illustrate some rough estimates for the effects of comparable amounts of chemical, nuclear, and biological weapons. These are based on somewhat arbitrary assumptions, but they do give a basis for relative comparison of the weapon types.

These comparisons suggest the following generalizations:

- nuclear weapons remain the most massively destructive weapons that can be built: unlike chemical and biological weapons, nuclear weapons also threaten massive destruction of property (civilian or military);
- in principle, biological weapons efficiently delivered under the right conditions against unprotected populations would, pound for pound of weapon, exceed the killing power of nuclear weapons; on the other hand, if warning is provided, effective civil defense measures are considerably easier to take against chemical and biological weapons than against nuclear weapons;
- for maximum physical effect, chemical and biological weapons are more efficiently delivered by aircraft or artillery barrages than by high-speed missiles; missile attacks, however, may be useful as instruments of terror;
- chemical weapons must be delivered in great quantities to approach the potential lethality of nuclear and biological weapons; against well-protected troops or civilians, they will be less lethal than even conventional explosives; and

13 Center for International Security and Arms Control, Stanford University, *Assessing Ballistic Missile Proliferation and Its Control* (Stanford, CA: CISAC, November 1991), p. 7.

14 See Edward Luttwak, foreword to Seth Carus, *Ballistic Missiles in Modern Conflict* (New York, NY: Praeger, 1991) p. vii

Figure 2-l-Comparing Lethal Areas of Chemical, Biological, and Nuclear Weapons: Missile Delivery on an Overcast Day or Night, With Moderate Wind (Neither Best nor Worst Case)

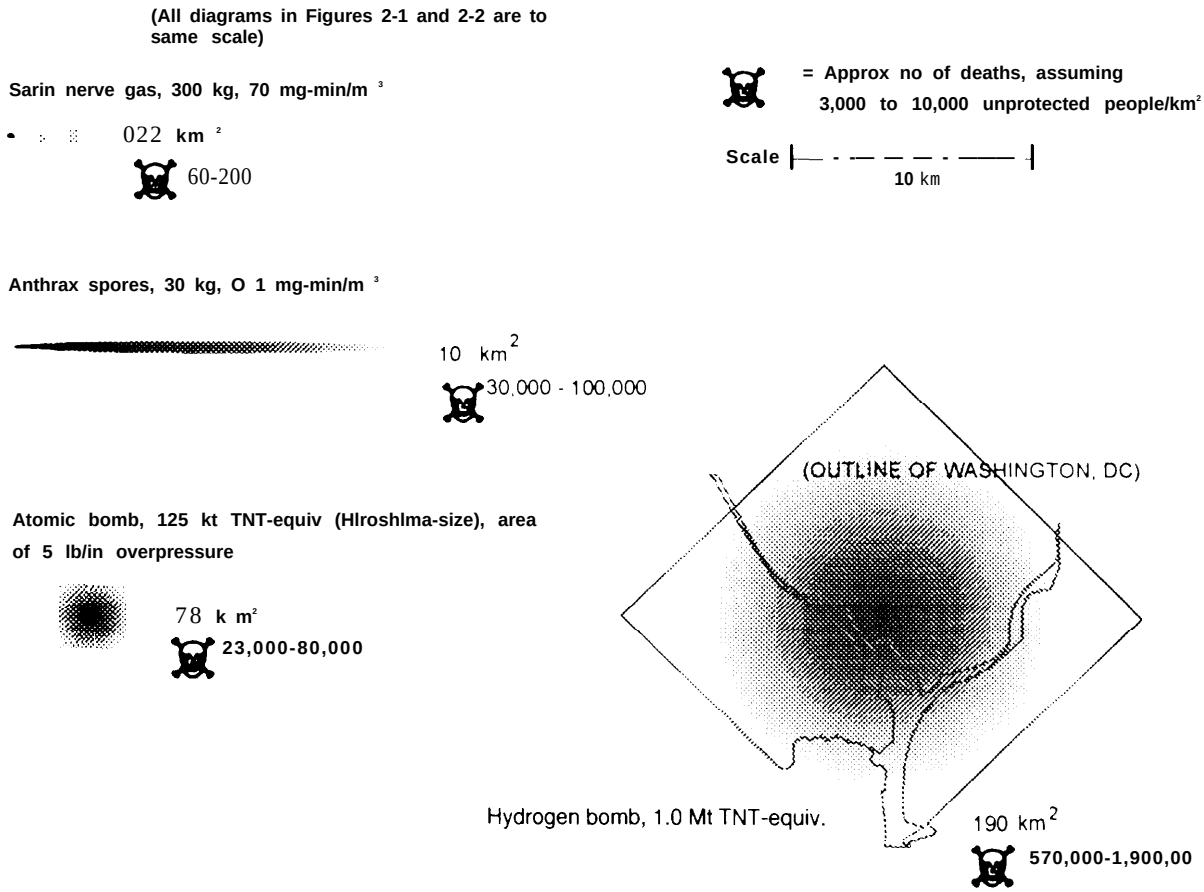


Figure shows the lethal areas of the agents delivered by a Scud-like missile with a maximum payload of 1,000 kg (note that the amount of biological weapon agent assumed would weigh considerably less than this; since the lethality per unit weight is great, the smaller amount considered here would still more than cover a large urban area). The estimates of lethal areas for chemical and biological weapons were prepared using a model that takes account of postulated release height, wind velocity, deposition velocity, height of temperature inversion layer, urban air currents, and residence time in air of the agent. The diagrams show approximate outer contours of areas with sufficient concentrations of agent that 50 percent to 100 percent of the unprotected people would receive fatal doses. Although some people within the defined area would survive, about the same number in the outer, less lethal areas, would die; therefore, the defined areas give approximations of the total number of unprotected people who could be expected to die in each scenario, With ideal (forlethalit y) population densities and weather, the chemical and biological agents could kill more people than shown here; under worse conditions, they might kill many fewer. The atomic weapons (fission and fusion) are assumed to be ah burst for optimum blast and radiation effects, producing little lethal fallout. The lethal area is assumed to be that receiving 5 lb/in² of overpressure--enough to level wood or unreinforced brick houses.

SOURCE Office of Technology Assessment, 1993.

Figure 2-2-Comparing Lethal Areas of Chemical and Biological Weapons: Delivery by Aircraft as Aerosol Line Source

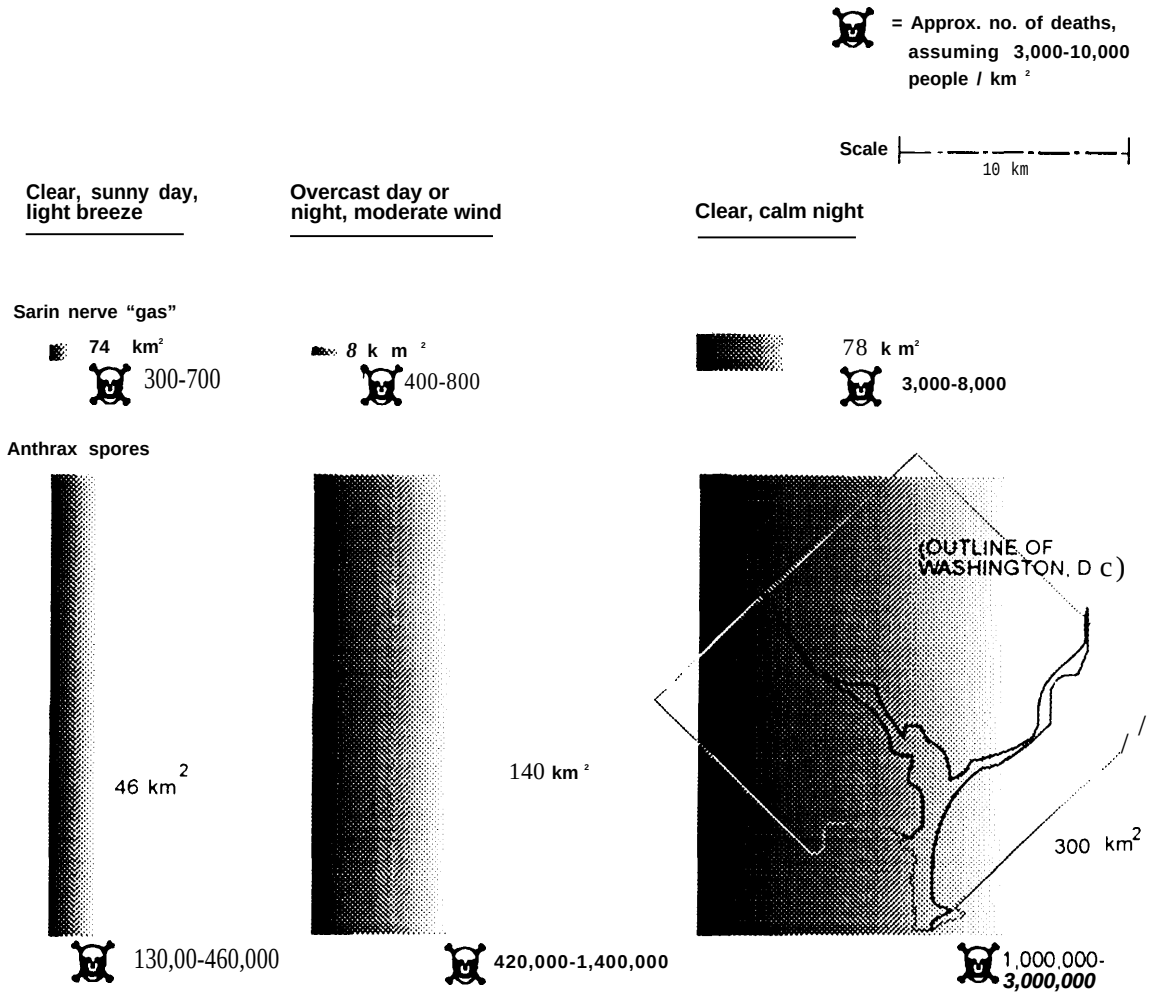


Figure shows the lethal areas of single airplane-loads of chemical and biological weapons, assuming a highly efficient line-source delivery of the killing agents. The figure also assumes that the aircraft has a greater payload than the missile in figure 2-1, delivering 1,000 kg of sarin nerve agent or 100 kg of anthrax spores. (More anthrax would be inefficient in a city attack.) Given these two factors, a single airplane delivering chemical or biological weapons can be considerably more lethal than a single missile. For an anthrax attack, the diagram shows how fatalities could vary greatly under three different weather scenarios. In one case, that of an overcast day or night with moderate wind, maximizing the lethal area would require distributing the agent in a 4.5 km by 34 km area, which would not be appropriate for most cities; therefore, the figure assumes a more rectangular distribution, which would still generate a comparable number of casualties.

SOURCE: Office of Technology Assessment, 1993.

- because they are so dependent on weather and the degree of defensive protection, the consequences of chemical and biological weapons are much less predictable than those of nuclear weapons; nevertheless, even when military utility is questionable, chemical and biological weapons may terrorize civilian populations (and, particularly for terror uses, the attacker may be able to wait for optimal weather).

Military Utility

A principal-but by no means exclusive—motive for developing countries to acquire weapons of mass destruction is for their potential military utility. The symbolic, deterrent, or intimidating uses of these weapons may be disproportionate to their actual effects on opposing military forces.[15] On the other hand, political inhibitions on using the weapons may render moot their purely military effectiveness. These cautions noted, table 2-4 compares general military uses of the weapons (along with conventional explosive weapons, for comparison).

The nuclear age has generated special meanings for the terms *strategic* and *tactical* as applied to weapons of mass destruction. The general meaning of *strategic military* action in this context is the attempted destruction of the military infrastructure, economic base, and even the population that enables the enemy nation to make war. *Tactical* attacks, on the other hand, are those more directly engaging the enemy's frontline military forces, immediate reinforcements, or supply lines. As table 2-4 indicates, nuclear, chemical, and biological weapons can each be applied tactically or strategically. From a strictly military viewpoint, though, their utilities are not equivalent because the consequences of using each are different.

TACTICAL USES

The tactical uses of weapons of mass destruction may have both direct and indirect purposes. The direct purpose would be to destroy or disable specific military targets-bases, equipment, or personnel. The indirect purpose would be to compel the enemy to change his operations to cope with extraordinary threats. For example, the threat of nuclear attack might force the dispersal of large troop or armor concentrations. Chemical weapon threats might require troop dispersals and protective measures that reduce combat effectiveness, while perhaps overburdening medical services with injured personnel. Biological weapon threats would impose similar burdens.

During the Cold War, the United States and the Soviet Union each deployed thousands of 'tactical' ' nuclear weapons (e.g., artillery, rockets, short-range ballistic missiles, aerial bombs). For the most part, these weapons would have been aimed at military forces and installations more or less directly involved in battle. Their explosive yields reportedly ranged from less than 1 kiloton (kt) of TNT to several hundred kt.[16] Limited use of these weapons in Europe would, at the very least, have forced armies on both sides to alter their tactics to avoid presenting large concentrations of troops and armor as targets. Used en masse, these tactical weapons might have produced damage to the population and the civilian infrastructure resembling that to be expected from

15 In some unusual cases, the uses may intend provocation, as opposed to deterrence or intimidation. The apparent intent Of Iraq's use of Scud missiles against Israel during the Gulf War was to lure Israel into military retaliation. Iraq might then have persuaded the Arab members of the Coalition to change sides to avoid fighting on the same side as Israel. Thus, even though the Iraqi attack would probably have had little direct military effect, its political effect might have been enormous. (Iraq might have increased the chances of Israeli military action had it used chemical warheads on its missiles; on the other hand, Iraq also had to consider the possibility that Israel would respond to such an attack with nuclear weapons, an escalation Saddam Hussein probably wanted to avoid,)

16 See william M. Arkin and Richard W. Fieldhouse, *Nuclear Battlefields: Global Links in the Arms Race* (Cambridge, MA: Ballinger, 1985), pp. 57-58. By way of comparison the bomb that destroyed Hiroshima had a yield of 12.5 kt.

Table 2-4-Applications of Weapons of Mass Destruction Compared

Characteristics	Conventional explosives (for comparison with WMD)	Nuclear	Chemical	Biological
Destructive effects (See table 2-1)	Blast, shrapnel, fire	Blast, fire, thermal radiation, prompt ionizing radiation, radioactive fallout[1]	Poisoning: skin, lungs, nervous system, or blood	infectious disease or biochemical poisoning
Typical militarytargets	Military bases and equipment; Command-and-control installations (e.g. command posts, radars); troop concentrations; ships[2]	Similar to targets for conventional munitions (esp. targets hardened against blast) Enemy nuclear or other WMD facilities	infantry concentrations, towed artillery, air bases, ships, ports, staging areas, command centers	infantry concentrations, air bases, ships, ports, staging areas, command centers
Typical missions against military targets	Destruction of targets, personnel casualties	Destruction of targets Personnel casualties intimidation of personnel Disruption of operations by requiring dispersal of units. Disruption of communications by electromagnetic pulse effects	Unprotected personnel casualties; disruption of operations by requiring protective measures or decontamination Demoralization or panic of personnel	Unprotected personnel casualties; disruption of operations by requiring protective measures or decontamination Demoralization or panic of personnel
Drawbacks as military instrument	Small lethal radius requires either many weapons or great accuracy for most military missions	Potential for great "collateral damage" Risk of retaliation and escalation in kind Radioactive contamination of ground that user may wish to cross or occupy	Relatively large quantities required Protective measures may greatly reduce casualties Leave buildings and equipment reusable by enemy (but persistent agents may require decontamination) With persistent agents, chemical contamination of ground that user may wish to cross or occupy	Protective measures may reduce casualties Most agents degrade quickly With persistent spores, contamination of ground that user may wish to cross or occupy Leave buildings and equipment reusable by enemy (but persistent spores may require decontamination) Effects depend on weather and time of day; are delayed, unpredictable, or uncontrollable

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a‘ ‘strategic” nuclear war.[17] Moreover, they were deployed in the context of superpower arsenals containing thousands more strategic nuclear weapons aimed at each other’s homeland.

New nuclear powers are likely to have anywhere from one to a few hundred nuclear weapons, most likely of explosive yields equivalent to a few tens of kilotons of TNT. These new nuclear powers might intend to use their limited numbers of weapons against isolated military targets for tactical purposes, or they might seek to achieve maximum economic damage and psychological effects by directly attacking cities. The decision would probably depend on the military and political context, including whether the adversary or its allies also had nuclear arms, and, if so, how many.

During World War I, both sides used large amounts of chemical weapons. Japan used chemical and biological weapons against China in World War II. Since then, the world has had some further experience with use of chemical weapons: Egypt (reportedly) in Yemen in 1967 and 1968; Iraq against Iran during the 1981-1988 war, Iran against Iraq, and Iraq against some of its own Kurdish population. During its war with Iran, Iraq used aerial bombardment and artillery to deliver mustard and nerve agents against Iranian infantry and ‘‘human wave’ attacks and against support troops and staging areas.[18] Iranian troops were poorly protected throughout, but apparently only by 1986 did the Iraqis learn to use their chemical weapons in coordinated and effective ways, preventing Iranian troops from massing and counterattacking with conventional forces. In 1988, Iraq used chemical weapons in an offensive mode, weakening Iranian forward positions and limiting rear operations. Iraq reportedly also used a combination of mustard and nerve agents on Kurdish civilian villages and rebel encampments.[19]

Pelletiere and Johnson point out that, as was the case in World War I, the ratio of deaths to injuries from chemicals seems to have been low in the Iran-Iraq war, and that therefore chemical weapons should not be thought of as ‘‘a poor man’s nuclear weapon. ’[20] Anthony Cordesman concludes that although the contribution of chemical weapons to Iraqi success in any one battle is hard to estimate, and although they produced less than 5 percent of the more than 1 million Iran-Iraq war casualties,

> Nevertheless, [they] had a critical effect on Iranian military and civilian morale by late 1987, and during the Iraqi counter-offensives and ‘‘war of the cities” in 1988. Sheer killing power is not the key measure of success: it is rather the strategic, tactical, and psycho-political impact of the use of such weapons. Even when troops are equipped with defensive gear, they often feel they

17 Indeed, full application of the conventional firepower deployed in Europe might have had consequences nearly as terrible—which may be one reason why NATO allies were willing to rely so heavily on nuclear deterrence against a Soviet attack.

18 See Steven C. Pelletiere and Douglas V. Johnson II, *Lessons Learned: The Iran-Iraq War* (Carlisle Barracks, PA: Strategic Studies Institute, U.S. Army War College, 1991), “Appendix B: chemical Weapons,” pp. 97-101; and Anthony H. Cordesman, *Weapons of Muss Destruction in the Middle East* (London: Brassey’s (UK), 1991), pp. 85-93. The following discussion is drawn primarily from these sources.

19 Signs of mustard, nerve, and blood agents were reported found in Kurdish areas in statements of Robert Cook-Degan and of Deborah Lief-Dienstag and supporting documents (given in U.S. Congress, Senate Committee on Governmental Affairs, Permanent Subcommittee on Investigations, *Global Spread of Chemical and Biological Weapons, Hearings,* 101st Cong., 1st sess., S. Hrg. 101-744 (Washington, DC: U.S. Government Printing Offfice, 1990), pp. 242-266). There is general agreement that Iraq used the mustard and nerve agents. Some authors argue that Iraqis also delivered cyanide on the village of Halabjah, but Cordesman, ibid., concludes that Iranians were the likelier source.

Gordon Burck argues that the cyanide could have come from ill-manufactured Iraqi nerve agent (“The Geneva Protocol: Selective Enforcement” in Lessons *of the Gulf War: Mediation and Conflict Resolution,* AAAS, *Proceedings from an Annual Meeting Symposium,* Feb. 17, 1990, New Orleans, Louisiana, p. 17). Kenneth Timmerman, on the other hand, charges that Iraqis were using purposely developed hydrogen cyanide bombs; see *The Death Lobby: How the West Armed Iraq (New* York, *NY:* Houghton Mifflin, 1991) p. 293. The UN Special Commission, however, did not report finding hydrogen cyanide weapons in the Iraqi arsenal.

20 See Pelletiere and Johnson, op. cit., footnote 18, p. 100. They report that although 27.3 percent of all American casualties in World War I were gas-generated, and 31,4 percent of wounds were gas-related, the death rate among gas victims was only 2 percent.



U.S. AIR FORCE PHOTOS

Even if chemical weapons did not inflict large-scale casualties, they could seriously interfere with military operations. These pictures were taken during a 1988 exercise at Eglin Air Force base. On the left, an airman dons cumbersome protective gear. Top right, a simulated casualty is carried away from the airfield. On the bottom right, an aircraft is decontaminated by spraying and scrubbing with neutralizing chemicals.

> are defenseless and break and run after limited losses. Populations which fear chemical attacks may well cease to support a conflict.[21]

On the other hand, chemical weapons used against troops in World War I did not appear to damage civilian morale. Nor can it be shown that chemical weapons clearly affected civilian morale in the Iran-Iraq war.

Chemical weapons may be used in tactical warfare either to kill or terrorize instantly, or to impose operational difficulties on the enemy by contaminating key areas or equipment for hours or days. Thus, an attack on an infantry position might use a volatile agent like GB, while a viscous, persistent agent like VX might be applied to an airbase or a strip of territory. Table 2-5 indicates approximate quantities of those two types of agent that might be needed for some representative military missions. Although a few drops of nerve agent can kill, the fact that chemical agents are usually disseminated as a wind-borne aerosol or spray means that many tons may be needed to produce many battlefield casualties. The military utility of attacks on troops

21 Cordesman, op. cit., footnote 18, p. 92.

Table 2-5-Quantities of Chemical Weapons for Various Missions

Mission	Quantity
Attack an Infantry position: Cover 1.3 km² of territory with a "surprise dosage" attack of GB (Sarin) to kill approximately 50% of unprotected troops	216 240-mm rockets (e.g., delivered by 18, 12-tube Soviet BM-24 rocket launchers) each carrying 8 kg agent (totalling 1728 kg)
Prevent launch of enemy mobile missiles: Contaminate a 25 km² missile unit operating area with 0.3 tons of VX per sq. km	8 F-16 bombers each delivering 0.9 ton of VX (totalling 7.2 tons)
Immobilize an air base Contaminate a 2 km² air base with 0.3 tons of VX twice a day for three days	1 F-16 bomber, 6 sorties
Defend a broad front against large-scale attack: Maintain a 300-m deep strip of VX contamination in front of a position defending a 60-km wide area for 3 days	65 metric tons of agent delivered by approximately 13,000 155-mm artillery rounds
Terrorize population: Kill approximately 125,000 unprotected civilians in a densely populated (10,000/km²) city	8 F-16 bombers each delivering 0.9 ton of VX (totalling 7.2 tons) under optimum conditions

SOURCE: Adapted from Victor A. Utgoff, The *Challenge of Chemical Weapons* (New York, NY: St. Martin's Press, 1991), pp. 23S-242.

would depend greatly on how effectively they were protected with gas masks, clothing, and shelters .22

For biological weapons, there is little documented experience with military use.[23] One analyst speculates that, for surprise attacks or for repelling immediate attacks by others, biological weapons would be too slow and unpredictable to be militarily attractive. He argues, however, that they might be useful on the front lines against freed defensive positions in long wars of attrition.[24] Another analyst argues that suitable tactical targets for biological weapons might include reserve combat units, formations massing in preparation for an offensive, air force squadrons, and rear area support units:

> Thus, it would appear that biological weapons could be militarily useful in situations when immediate results are not required and where the danger to friendly forces is minimal. Thus, even

22 Chemical weapon researchers very likely have in the past studied methods of penetrating gas masks with chemical warfare agents.

23 Japan reportedly used biological warfare against China before and during World War II, with inconclusive results. Although the Japanese Army performed field trials in which bombs carrying plague-infested fleas were dropped on at least 11 Chinese cities, the weapons were not reliable and had little military impact-although they claimed an estimated 700 civilian lives. Contamination of Chinese territory with plague also caused thousands of unintended casualties among Japanese troops. See "Japan's Germ Warfare: The U.S. Cover-Up of a War Crime," *Bulletin of Concerned Asian Scholars,* vol. 12, October-December 1980, pp. 2-17; John W. Powell, "A Hidden Chapter in History," *Bulletin of the Atomic Scientists,* vol. 37, No. 8, October 1981, pp. 44-52; and Peter Williams and David Wallace, *Unit 731: Japan's Secret Biological Warfare in World War H* (New York, NY: Free Press, 1989).

24 Raymond A, Zilinskas, "Biological Warfare and the Third World," *Politics and the Life Sciences,* vol. 9, No. 1, August 1990, pp. 59-76.

> if biological warfare has only slight immediate value on the battlefield, it could have considerable utility when directed at rear units.[25]

Note that even if not many troops were killed, a sudden epidemic of incapacitating disease could at least temporarily paralyze both logistic and fighting units.

It is feasible—if the right weather occurs and can be utilized-for a single aircraft to disseminate high dosages of biological agent over hundreds, or even thousands, of square kilometers by spraying a long line upwind from the target region. This was one nightmare scenario for coalition forces facing Iraq in northern Saudi Arabia during the Gulf War. For comparison of the relative lethalities of biological, nuclear, and chemical weapons under somewhat different scenarios, see figures 2-1 and 2-2.

Defending against biological weapons may be difficult. Currently there is no reliable way of quickly detecting their presence or identifying them, so soldiers may not take shelter or don protective clothing in time. Vaccination requires advance knowledge of the infective agents the troops will encounter, the availability of effective vaccines, and sufficient time for the soldiers to develop immunity. High concentrations of agent may overcome the immunity even of vaccinated personnel.

According to the commander of the recently created U.S. Army Chemical and Biological Defense Agency (CBDA),

> . . . the biological threat has been recently singled out as the one major threat that still poses the ability for catastrophic effects on a theater-deployed force. Desert Storm solidified the perception in our country-in the Congress and among our military leadership--that [biological warfare] was something that third-world nations considered a potential equalizer.[26]



DEPARTMENT OF DEFENSE

With adequate warning, troops can be protected from biological weapon attack by means of protective suits. Soldiers in Saudi Arabia during Operation Desert Shield (prior to Desert Storm) sometimes trained wearing chemical/biological protective gear.

STRATEGIC USE

Nuclear—Between World Wars I and II, the military theorist Giulio Douhet and others developed an idea of strategic bombing in which aerial attacks on key military and economic targets in the enemy's homeland would severely diminish his ability to make war. During World War II, strategic bombing evolved in practice into efforts not only to inflict crippling damage on the enemy's infrastructure, but to cripple his war effort by demoralizing the population. Although the strictly military and economic effects of the two atom bombs dropped on Japan did not directly affect Japan's armed forces, the shock of the attacks (combined with the fear that more might follow) led to an unconditional surrender that might otherwise not have come so soon. During the Cold War, the nuclear standoff between the United States and the Soviet Union was sometimes called the ''balance of terror." Although both superpowers integrated nuclear weap-

25 Carus, op. cit., footnote 9, p. 37.

26 Brig. Gen. George Friel, Commanding General, U.S. Army CBDA, quoted in John G. Roos, ''Chem-Bio Defense Agency Will Tackle 'Last Major Threat to a Deployed Force,' '' ***Armed Forces Journal International,*** December 1992, p. 10.

ons into their military forces, the primary role of the weapons was not to win wars but to back threats.

This terroristic component to strategic warfare with weapons of mass destruction makes it difficult to analyze just what would constitute ''rational' or ''irrational' use by proliferant states. When leaders threaten to use the weapons (whether in an initial or a retaliatory attack), they must decide what level of threat will be sufficiently intimidating. In some cases, conveying the impression that one could assemble a nuclear bomb in 2 weeks might seem enough; in other cases, the threat to launch a nuclear missile attack in 1 hour might not.

A leader actually ordering a strategic attack must subjectively predict its psychological impact on the other side's population and government, not just calculate the physical effects of the weapons on the other side's war machine. The attacker must also estimate what kind of retaliation to expect, and whether he would be willing to accept it. Alternatively, the leader may be ordering a retaliatory attack, either in pure revenge or to warn against further escalation of the conflict. In sum, this section's discussion of the physical suitability of the weapons for strategic warfare is only part of the story.

Threatening both population and property, nuclear weapons are the most dangerous strategic weapons. While civil defense measures can mitigate their effects somewhat, within a certain radius (dependent on the explosive yield) they promise certain destruction of all but deeply buried blast shelters. Despite the great uncertainties in calculating the precise consequences of nuclear war, the impact of even a ''small' or "limited" nuclear attack would be enormous.[27]

Chemical—Medium- to large-scale attacks with chemical weapons (e.g., tens of tons) on civilians may kill many more unprotected people (e.g., thousands) than would equivalent amounts of high explosives. On the other hand, the many uncertainties involved in dispersing chemical agents efficiently-as well as the effectiveness of relatively simple civil defense measures (e.g., wearing gas masks and remaining inside living spaces that are sealed off during attack)--could keep casualties relatively low. Contamination of certain areas by persistent chemical agents might slow down industrial activities for days or weeks, but for the most part chemical weapons would leave the economic infrastructure of cities intact. Enclosed military facilities are even more likely to be protected and to continue functioning.

Biological—Like chemical weapons, biological weapons would leave the material (as opposed to human) economic and military infrastructure relatively untouched.[28] Like nuclear weapons, they have the potential in modest amounts (e.g., a few kilograms of agent), properly delivered, to kill and disable many thousands of urban residents and to seriously impair war-supporting activities. On the other hand, biological weapons (except for some toxins) act more slowly than chemical or nuclear weapons, taking days or weeks to achieve full effect. Moreover, their effects are much harder to predict than those of nuclear weapons: weather, time of day, local terrain, and civil defense measures could all act to reduce casualties (as with chemical weapons).

Unlike nuclear and chemical weapons, the use of biological weapons might not be attributed to enemy attack, since outbreaks of disease can occur naturally. The problems of protecting civilian populations against biological attack are similar to those cited above for protecting troops: immediate detection and protection are likely to be difficult, and effective advance vaccination may be infeasible.

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27 See OTA, *The Effects of Nuclear War,* Op. Cit., footnote 3, p. 4.

28 With the exception that biological weapons can and have been developed for application to target food crops, with the aim Of strategic reductions of the enemy's food supply. Moreover, spore-forming organisms such anthrax might require major decontamination efforts, and therefore interfere seriously with normal economic or military activities.

NEAR-TERM PROLIFERATION THREATS: SUSPECTED PROLIFERANT NATIONS

Weapons

At the U.S. State Department's last count published in 1992, *there* were 188 countries in the world. Five of the world's nations (United States, Russia, United Kingdom, France, China) have acknowledged owning nuclear weapons. Three other states—Ukraine, Belarus, and Kazakhstan—have on their territory former Soviet strategic nuclear weapons, nominally under control of the Commonwealth of Independent States,[29] and it is not yet fully certain that all will give them up. Since the end of World War II, three states have admitted having chemical weapons (United States, Russia, and Iraq). None say they have deployed biological weapons, although five (United States, Russia, France, the United Kingdom, and Canada) admit having had offensive weapon munition supplies or development programs in the past. Additional countries are suspected either of possessing some of these weapons of mass destruction or of trying to acquire them, but many more are not. In sum, the scope of the problem of proliferation is worrisome but still limited enough to encourage hope that it can be contained.

This section presents data intended to convey a sense of the general character of the near-term proliferation problem. It names countries cited in the public literature as having either the weapons, or programs to acquire the weapons, of concern to this report. The arbitrary criteria for including countries are explained in the footnotes to each list. These lists should be treated with caution and should in no way be considered authoritative or as representing official U.S. Government assessments. To have included such assessments in this report would have resulted in its classification as a secret document, since the U.S. Government has released few of its estimates about the activities of specific countries.

Intelligence information might tend to confirm or undermine some of the estimates in the public literature, These details, however, are more important for the implementation of U.S. unilateral policies (particularly those involving covert action or certain bilateral international arrangements) than for the formulation of the broader policies to be addressed in this report and its sequel.[30] In any case, the broader policies *must be* formulated in the context of publicly available information. First, although Congress can authorize classified activities that may be subject to some oversight, it cannot pass secret legislation. Second, Congress responds to public pressure, which in turn derives from publicly available information. Third, achieving international consensus and collective action on proliferation will require openness. Fourth, multilateral agreements such as the Nuclear Non-Proliferation Treaty (NIT), the Biological Weapons Convention (BWC),[31] and the Chemical Weapons Convention (CWC) were not negotiated or implemented in secrecy.

The United States will have to choose and carry out its national policies toward specific countries on the basis of the best information available, classified and unclassified. Nevertheless, it should be understood that both classified and unclassified assessments of foreign weapon programs will be subject to uncertainties, incompleteness, lack of integration of available data, or inadequate interpretation-as the case of the Iraqi nuclear program well illustrates.

Table 2-6 summarizes a published estimate of what countries (beyond the five self-acknowledged nuclear powers) are pursuing nuclear weapon programs. Note that some of the countries

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29 The three non-Russian states have at least a political veto over launch of the weapons on their territory, but apparently they do not currently have the technical means to launch them independently.

30 OTA report on nonproliferation policies, in preparation.

31 convention *on the Prohibition of th, Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction.*

Table 2-6--Countries Reportedly Trying to Acquire Nuclear Weapons

Region	Country	Comment
Middle East/ North Africa	Algeria	Possibly interested in nuclear weapons, but currently lacks facilities; has agreed to IAEA inspection of formerly secret, Chinese-supplied nuclear reactor; not a party to the NPT.
	Iran	Reportedly pursuing nuclear weapons, but little public evidence of progress; CIA testimony estimated production unlikely before the end of the decade without foreign assistance.
	Iraq	Massive program uncovered after Gulf War; United Nations has required destruction of most infrastructure, but knowledgeable personnel still in country.
	Israel	Widely believed to have a clandestine nuclear arsenal of approximately 100 weapons.
South Asia	India	Exploded a nuclear device in 1974; probably has sufficient materials for several weapons.
	Pakistan	Undoubtedly has nuclear weapon program, probably successful. U.S. President no longer certifies to Congress that Pakistan does not possess a nuclear device, suggesting high likelihood that it does.
East Asia	North Korea	Suspicious reactor and reprocessing laboratory; submitted to some IAEA inspections in 1992 and 1993, but refused others; in March 1993, denied IAEA access to suspected reprocessing waste sites and declared its intention to withdraw from NPT (since rescinded).
Latin America	Argentina	in agreement with Brazil, seems to have ceased weapons program. No disclosure of progress towards weapons, but suspected of having developed clandestine enrichment plant, a key step towards weapons.
	Brazil	In agreement with Argentina, has apparently ceased weapons program. in 1987, revealed it had developed the ability to enrich uranium. (Brazil has also had a nuclear power submarine program requiring highly enriched uranium fuel.)
Africa	South Africa	Widely suspected to be very near nuclear-weapon capability, South Africa declared in March 1993 that it had in fact constructed 6 nuclear weapons, but dismantledthem in 1990. The South African president promised that South Africa would cooperate fully with the IAEA to assure the world that it was complying with the NPT. Joined NPT in 1991, placed declared weapons grade uranium under IAEA inspection, and presumably dropped nuclear weapon ambitions,

SOURCE: Leonard S. Spector and Jacqueline R. Smith, *Nuclear Ambitions: The Spread of Nuclear Weapons 1989-1990* (Boulder, CO: Westview Press, 1990) and Nuclear Non-Proliferation Project, "Nuclear Proliferation Status Report July 1992," (Washington, DC: Carnegie Endowment for International Peace, July 1, 1992). The latter report also: names Libya as "presumed to be seeking N-weapons," but does not cite evidence of indigenous nuclear weapon facilities; and names Syria as identified by a U.S. official as having a "nuclear program with suspicious intentions," but no suspicious facilities have been publicly cited.

on this list now appear to have halted, or even reversed, their programs. In a class by themselves are three republics of the former Soviet Union—Belarus, Kazakhstan, and Ukraine. On the territory of each are former Soviet strategic nuclear weapons. These weapons are nominally under the joint control of the Commonwealth of Independent States. Each of the three governments has pledged to abide by the START I agreement and to join the NPT as a non-nuclear-weapon state (so far, Belarus has ratified both treaties, Kazakhstan the START I Treaty). Should any of them fail to abide by that promise, it would become a de facto nuclear-weapon state, although

Table 2-7-Countries Generally Reported as Having Undeclared Offensive Chemical Warfare Capabilities

Region	CW Capability
Middle East	Egypt
	Iran
	Iraq[a]
	Israel
	Libya
	Syria
East Asia	China
	North Korea
	Taiwan
Southeast Asia	Myanmar (Burma)
	Vietnam

SOURCE: Gordon Burck and Charles C. Flowerree, *International Handbook on Chemical Weapons Proliferation (New York, NY:* Greenwood Press, 1991), pp. 164-171, cite 19 published reports, from 1985 *to* 1989, that identify nations suspected by various sources as having chemical weapon programs. In addition, a later publication, Elisa D. Harris, "Towards a Comprehensive Strategy for Halting Chemical and Biological Weapons Proliferation," *Arms Control: Contemporary Security Policy, vol. 12,* No. 2, September 1991, p. 129, cites statements of U.S. Government officials listing suspect countries; also added is *Russian Federation Foreign Intelligence Service Report: A New Challenge After the Cold War: Proliferation of* Weapons *of Mass* Destruction, JPRS-TND-93-O07. OTA hes listed here the nations mentioned In two-thirds or more of t hese sources published since 1989. See app. 2-A for the table compiled from these sources,

a U.N. inspections of Iraq found a considerable chemical arsenal; that which has been found is being destroyed. Quiescence of Iraqi programs probably depends on continued U.N. monitoring.

it might face technical difficulties in operating and maintaining the weapons.[32] As of this writing, Ukrainian delays in ratifying START and the NPT have caused the most international concern.

Table 2-7 names countries appearing in at least two-thirds of 11 published lists of countries suspected of covertly developing or producing offensive chemical weapon capabilities. OTA has made no effort to assess the scale of each countrys program, the precise meaning of capability,' or the evidence on which the allegations are based.

Table 2-8-Countries Generally Reported as Having Undeclared Offensive Biological Warfare Programs

Region	BW Program
Middle East	Iran
	Iraq[a]
	Israel
	Libya
	Syria
East Asia	China
	North Korea
	Taiwan

SOURCE: Mentioned in at least four of the following six (i.e., two-thirds): David Fairhall, "Eleven countries Defying Ban on Germ Weapons," *The Guardian* (London), Sept. *5, 1991,* p. 1.; Elisa Harris, "Towards a Comprehensive Strategy. . .," op. cit., p. 129; Seth Carus, " 'The Poor Man's Atomic Bomb'?' . . .," op. cit., p. 25; and Harvey J. MeGeorge, "Chemical Addiction," *Defense and Foreign Affairs,* April 1989, p. 17; Russian Federation Foreign Intelligence service, op. cit., and U.S. Arms Control and Disarmament Agency, "Adherence to and Compliance with Arms Control Agreements and The President's Report to Congress on Soviet Noncompliance with Arms Control" (Washington, DC: ACDA, January 14, 1993). See app. 2-A for the table derived from these sources.

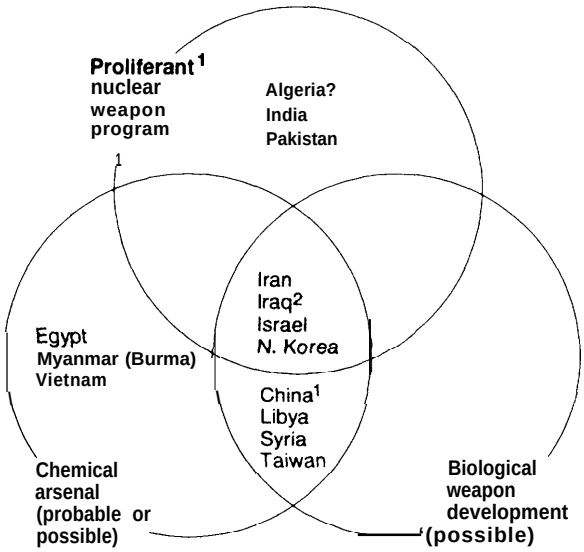
a U.N. inspections of Iraq found some evidence of offensive biological weapon research, but no stocks of agent. Quiescence of Iraqi programs probably depends on continued U.N. monitoring.

Table 2-8 summarizes 6 published lists of nations suspected of having undeclared biological weapon programs (which may include anything from research on offensive biological weapons to actual stockpiles of munitions). Like the list of chemical weapon suspects, this one arbitrarily identifies those appearing in two-thirds of the published reports. (The former Soviet Union had an undeclared offensive biological weapon program that violated its obligations under the 1972 BWC. The Russian Republic has ostensibly ended this program, but, since doubts remain about whether the program has been totally eliminated, it could be argued that Russia should be on the list.)

Figure 2-3 combines the data in the previous three tables to provide a combined perspective on

[32] A longer term option might be to dismantle the existing weapons and incorporate their fissile materials into new weapons.

Figure 2-3-Suspected Weapon of Mass Destruction Programs



This figure shows the considerable overlap among countries of chemical, biological, nuclear, and missile proliferation concern. The countries named In the figure are those in Tables 2-6,2-7, and 2-8; as the notes to those tables indicate, the lists are compiled from unclassified sources and should not be considered either authoritative or complete.

SOURCE: Office of Technology Assessment, 1993.

the states suspected of having or trying to develop **or produce weapons of mass** destruction. Three features of the problem stand out. First, the estimate for the current number of potential nuclear proliferants is relatively small--and smaller than **it might have been a** few years ago. Second, the **set** of countries trying to acquire nuclear weapons overlaps considerably with the set suspected of having chemical and biological weapon programs. Third, the most immediate and serious threats (beyond the potential threat posed by former Soviet republics) are concentrated in three regions of international rivalry: the Koreas, India-Pakistan, and the Middle East. Thus, on the one **hand, proliferation is still limited enough to encourage hope that it can be contained. On the other hand, it is occurring in places where political conflicts pose a major complication to nonproliferation efforts.**

Delivery Systems

The countries in shaded areas in figure **2-3 also** have Scud-range or better ballistic missiles. In addition, all the nations in the figure except Burma have fighter-bomber aircraft, most with ranges of 1,000 km or more and with payloads between **3,000 and 8,800 kg.**

Over a dozen countries outside of the five declared nuclear powers possess or are developing ballistic missiles **with ranges from 300-600 km.**[33] **Soviet** export of Scud-B missiles in the 1970s and 1980s played a major role in the spread of these missiles. The Missile Technology Control Regime has reduced the potential number of suppliers of missiles. However, additional countries have learned to copy, modify, extend the range of, and produce their own versions of previously imported missiles; a few have developed their own long-range systems-often in conjunction with space-launch programs and foreign technical assistance.

Those emerging missile powers that might have the intent to strike at the United States (e.g., Iran, Iraq, North Korea, Libya) will not be able to field long-range missiles or ICBMs over the next 10 years, and those that could develop the capability (e.g., Israel, India, Taiwan) are not likely to have the intent. It is therefore unlikely that any country (other than China and the former Soviet republics that already possess intercontinental ballistic missiles or ICBMs) would pose a direct ballistic missile threat to the U.S. within the next 10 years.

The only developing country that in the next decade is likely to be able to threaten U.S. territory with ballistic missiles is China, which

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[33] See OTA, op. cit., footnote 11.

Table 2-9-Classification of Indigenous Production Capabilities of Ballistic Missiles

Country	None	Incipient[a]	Intermediate[a]	Advanced[a]
Middle East				
Libya	X			
Egypt		X ——————>		
Israel	—	—	—	X
Syria	X			
Iraq		X		
Iran	—	X ——————>		
Saudi Arabia	X			
Yemen	X			
South Asia				
India	—	—	—	X
Pakistan		X ——————>?		
East Asia				
Taiwan	—	—	—	X[b]?
North Korea	—	—	X ——> ?	
South Korea		—	X[b] ——————>	
Southern Africa				
South Africa		—	X ?——————> ?	
Latin America				
Argentina	—	— X ? — >		
Brazil	—	—	X[b] ——————>	

NOTES:

a "Incipient" means some capability to modify existing Scuds, but little else. "Intermediate" means the capability to reverse-engineer Scud-like missiles, to introduce changes, and to make solid-propellant short-range missiles. "Advanced" means capable of making missiles comparable to those produced by the United States in the mid-1960s (including intercontinental ballistic missiles and space launch vehicles).

b South Korea could be characterized as "Advanced" although it has only demonstrated capabilities for reverse-engineering. Largely because of diplomatic efforts by the United States since the 1970s, Taiwan and South Korea do not appear to be aggressively pursuing either ballistic or space-launch missile programs at the present time, although they would have the technological capability to do so if they chose. Brazil's space-launch rocket program is in abeyance for financial reasons, but its technological capability gives it missile-making potential.

—> Indicates estimated potential for progress over next 10 years.

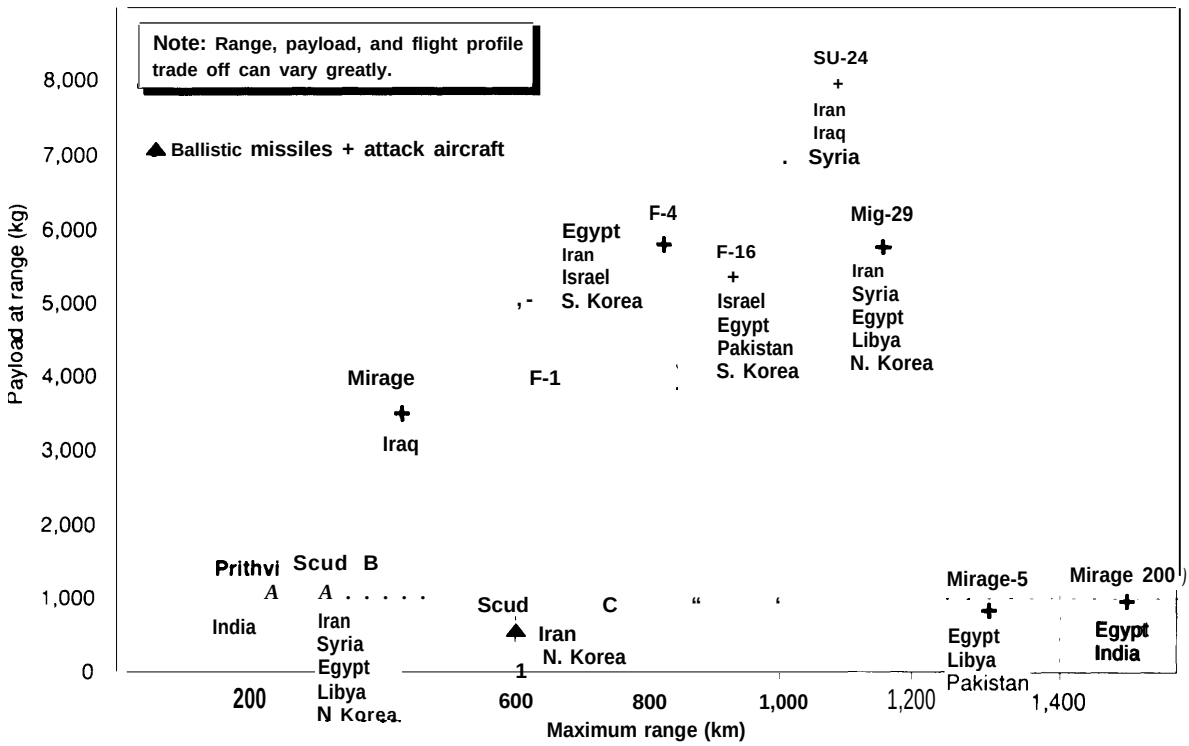
? Indicates greater uncertainty.

SOURCE: Adapted by OTA from Stanford Center for International Security and Arms Control, *Assessing Ballistic Missile Proliferation and Its Control,* November 1991, pp. 153, 15. See OTA background paper on technologies underlying weapons of mass destruction, in press.

has long had that capability. Israel and India, both suspected nuclear powers, have space launch vehicles in principle adaptable as missiles that could deliver weapons to intercontinental ranges. Both have also tested ballistic missiles that could reach the territory of other nuclear powers (e.g., Russia, in the case of Israel, and China, in the case of India), posing an implicit nuclear threat and possibly provoking counter-threats in return.

As shown in table 2-9, countries of proliferation concern vary widely in their ability to produce missiles, extend their capabilities, or design new types. Whereas several developing nations have essentially no indigenous capability, others match that of the United States in the mid-to-late 1960s. Practically all, however, depend on assistance or at least purchases of supplies from abroad; outside the most industri-

Figure 2-4--Proliferants' Delivery Systems: Selected Aircraft and Missiles



This figure shows nominal ranges and payloads of selected aircraft and missile systems of countries (beyond the 5 nuclear-weapon states) suspected of having or trying to acquire weapons of mass destruction, The graph is not Intended to be exhaustive, but only to indicate that each country already possesses aircraft or missile systems of one kind or another that could be adapted to deliver weapons of mass destruction.

SOURCE: Office of Technology Assessment, 1993.

ally advanced countries, only Israel, India, and China might be argued to be independent in missile design and production.[34] For a more detailed breakdown of missile possessions and programs, see the background paper to this report.

Few nations can produce advanced fighter aircraft indigenously; some produce them locally using foreign-licensed technology, but many have been able to import them. Figure 2-4 shows some of the types of combat aircraft owned by proliferate countries listed in figure 2-3. Scud missiles, the Iraqi-modified Scud, and the Indian Prithvi missile are included for comparison.

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34 Janne E. Nolan, *Trappings of Power: Ballistic Missiles in the Third World* (Washington, DC: Brookings Institution, 1991), P. 18. One reviewer of the literature on ballistic missile proliferation has concluded:

> . . . it is possible to show that the missile programs of almost all countries have been exaggerated in the literature. A careful scrutiny of the data shows that as of early 1992, only six or seven countries of the [author's] list of twenty-two had a meaningful ballistic missile program or capability. That includes India and Israel, the countries with the most developed programs; Brazil, Argentina, and possibly South Africa, which have meaningful indigenous launcher development programs but not yet operational ballistic missiles; and North Korea and Iraq which possess (in the case of Iraq did possess) the indigenous capability to produce Scuds. All of the other countries have either purchased missiles (mostly Frogs or Scuds or have indigenous efforts which does [sic] not look promising.)

Matthias Dembinski, "Ballistic Missile Proliferation and the New World Order: A Critical Survey of the Literature, " CSIA Discussion paper 92-07, Kennedy School of Government, Harvard University, July 1992, p. 6.

More than 40 developing countries possess antiship cruise missiles, with ranges typically under 150 km.[35] So far, there have been no publicly identified programs among proliferant nations to develop cruise missiles for delivering weapons of mass destruction. Rather than buy or indigenously develop long-range cruise missiles, proliferant states seeking them will most likely attempt either to attach warheads to nonmilitary systems (such as small aircraft) or to retrofit missiles originally equipped with conventional warheads (see delivery systems chapter of the background paper on technologies underlying weapons of mass destruction).

Since both nuclear and biological weapons carry so much destructive potential in such small packages, they are both suitable for small scale attacks by unconventional methods-e. g., smuggling and secret emplacement, or delivery by small boat or light aircraft. Politically and technically plausible scenarios for the current set of suspected proliferants to threaten U.S. territory with nuclear or other weapons of mass destruction, however, are difficult to devise. None have missiles or combat aircraft with sufficient range to reach the United States. But since strategic warfare with these weapons would be so much a matter of psychology, it is also difficult to rule it out. A state that badly wanted to wreak destruction on a U.S. city could probably do so, whether it had advanced delivery systems or not (and whether the United States had effective antiaircraft or antimissile defenses or not).

IMPLICATIONS OF PROLIFERATION

If more nations do acquire nuclear, chemical, or biological weapons, what will be the effect on international security? Since there are important differences in the effects and the military utilities of each of the three types of weapons, the consequences of their proliferation will not be the same. They may, however, be interrelated.

The following sections explore the consequences of proliferation from two perspectives. First, considering the broader concerns of the global political system and human welfare, what might be the consequences for the world? Second, from the narrower Perspective of U.S. deterrence and potential uses of force, what might be the consequences for U.S. foreign and military policies?

The International Community

NATURE OF WARFARE

Destruction of human beings on a large scale is not new to warfare, or even to this century. Nevertheless, weapons of mass destruction compress the amount of time and effort needed to kill. Wars lasting a few hours could now devastate populations, cities, or entire countries in ways that previously took months or years. Nuclear or biological wars among proliferant nations may not match the scope of a U.S.-Soviet exchange of thousands of thermonuclear weapons, but the damage to their people could still be catastrophic.

Even in a conventional war, high-explosive or incendiary bombing attacks on nuclear, chemical, or biological facilities could release harmful substances into the environment. In this way, a countrys own weapons of mass destruction could be turned against it. In a war in which only one side had and used weapons of mass destruction, the other might retaliate by attacking nuclear reactors, possibly causing mass casualties (from radioactive fallout) and economic disruption comparable to those it had suffered.

CHANCES OF WAR

Some scholars have argued that, at least under the right circumstances, further nuclear prolifera-

35 W. Seth Carus, *Cruise Missile Proliferation in the 1990s* (Washington, DC: Center for Strategic and International Studies, 1992), p. 2; and *Eric* Arnett, *Sea-bunched Cruise Missiles and U.S. Security (New York, NY:* Praeger, 1991), p. *28.*

tion could be a good thing.[36] One of these authors argues that well-managed proliferation could produce a stable order in Europe, but that "Unfortunately, however, any proliferation is likely to be mismanaged. ' He cites four principal dangers:

- existing nuclear powers might use force to prevent others from getting nuclear weapons (as Israel tried against Iraq);
- new nuclear powers might only be able to afford nuclear forces vulnerable to destruction by preemptive first strikes, leading to instabilities;
- those controlling nuclear weapons might believe they could fight and win nuclear wars; and
- increasing the number of fingers on the nuclear trigger would increase the probability that some would use them accidentally or irrationally, or that terrorists would steal them.[37]

The same principles would probably apply, in varying degrees, to chemical and biological weapons. The predominant view amongst most scholars-and national governments-is that these dangers are not controllable and that proliferation should be avoided, not accepted.

INTERSTATE RELATIONS

Massively destructive weapons can alter international balances of power in both positive and negative ways. A relatively small nation may gain useful leverage against larger or more numerous adversaries. France's primary argument for acquiring its nuclear force *de frappe* was that although a French nuclear blow would be limited in comparison to the damage that the Soviet Union could inflict, it might still impose a higher price on aggression than the Soviets would find worthwhile. Israel seems to believe that its undeclared nuclear weapons give it an ultimate deterrent against invasion from its more numerous Arab neighbors. But, while some nations might use nuclear weapons to deter aggression, aggressor nations might use them to deter resistance.

COLLECTIVE SECURITY OPERATIONS

The spread of weapons of mass destruction may make it more difficult to organize groups of nations (whether under U.N. aegis or within regional security groupings) to respond to acts of aggression. For example, we do not know, if the Iraqi Scuds had been known to carry nuclear warheads,

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36 See Kenneth N, Waltz-, 'The Spread of Nuclear Weapons: More May Be Better,' *Adelphi Paper 171* (London: International Institute for Strategic Studies, 1981) and John J. Weltman, "Nuclear Devolution and World Order," *World Politics,* vol. *32,* January 1980, pp. 169-193, arguing although that considerable nuclear proliferation is inevitable, regional balances of nuclear power could emerge and be no less stable than the superpower balance; the latter author was only slightly less optimistic in "Managing Nuclear Multipolarity,' *International Security,* winter 1981/82, vol. 6, No. 3, pp. 182-194. See also John Mearsheimer, "Back to the Future: Instability in Europe After the Cold War, " *International Security,* summer 1990 (vol. 15, No. 1), pp. 5-56. Mearsheimer advocates that

> . . . the United States should encourage the limited and carefully managed proliferation of nuclear weapons in Europe. The best hope for avoiding war in post-Cold-War Europe is nuclear deterrence; hence some nuclear proliferation is necessary to compensate for the withdrawal of the Soviet and American nuclear arsenals from Central Europe. Ideally, as I have argued, nuclear weapons would spread to Germany, but to no other state. (p. 54)

He does not explain how proliferation can be "carefully managed" and confined only to Germany, or, indeed, only to Europe.

Another author argues not so much that nuclear proliferation will be stabilizing, but that it is inevitable, He therefore concludes that the U.S. must learn to adjust to the situation. While it may be possible tofocus some policy efforts on temporarily delaying proliferation to some "unstable or brutal anti-American dictatorships,' for the most part the U.S. should give up 'a non-proliferation system that is becoming less and less viable." Ted Galen Carpenter, "A New proliferation Policy," *The National Interest,* summer 1992, pp. 63-72,

37 Paraphrased from Mearsheimer, Op cit., footnote 36, pp. 37-38.

- whether Saudi Arabia would have agreed to participate in a coalition to drive Iraq from Kuwait,
- whether other Arab states within range of Iraqi missiles or aircraft would have joined,
- whether the United States and European nations would have been willing to send their troops into the region, or
- what role U.S. nuclear capabilities might have played in building coalition consensus.

Nor do we know what coalition reactions would have been if Iraq had threatened to respond with nuclear or biological attacks on European cities. A more dangerous Iraqi threat might have caused coalition participants to think twice. On the other hand, they may have come to feel all the more strongly that it was better to stop Iraqi aggression sooner, rather than later when its ambitions and power had grown even larger. The United States, for its part, might have considered additional long-range bomber or cruise missile attacks as alternatives to large ground-troop concentrations.

FALLING DOMINOES

Arms races

One likely result of proliferation is more proliferation. India justifies its nuclear weapon program by pointing to China's. Pakistan has tried to keep up with India. Iran may have decided it must match Iraq's chemical weapons, as well as try to develop nuclear weapons. Some Arab nations have sought nuclear weapons to counter those of Israel; or, they may have pursued biological weapons as the "poor man's atomic bomb. " If proliferation proceeds, more nations that until now have forgone the nuclear option may reconsider. For example, if North Korea got nuclear weapons, South Korea would be strongly tempted to follow suit, particularly if it perceived U.S. security guarantees and involvement in Pacific affairs to weakening. Japan also might question its own renunciation of the weapons.

Erosion of norms

Iraq's use of chemical weapons has already weakened the international taboo attached to them. The frost large-scale use of biological weapons would be shocking, the next less so, and so on. Moreover, a single successful application of a biological weapon might inspire non-state terrorists to try the same thing. Although a small nuclear war *might* mobilize the international community into action to prevent a recurrence, it might instead show that outside powers will try to keep their distance.

Increase of supply

More states in the business of making nuclear, chemical, or biological weapons could also mean more potential suppliers of means of production or actual weapons to still other parties-perhaps states, perhaps terrorist groups. Even if proliferant states did not intentionally transfer these goods, they might become targets for illicit foreign purchasers and smugglers.

SHORT OF WAR...

Nuclear, chemical, and biological weapons exact a toll, whether possessing states ever use them or not. Experiences in both the United States and the former Soviet Union show some of the costs and risks.

Increased chances of terrorist theft

This report does not address the non-state terrorist uses of weapons of mass destruction.[38] But any state building these weapons must erect and maintain a formidable security apparatus, both to protect the secrets of the weapons and to prevent their falling into unauthorized hands. Ineffective or inexperienced governments, especially those with relatively unstable regimes, may

38 See U.S. Congress, Office of Technology Assessment, *Technology Against Terrorism: Structuring Security*, OTA-ISC-511 (Washington, DC: U.S. Government Printing Office, January 1992).

not be as successful as the owners of nuclear, chemical, or biological weapon facilities have been so far. Indeed, it is still too early to be certain that Russia will successfully gain and keep stable, central control over all the weapons of the former Soviet Union.

Increased risk from political fragmentation

Disintegration of national political authority, regional secession, or civil war could deliver weapons of mass destruction into the hands of groups **that, at** best, would be poorly equipped to manage the weapons safely, or at worst, would use them irresponsibly. Again, the republics of the former Soviet Union, perhaps including Russia, seem vulnerable to this risk.

Diversion of economic resources

The start-up costs of a nuclear weapon program are great. Iraq probably spent about $10 billion before its efforts were interrupted. A narrower program than Iraq's might cost less, but could still cost billions. Acquisition programs for chemical and biological weapons cost much less. Despite the expense, some countries may see weapons of mass destruction as substitutes for larger, even more expensive, conventional forces (the United States decided in the 1960s that nuclear weapons were a way of getting ''more bang for the buck' '). At the same time, those in charge of conventional forces may feel that spending on weapons of mass destruction diverts resources from more usable military instruments. Nevertheless, in most cases the quest for weapons of mass destruction is usually embedded in an across-the-board arms competition. Each country's possession of such a weapon will inevitably increase the stakes of the competition for its adversaries, feeding regional arms races. Nations pay for these arms races at the cost of their peoples' welfare.

Safety and environmental effects on proliferants' and their neighbors' populations

The United States and the former Soviet Union face monstrous clean-up operations: radioactive elements and hazardous chemicals contaminate the soil, sediments, surface water, and groundwater at most or all of the sites where nuclear weapons were manufactured.[39] To complete the U.S. cleanup could cost hundreds of billions of dollars. Little is known about the public health consequences if this mess is not cleaned up-as, in the former Soviet Union, it seems unlikely to be. Production-and destruction--of chemical weapons also poses environmental risks. Neither the United States nor Russia has developed politically acceptable plans (let alone built the facilities) to destroy their chemical weapon stockpiles according to the 10-year schedule specified in the CWC.[40]

There is little reason to think that developing nations manufacturing weapons of mass destruction will allocate much of their scarce resources to environmental health and safety. One might take as an indicator the recklessness with which the Iraqi chemical weapon program handled toxic chemicals (as reported by U.N. Special Commission inspectors).

Infectious biological agents eventually die, and toxins are biodegradable. But some spore-forming microorganisms, in particular anthrax bacteria, can persist in the environment for many years. Moreover, biological weapon programs themselves can pose a threat to public health, as apparently happened when anthrax spores were accidentally released in 1979 from a biological

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39 See U.S. Congress, Office of Technology Assessment, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production, OTA-O-484 (Washington* DC: U.S. Government Printing Office, February 1991) for an assessment of the scope of the U.S. problem; the situation in the former Soviet Union is unquestionably **far** worse.

40 See U.S. Congress, Office of Technology Assessment, *Disposal of Chemical Weapons: Alternative Technologies*, background paper, OTA-BP-O-95 (Washington, DC: Office of Technology Assessment June 1992).

weapon research facility in the Soviet city of Sverdlovsk, triggering a deadly epidemic.[41]

U.S. Political-Military Policies

U.S. military forces are likely to continue to be called to deter or combat military actions abroad, whether unilaterally or as a member of an international coalition. Future aggressor states having weapons of mass destruction will change the context for U.S. decisions about when and how to threaten or use force.

DETERRENCE

Deterrence oft he United States

The United States acted to protect its national interests against challenges from a Soviet Union heavily armed with nuclear, chemical, and possibly biological weapons aimed at U.S. territory, U.S. forces abroad, and U.S. allies. Nevertheless, the risk of direct conflict with the Soviet Union clearly constrained U.S. definitions of its national interests, its policies for defending those interests, and its strategies and tactics for managing clashes with Soviet international policies.

Would other, though vastly smaller, nuclear (or biological or chemical) powers be able to deter the United States from regional interventions to protect its interests? Possibly, depending on whether U.S. leaders perceived the stakes to be worth the risks. In the case of Iraq, for example, the United States was concerned about, but not deterred by, the known Iraqi chemical arsenal and the possibility of a biological weapon threat. The United States would have had a different problem if Iraq had had nuclear weapons. If Iraq could have credibly threatened to use a few nuclear weapons against U.S. cities or those of U.S. allies, the calculus of U.S. intervention would have been even more different.

The nature of U.S. decisions might have depended in part on whether U.S. leaders believed that the Iraqi rulers would have themselves been deterred from escalating to the use of nuclear weapons by U.S. nuclear retaliatory capabilities. (To the extent that U.S. military forces will be used in conjunction of those of other states, the dynamics of building and sustaining coalitions in the face of threats from weapons of mass destruction will also be important; this topic is discussed below.)

We now know of one historical case in which the proliferant country hoped to use its nuclear weapon not to *deter* U.S. military intervention, but to ***cause*** it. Although South Africa kept its nuclear weapon program secret,

> The strategy was that if the situation in southern Africa were to deteriorate seriously, a confidential indication of the [nuclear] deterrent capability would be given to one or more of the major powers, for example the United States, in an attempt to persuade them to intervene.[42]

Thus, South Africa hoped to engage in a kind of reverse nuclear blackmail.

Deterrence by the United States

To some extent, the U.S. and Soviet nuclear arsenals neutralized each other; the two nuclear superpowers never engaged in direct military conflict with one another at least in part because of the risk of escalation to mutual annihilation. Even in much more one-sided confrontations, the availability of nuclear weapons to the greater power did not deter, for example, the North Vietnamese from engaging the United States or the Mujaheddin in Afghanistan from taking on the

41 U.S. suspicions about this *event* were finally *Officiall, confirmed* by the Russians in *1992*. See R. Jeffrey Smith, "Yeltsin Blames '79 Anthrax On Germ Warfare Efforts, ' *Washington Post,* June 16, 1992, pp. Al, A2. For a Russian *Komsomolskaya Pravda report with* details on the incident, see Foreign Broadcast Information Service, *JPRS Report: Proliferation,* JPRS-TND-92-022, July 10, 1992, pp. 19-24. See also Milton Leitenberg, "Anthrax in Sverdlovsk: New Pieces to the Puzzle," *Arms Control Today,* April 1992, pp. l&13.

42 President F.W. de Klerk, speech to joint session of South African Parliament, transcribed from Johannesburg Radio South Africa Network, Mar. 24, 1993 (JPRS-TND-93-009, Mar. 29, 1993, p. 2).

Soviet Union. Nor did the nuclear stand-off deter the superpowers from arming each other's enemies in those two conflicts. In these cases, the lesser powers had good reason to believe that the nuclear superpowers were very unlikely to use their nuclear weapons-both because of the opprobrium that would come from such a disproportionate use of violence and because of the risk of escalation of conflict with the victim's nuclear-armed ally.

Emerging nuclear powers that avoid direct attacks on the United States may justifiably doubt whether the United States would unleash nuclear weapons on them for conventionally armed acts of aggression elsewhere. Thus, U.S. *nuclear* deterrence, already a small factor in such situations, might not be much affected by nuclear proliferation.

U.S. *conventional* military threats may have deterred less industrialized countries from attacking U.S. interests abroad. Would further proliferation of weapons of mass destruction weaken such deterrence in the future? The issue in this case is not just whether U.S. leaders decide that U.S. interests at stake justify deploying conventional forces in the face of the risks to them posed by weapons of mass destruction: it is also whether the nation to be deterred would believe that its own threats would counter-deter the United States, leaving itself free to act without fear of U.S. intervention. For the next several years, such a counter-deterrent threat might take the form of either limited unconventional attacks on U.S. cities, or somewhat larger, but still limited, attacks on U.S. forces intervening abroad.

MILITARY OPERATIONS

In preparing for war in Central Europe, U.S. forces had to take account of the possibility that they would confront Warsaw Pact nuclear or chemical weapons. They could probably learn to prepare to operate under such threats elsewhere in the world. Even so, having to cope with weapons of mass destruction would make U.S. foreign interventions costlier and more difficult. Nuclear or biological[43] weapons (to a greater extent than chemical) would increase the risk of casualties. For Operation Desert Shield (preceding Desert Storm), the U.S. had to move in large quantities of troops and supplies through a few ports and airfields. An effective nuclear, chemical, or biological threat against vital transportation nodes or staging areas would have caused great difficulty for the Coalition. (An alternative strategy might have been to rely on still more intensive long-range cruise-missile and bombing attacks than were used in Desert Storm; this strategy, however, would still leave the problem of occupying territory on the ground.)

During the Cold War, part of U.S. preparedness in the European theater was based on the assumption that the United States would retaliate in kind against Soviet nuclear (and possibly against chemical) attacks; tither, the United States did not foreclose the possibility that it would initiate the use of nuclear weapons if it were losing a conventional battle. On the other hand, much of the world would probably see U.S. first use of nuclear weapons in the developing world as grossly disproportionate to any conceivable U.S. interests there.[44]

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[43] In the absence of effective means of detection that would allow soldiers to don protective gear soon enough.

[44] U.S. decisionmakers may have already internalized such concerns. Lewis Dunn notes that

> . . . war games on this subject have frequently revealed a reluctance of players from the Washington national security elite to use nuclear weapons against third-world countries, even in retaliation for nuclear use.

Containing Nuclear Proliferation, Adelphi Papers 263 (London: Brassey's for the International Institute for Strategic Studies, 1991), p. 73, note 1-4S.

ALLIANCES OR COALITIONS

A continuing theme of the Cold War was the West European fear that the superpowers would fight a ''tactical' nuclear war in Europe-with consequences for them similar to those of a ''strategic' nuclear exchange for the United States. In the case of the U.S.-Soviet contest, however, the United States shared at least some risk of nuclear devastation with its allies. In confrontations with proliferant nuclear powers lacking the means to attack the United States, U.S. allies abroad would bear heavier relative risks and may be reluctant to participate.

On the other hand, some states facing a nuclear adversary might welcome an alliance with a nuclear power—if they believed that the adversary would be deterred by the possibility of U.S. nuclear retaliation. As noted above, though, such a deterrent threat might not be fully credible.

A NEW DIMENSION TO PROLIFERATION: RISKS FROM THE BREAKUP OF THE SOVIET UNION

The breakup of the Soviet Union—and the shakiness of governmental authority in the splintered republics--could contribute to all categories of the proliferation problem.[45] The threat is potentially great, but just how great it will be is hard to predict at this writing. The major dangers include the following.

Seizure of Soviet Weapons by Non-Russian Authorities

Ukraine and Kazakhstan have agreed in principle to ultimate elimination of the strategic nuclear weapons on their territories. Even so, the missiles and warheads are still in place. In the case of Ukraine, as of this writing the government continues to place various conditions (such as monetary compensation and regional security guarantees) on its progress toward non-nuclear status. Even if the various republics comply fully with their commitment-in the Lisbon Protocol to the START agreement-to forswear nuclear weapons, actual removal would take several years. Should they choose in the meantime to become nuclear powers themselves, they could seize these weapons and adapt them to that purpose. Alternatively, they might dismantle the weapons for their fissile materials and then fail to control those materials properly.

Emergence of Ukraine or Kazakhstan (Belarus has ratified the NPT) as new nuclear powers would seriously undermine the nonproliferation regime in several ways. First, depending on world reaction, other potential nuclear powers may conclude that the political and diplomatic costs of joining the nuclear club are tolerable. Second, the retention of former Soviet nuclear weapons outside Russia would likely torpedo the ongoing nuclear arms reductions between the United States and Russia. Russian ratification of the START I Treaty was contingent on the other republics ratifying the Treaty, agreeing to implementation measures, and joining the NPT Since the NPT links renunciation of nuclear weapons on the part of the nonnuclear powers with ''effective measures relating to cessation of the nuclear arms race,'' interrupting the U.S./Russian arms reductions process could have serious repercussions when a conference to renew the NPT convenes in 1995. Finally, the de facto creation of new nuclear states in Europe would affect regional security issues and balances of power, possibly triggering other European states to reevaluate their nonnuclear status.

It appears that all Soviet tactical nuclear weapons have been pulled into the Russian

[45] For further discussion of resources from the former Soviet Union that could aid nuclear proliferation, see Zachary Davis and Jonathan Medalia, *Nuclear Proliferation From Russia: Options for Control, Report 92-310 INR* (Washington, DC: Congressional Research Service, Mar. 30, 1992). See also Kurt M. Campbell, Ashton B. Carter, Steven E. Miller, and Charles A. Zraket, *Soviet Nuclear Fission: Control of the Nuclear Arsenal in a Disintegrating Soviet Union* (Cambridge, MA: Harvard University Center for Science & International Affairs, Studies in International Security, No. 1, November 1991); and Graham Allison et al., *Cooperative Denuclearization: From Pledges to Deeds* (Cambridge, MA: Harvard University Center for Science & International Affairs, Studies in International Security, No. 2, January 1993).

Federation. The question of whether the Russian Federation itself will fragment, or whether the custodial system for the thousands of former Soviet nuclear weapons and hundreds of tons of nuclear weapon materials (enriched uranium and plutonium) will break down, still seems unsettled. One can imagine either successor states attempting to become nuclear powers, or non-state groups seizing and exploiting weapons or materials.

Export of Weapons or of Weapon Components

Press reports indicate the smuggling of all kinds from the former Soviet Union is a growing problem. Despite some rumors, there is as yet no serious evidence that Soviet nuclear weapons have been sold to other countries. There have been no reports of the export of chemical or biological weapons, but the possibility that it might happen cannot yet be entirely excluded. Much will depend on the continued integrity of the Russian nuclear weapon custodial system under conditions of economic hardship and political confusion.

Emigration of Technical Personnel

There is also no clear evidence yet that former Soviet technical personnel with knowledge of how to build weapons of mass destruction have emigrated to other countries. There have been reports of some attempts at recruitment. Although such scientists or technicians might not be essential to a third-world country's weapon program, they might be able to provide useful guidance about what works and what doesn't work, thus speeding the development of weapons.

Export of Critical Information, Equipment or Materials

The most immediate risk may lie here. The major areas of concern are dual-use technologies, critical dual-use materials, and fissile materials. Russia and the other former Soviet republics face severe shortages of hard currency. They are trying to establish market systems of production and trade, but the legal infrastructure to regulate those activities is not yet fully developed. It is possible that some exporting enterprises may be unaware of the proliferation risks of particular goods; others may intentionally take advantage of poorly enforced or corruptly administered export control laws. A Ukrainian firm reportedly has already exported tens of tons of hafnium and zirconium, metals on the Nuclear Suppliers Group list of restricted dual-use items.[46]

In its need for foreign trade, a government itself may disagree with other nations' judgments about which exports constitute a proliferation risk. For example, Russia has declared its intent to proceed, over U.S. objections, with sale to India of cryogenic rocket motor technology for space launch vehicles. The United States, declaring the sale to be in violation of the Missile Technology Control Regime constraints that the Russians had voluntarily adopted, has suspended U.S. trade with both the Russian and Indian organizations involved.

Fissile materials might in one way or another be diverted from former Soviet weapon stockpiles or from production facilities. The possibility of a breakdown in the Russian custodial system for weapons is mentioned above. A similar breakdown in the control of material production facilities, leading to theft and export of fissile

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46 See William C. Potter, "Nuclear Exports From the Former Soviet Union: What's New, What's True," *Arms Control Today*, January/February 1993, p. 3.

materials, is also conceivable. Outside Russia, some important former Soviet production facilities remain; of particular concern is a fast breeder reactor, capable of producing over 100 kg of weapon-grade plutonium per year, at Aktau, Kazakhstan.[47]

Indigenous Weapon Development

A longer term possibility is that some former Soviet republics might utilize their own expertise, equipment, or materials to develop indigenous weapon programs.[48] Unlike other new proliferants, such countries might inherit, rather than have to import, some critical weapon technologies. Given the current economic conditions throughout the former Soviet Union, new nuclear weapon programs do not seem to be an immediate threat. Chemical or biological weapons would be easier to develop. Kazakhstan has inherited chemical and biological weapon facilities from the former Soviet military complex; Uzbekistan has inherited test ranges for both types of weapons.

47 Ibid., *p.* 5. See also William C. Potter, *Nuclear Profiles of the Soviet Successor States* (Monterey, CA: CIS Nonproliferation Project, Monterey Institute of International Studies, April 1993) for more detailed listings of former Soviet nuclear-related facilities.

48 See Central Intelligence *Agency,* Directorate of Intelligence, ***The Defense Industries of the Newly Independent States of Eurasia,*** CIA publication number OSE-93-10001, January 1993.

Appendix 2-A

Sources on Tables Listing Countries of Chemical and Biological Weapon Concern

Tables 2-7 and 2-8 list countries reported in various published sources to have, or to be trying to acquire, chemical or biological warfare capabilities. As indicated in the chapter text, the lists provided there are in no way to be considered authoritative or comprehensive. OTA has merely recorded the countries listed in two-thirds or more of the cited publications. The following tables show not only the countries making this arbitrary cut-off line, but also the other countries mentioned in fewer than two-thirds of the sources. In the case of the chemical warfare program list, this appendix also details the sources cited in the *International Handbook on Chemical Weapons Proliferation* and utilized in the OTA table.

Table 2-A-1—Proliferation Risks: Chemical Weapon Programs Suspected

Countries	Harris 1989/90	DNI 1989	NY Times 1989	Time 1989	USNWP 1989	Knight 1989	Chi Trib 1989	McGeorge 1989	McCain 1989	Harris 1991	FIS 1993	Total	%
Israel	?	?	?	?	?	?	?	?	√	√	√	11	100%
Libya	?	?	?	?	?	?	?	?	√	√	√	11	100%
Iraq	?	?	?	?	?	?	?	?	√	√	√	11	100%
Egypt	?	?	?	?	?	?	?	?	√	√	√	11	100%
Iran	?	?	?	?	?	?	?	?	√	√	√	11	100%
Syria	?	?	?	?	?	?	?	?	√	√	√	11	100%
Taiwan	?	?	√	?	?	?	?	?	√	√		10	91%
Korea, North	?	?	√	?	?	?	?		√	√	√	10	91%
Vietnam	?	?	√	?		?	?	√	√	√		9	82%
Myanmar	?	?	√	?		?	?	√	√	√		9	82%
China	?	?	√	?			?	√	√	√		8	73%
Pakistan	?	?	?					?	√	√	?	7	64%
Korea, South	?				√	√	√	?	√	√		7	64%
India	?	√	?						?	√	√	6	55%
Ethiopia	√	√	√	√	?					√		6	55%
Indonesia	?		√				√	?				4	36%
Chile								?	?		√	3	27%
Afghanistan	?			√				?				3	27%
Thailand			√			?		?				3	27%
South Africa	?						√		√			3	27%
Laos	?						√					2	18%
Brazil								?	?			2	18%
Cuba							?					1	9%
Argentina								?				1	9%
Peru									?			1	9%
Angola	?											1	9%
Chad	?											1	9%
Philippines	?											1	9%
Mozambique	?											1	9%
El Salvador												0	0%
Nicaragua												0	0%

? indicates doubt expressed by source.

SOURCE: Adapted by Office of Technology Assessment, 1993, from Gordon Burck and Charles Floweree, 1991 (see previous page)

Sources Cited in Table 2-A-1, Proliferation Risks: Chemical Weapon Programs

Sources and Commentary from Gordon Burck and Charles C. Flowerree, *International Handbook on* **Chemical** *Weapons Proliferation (New York, NY:* **Greenwood Press, 1991), pp. 164-171:**

DNI(1989:	**Director of Naval intelligence, Rear Admiral Thomas Brooks, prepared testimony for the Seapower and Strategic and Critical Materials Subcommittee, House Armed Services Committee, Feb. 22, 1989, pp. 38-39.**
Harris 1989/1 990:	**Elisa Harris, "Chemical Weapons Proliferation in the Developing World,"** *RUSI-Brassey's Yearbook 1989* **(London: Brassey's Defence Publishers, 1989), p. 74.**
NY Times 1989:	**Stephen Engelberg, "Chemical Arms: Third World Trend,"** *New York Times,* **Jan. 7,1989 (not a complete listing). (Source given as U.S. administration officials; ?—France is not mentioned in the article).**
Time 1989:	**Jill Smolowe, "The Search for a Poison Antidote,"** *Time,* **Jan. 16, 1989, p. 22 (source given as SIPRI).**
USN 1989:	**Joseph L. Galloway et al., "Bad Chemical Reactions,"** *U.S. News & World Report,* **Jan. 16, 1989, p. 30 (sources for a table that also contains other information are given as ArmControl Associaiton, Federation of American Scientists, and Senate Armed Services Committee).**
Knight 1989:	**Knight-Ridder news services, James McCartney, "U.S. Sees Threat of Chemicals,"** *Philadelphia Inquirer,* **Jan. 8,1989, p. F1 (also named Japan, Netherlands and Switzerland—a historical possessor and two states that probably have never possessed CW weapons, making this list unusually unreliable).**
Chi Trib 1989:	**Thoma Shanker, "West Underwrites Third World's Chemical Arms,"** *Chicago Tribune,* **Apr. 3, 1989, pp. 1,6; and "Lack of Candor Blocks Chemical Arms Treaty," Apr. 4, 1989, pp. 1,** *6* **(source given as U.S. Government officials).**
McGeorge 1989:	**Harvy J. McGeorge, "Chemical Addiction,"** *Defense & Foreign Affairs,* **April 1989, pp. 16-19, 32-33.**
McCain 1989:	**Senator John S. McCain, "Proliferation in the 1990s: implications for U.S. Policy and Force Planning," table 1,** *Congressional Record, Nov.* **1, 1989, p. S14605; "Estimates are Based on a Variety of Sources, including unclassified testimony by CIA Director William H. Webster, Seth Carus, David Goldberg, Elisa D. Harris and others and do not reflect the estimates of the U.S. Government." Also published as "Proliferation in the 1990s: implications for U.S. Policy and Force Planning,"** *Strategic Review,* **summer 1989, p. 11.**
Additional sources:	
Harris 1991:	**Elisa D. Harris, 'Towards a Comprehensive Strategy for Halting Chemical and Biological Weapons Proliferation,"** *Arms Control: Contemporary Security Policy, vol. 12, No. 2,* **September 1991, p. 129, which cites statements of U.S. Government officials listing suspect countries.**
FIS 1993:	*Russian Federation* ***Foreign Intelligence Service Report: A New Challenge After the Cold War: Proliferation of Weapons of*** *Mass Destruction, JPRS-TND-93-O07.*

Table 2-B-l—Proliferation Risks: Biological Weapon Programs Suspected

Countries	Carus (Policy Paper)	Harris (USG officials)	Guardian (London)	McGeorge Def. & FA	FIS 1993	ACDA 1993	Total	%
Libya	√	√	√	√	√		5	83
Korea, North	√	√	√	√	√		5	83
Iraq	√		√	√	√	√	5	83
Taiwan	√	√	√			√	4	67
Syria	√	√	√			√	4	67
Soviet Union	√		√	√		√	4	67
Israel	√		√	√	√		4	67
Iran	√	√		√	√		4	67
China	√	√	√			√	4	67
Egypt			√		√	√	3	50
Vietnam			√				1	17
Laos			√				1	17
Cuba				√			1	17
Bulgaria				√			1	17
India					√		1	17

SOURCE: Compiled by Office of Technology Assessment, 1993, from various source. See text below.

Detailed listing of sources for table 2-A-1: David Fairhall, "Eleven Countries Defying Ban on Germ Weapons," *The Guardian* (London), Sept. 5, 1991, p. 1.; Elisa Harris, "Towards a Comprehensive Strategy. . .," op. cit., p. 129; Seth Carus, " 'The Poor Man's Atomic Bomb'?'. . .," op. cit., p. 25; and Harvey J. McGeorge, "Chemical Addiction," *Defense and Foreign Affairs,* April 1989, p. 17; Russian Federation Foreign Intelligence service, op. cit., and U.S. Arms Control and Disarmamentt Agency, "Adherence to and Compliance with Arms Control Agreements and The President's Report to Congress on Soviet Noncompliance with Arms Control" (Washington, DC: ACDA, January 14, 1993).

Policy Background 3

This chapter surveys the range of policy measures, present and possible, that can be applied to the problem of limiting the spread of weapons of mass destruction. The chapter will also show that if these measures are to have a chance of success, meeting two conditions will be increasingly important. First, policymakers must engage the greatest possible international cooperation for nonproliferation. Second, as a prerequisite to obtaining that cooperation, they must act to strengthen international norms, or rules of acceptable behavior, against the acquisition and use of weapons of mass destruction. To meet those two conditions, policymakers must give the goal of nonproliferation higher priority than they did during the Cold War.

It is by no means certain that the levels of international cooperation needed to contain proliferation can be achieved. Indeed, some analysts have argued that the inherently anarchic nature of the international political arena will make nonproliferation efforts futile.[1] Others agree that the levels of cooperation needed to stop proliferation entail a transformation of international politics, but they believe that with the end of the Cold War, such a transformation has become feasible.[2]



UNITED NATIONS

[1] For example, one argued in 1980 that:

> . . . unless the system of states undergoes a revolutionary transformation, any suggestion that further proliferation can be stopped borders on the absurd. . . In a world of independent states, some proliferation will be inevitable, much as will some war and the threat of it.

John J. Weltman, "Nuclear Devolution and World Order," *World Politics,* vol. *32,* January 1980, p. 192-193. Ted Galen Carpenter, "A New Proliferation Policy," *The National Interest,* summer 1991, pp. 63-72, argues that nonproliferation policies were not only futile, but even counterproductive.

[2] See Randall Forsberg et al., "After the Cold War: A Debate on Cooperative Security," *Boston Review,* vol. 17, No. 6, November/December 1992, pp. 7-19. For further analysis of the linkages between nonproliferation policy and global security policy, see Ashton B. Carter, William J. Perry, and John D. Steinbruner, *A New Concept of Cooperative Security* (Washington, DC: Brookings Institution 1992).

What follows is a menu from which the components of a coherent nonproliferation strategy are likely to be chosen. The menu does not attempt to organize the policy measures discussed into such a strategy, nor to assess their feasibility y or promise. The second report of this study will specify and analyze selected options in greater detail.

Table 3-1 lists the primary international agreements and U.S. national laws that underpin the current nonproliferation regimes. The sections below summarize the measures already in effect in these regimes and identify measures that could intensify or broaden them. The measures are discussed under four broad categories:

- imposing obstacles to those trying to acquire the weapons,
- imposing disincentives to deter proliferants,
- offering rewards to increase the attractiveness of voluntarily forgoing the weapons, and
- offering global or regional security improvements to reduce perceived needs for the weapons.

An additional section addresses the special, urgent problems posed by the breakup of the Soviet Union.

IMPOSING OBSTACLES TO PROLIFERATION

Proliferant nations, particularly the less industrialized ones, generally need materials, equipment, and knowledge from abroad to acquire weapons of mass destruction.[3] Therefore, blocking their access to such supplies can hinder their progress. Methods of blocking access might include:

- use of secrecy to restrict the flow of knowledge;
- . export controls adopted by supplier nations;
- . diplomatic, military, or other actions to stop exports by third parties; or
- actions to stop or discourage experts from giving assistance.

If a proliferant nation nevertheless manages to acquire or build facilities for a weapon program, another kind of obstacle is still possible, although fraught with legal, political, and operational difficulties: taking military or other actions to disrupt or destroy the facilities.

Secrecy

Limiting the spread of nuclear-weapon knowledge through secrecy has been a tool of U.S. policy since the first weapons were created during World War II. Today, although the basic principles of nuclear materials production and nuclear weapon design and manufacture are well known throughout the world, important engineering details and technical shortcuts are still classified by the current nuclear powers. (Despite this secrecy policy, nuclear-weapon states have at various times helped other states develop the weapons: the United States cooperated in the development of the British nuclear weapon program; the Soviet Union helped China before the Sine-Soviet split in 1959; French nuclear assistance may have advanced the Israeli weapon program; China reportedly helped Pakistan; Israel reportedly helped South Africa, although in admitting its past nuclear weapon program, South Africa has denied this.)

The basic knowledge needed to produce chemical and biological weapon agents is much more accessible than that for nuclear weapons. Secrecy may help protect important details of incorporating the agents into more effective delivery systems, but will not be of much use in blocking proliferation of simpler weapons.

National and Multilateral Export Controls

The potency of export controls as an obstacle to proliferation depends on the degrees of:

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[3] Assuming, of course, that they cannot simply buy complete weapona outright. No state yet is known to have bought a complete nuclear weapon, but with the breakup of the Soviet Union, this possibility has become a more pressing concern.

Table 3-l—Primary Institutional Bases of Current Nonproliferation Regimes

Regime	U.S. Legislation	Supplier Groups	Consensual Treaties
Nuclear	Nuclear Non-Proliferation Act, 1978 (NNPA) Foreign Assistance Act, 1961 Export Administration Act (EAA), 1979 (1990 version vetoed, provisions then sustained by Executive Order, Act later reinstated as interim measure) Atomic Energy Act, 1954 Weapons of Mass Destruction Control Act of 1992 Iran-Iraq Non-Proliferation Act of 1992 Freedom Support Act of 1992 (aid to former Soviet republics)	Zangger Committee (Nuclear Exporters Committee), 1971 London Club (adherents to Nuclear Suppliers Guidelines), 1976 Coordinating Committee on Multilateral Export Controls (CoCom), 1949	International Atomic Energy Agency Statute, 1957 Nuclear Non-Proliferation Treaty (NPT), 1970 Treaty of Tlatelolco, 1968 (Latin American nuclear-free zone) Treaty of Rarotonga, 1986a (South Pacific nuclear-free zone)
Chemical	EAA Chemical and Biological Weapons Control and Warfare Elimination Act, 1991 Weapons of Mass Destruction Control Act of 1992 Iran-Iraq Non-Proliferation Act of 1992	Australia Group, 1984 CoCom	Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, 1925 Chemical Weapons Convention (CWC), 1993
Biological	EAA Chemical and Biological Weapons Control and Warfare Elimination Act, 1991 Weapons of Mass Destruction Control Act of 1992 Iran-Iraq Non-Proliferation Act of 1992	Australia Group CoCom	Geneva Protocol, 1925 Convention on the Prohibition of Bacteriological (Biological) and Toxin Weapons (Biological Weapons Convention, or BWC), 1975
Missiles	Arms Export Control Act, 1976 EAA Missile Technology Control Act, 1990 Weapons of Mass Destruction Control Act of 1992 Iran-Iraq Non-Proliferation Act of 1992	Missile Technology Control Regime (MTCR), 1987	None

a The United States is not party to this treaty.

SOURCE: Congressional Research Service and OTA. For a more comprehensive listing of relevant U.S. legislation, see Zachary S. Davis and Warren H. Donnelly, *Non-Proliferation: A Compilation of Basic Documents on the International, U.S. Statutory,* and *U.S. Executive Branch components of Non-Proliferation Policy* (Washington, DC: Library of Congress, Congressional Research service, Dec. 18, 1990), CRS Report 91-85 RCO. See also Zachary S. Davis, *Non-Proliferation Regimes: Policies To Control the Spread of Nuclear, Chemical,* and *Biological Weapons* and *Missiles* (Washington, DC: Library of Congress, Congressional Research Service, Feb. 18, 1993), CRS Report 93-237-ENR. See also Leonard S. Spector and Virginia Foran, *Preventing Weapons Proliferation: Should the Regimes be Combined?* (Muscatine, IA: The Stanley Foundation, 1992).

- proliferants' dependence on outside resources (and their ability to work around blockages of those resources);
- controllability of supplies having valid civil applications, but also usable for producing weapons of mass destruction;
- participation in controls by all suppliers; and
- effectiveness of each nation's monitoring and enforcement of controls.

As more nations advance technologically, the frost three of these factors are likely to decay. This is especially the case for chemical and biological technologies, which are already widely available. In the case of nuclear technologies, although the number of potential suppliers has been growing, many states have also been strengthening and broadening their export control policies. Therefore, changes in the net availability of technology useful for nuclear weapon programs are hard to assess.

Despite the global spread of technology, export controls will remain an important nonproliferation policy tool for many years, especially in the nuclear area. In addition to impeding proliferation, export controls also supply information important for detecting and monitoring it. Nevertheless, both tightening export controls and applying sanctions against foreign violators can have economic as well as political costs. These costs may be deemed worth the return in international security, but they should be acknowledged. First, controls can somewhat restrict international trade. Although the number of export denials is a small fraction of all international transactions, many transactions must be screened in order to detect those that ultimately are denied. Consequently, a wide range of businesses must keep informed about and comply with complex regulations and licensing procedures. Individual companies may find themselves losing significant legitimate sales and the other business opportunities that might have followed those sales. More seriously in terms of U.S. jobs and exports, U.S. firms may also find themselves losing market share to foreign competitors under less stringent controls. In such cases, not only do the U.S. firms lose business, but other suppliers obviate any nonproliferation benefits that the blockage or delay of sales might have had.

Another cost of controls may be imposed on international development policy: tighter control on dual-use technologies may not only hinder weapons proliferation, but it may also stunt the peaceful technological advancement of the importing countries. On the other hand, if controls are narrowly targeted to countries of serious proliferation concern, countries that cooperate with nonproliferation regimes should not find their peaceful development hindered.

NATIONAL EXPORT CONTROLS

Export controls have been a major tool of U.S. nonproliferation policy since the Atomic Energy Act of 1946 (superseded by the Atomic Energy Act of 1954, itself amended several times since then). Table 3-2 summarizes U.S. laws and regulations directed at restricting exports from the United States (or re-export of U.S.-originated items) that could contribute to the proliferation of weapons of mass destruction or of missiles. Other legislation, likely to be introduced in the 103rd Congress, would further restrict proliferation-related exports. A later table (3-4) describes sanctions established under U.S. law against countries or companies that violate export laws and regulations.

MULTILATERAL EXPORT CONTROLS

The United States can help limit proliferation by controlling its own exports and by trying to block aid from other countries to proliferants. Nevertheless, there are too many possible foreign sources of materials, equipment, and knowledge for unilateral U.S. policies to control the problem alone. Imposing restraints on proliferants requires multilateral cooperation to have a chance of being effective. The United States has

Table 3-2—U.S. Unilateral Proliferation-Related Export Control Legislation

Legislation, Regulation, or Executive Order	Description or Comment
Atomic Energy Act of 1954 (as amended)	Sets guidelines for dissemination and restriction of data relating to nuclear weapons. Provides statutory framework for export controls on nuclear trade.
Nuclear Non-Proliferation Act of 1978	Tightens export controls by requiring IAEA full-scope safeguards as a condition for exports of nuclear fuel and reactors. Seeks to establish U.S. as reliable supplier for nuclear reactors and fuels to nations adhering to nonproliferation policies. Seeks to strengthen international controls over transfer and use of nuclear materials and technology. Directs the President to seek agreement from all exporting nations to require recipients of nuclear technology and materials to accept International Atomic Energy Agency (IAEA) "full-scope" safeguards on all peaceful nuclear activities. Further specifies legal guidelines for regulation of nuclear commerce and technical assistance. Directs the President to publish procedures for the Commerce Department to control U.S. exports of "dual-use" items that could be used for nuclear explosives. Defines jurisdiction of Departments of State, Energy, Defense, and Arms Control and Disarmament Agency over nuclear exports.
Export Administration Act of 1979 and Executive Order 12735 (Nov. 16, 1990) on Chemical and Biological Weapons Proliferation	Commerce Department, after insulting with State and Defense, issues Export Administration Regulations; its Bureau of Export Administration administers export licenses on controlled commodities (including nuclear, chemical, or biological weapons-related or missile-related, as well as other items controlled for national security or foreign policy purposes). Authority extends primarily over dual-use goods. EAA of 1979, the primary authority for U.S. export controls, expired Sept. 30, 1990; President Bush vetoed successor act but extended export control authority by executive order under emergency power (conferred by the International Emergency Economic Powers Act of 1977). In 1992 Congress passed an interim renewal of the 1979 Act.
Chemical and Biological Weapons Control and Warfare Elimination Act of 1991	Amended EAA to require Secretary of Commerce to establish and maintain "a list of goods and technology that would directly and substantially assist a foreign government or group in acquiring the capability to develop, produce, stockpile, or deliver chemical or biological weapons" if licensing them would be effective, and then keep a list of countries for which exporters must obtain validated export licenses.
Arms Export Control Act of 1976	Authorizes State Department (through its Center for Defense Trade) to control by licenses items (including chemical and biological warfare agents and missiles) covered by International Traffic in Arms Regulations and U.S. Munitions List. In contrast to Export Administration Regulations (above), authority of this act extends mainly over sales of conventional weapons and weapon components.

1 Many other laws address nonproliferation issues; this list only covers the major ones.

SOURCE: OTA and Congressional Research Service (see table 3-1.)

Table 3-3-Current Multilateral Proliferation-Related Export Control Agreements

Agreement	Provisions or Comment
Treaty on the Non-Proliferation of Nuclear Weapons (NPT) (entered Into force Mar. 5, 1970)	Nuclear weapon state parties (now Including China, France, Russia, United Kingdom and United States) agree not to transfer nuclear devices to any recipient, nor to assist any non-nuclear-weapon State to make or acquire them, All state parties agree not to transfer nuclear materials or related equipment to any non-nuclear-weapon state unless the latter will accept International Atomic Energy Agency safeguards (monitoring) over the materials.
Nuclear Suppliers' Guidelines: Nuclear Exporters Committee (Zangger Committee) and London Suppliers Group (London Club)	To strengthen and better implement NPT export restrictions, seven NPT members who were major nuclear suppliers (the Zangger Committee) agreed Informally in 1971 on a list of nuclear technology items, the transfer of which would trigger application of IAEA safeguards to ensure that the items were not used to develop nuclear explosives. Forming the "London Club," in 1976,8 more nuclear supplier nations (including France, not then an NPT member) joined those on the Zangger Committee and agreed on a set of Nuclear Suppliers' Guidelines, under which "trigger list" exports would further require physical security for transferred items, acceptance of safeguards on facilities replicated from London Club member designs, and prohibitions against retransfer of Items to third parties; suppliers also agreed to "exercise restraint" in transfer of nuclear-sensitive facilities, technologies, and weapons-usable materials. Total of 27 nuclear suppliers agreed In April 1992 to an additional list of 65 categories of dual-use items to be controlled. Participating nations have adapted these controls voluntarily. There is no international mechanism for monitoring and enforcement, but a Japanese-administered secretariat in Vienna is now overseeing the application of the dual-use guidelines.
Australia Group	Group of Industrialized nations agreed in 1984 to establish national controls on chemical weapon agents and precursor chemicals that could be used to make them. Group, then with 22 members, agreed in March 1992 to add to the control list organisms, toxins, and equipment that might be used to make biological weapons. Has no formal coordination, monitoring, or enforcement, but does have informal agreements to share intelligence and notice of export denials. Eleven other states apply some or all Australia group standards.

attempted to enlist other supplier countries in nonproliferation export controls. Table 3-3 summarizes the results of these efforts.

Blocking Exports From Third Countries

The purpose of sanctions against suppliers to proliferant nations is primarily deterrence, not revenge. The hope of the policymakers is that potential suppliers will not want to risk U.S. sanctions just to get the business of the proliferants.

United States laws and regulations provide for sanctions (e.g., criminal penalties or government procurement embargoes) against U.S. and foreign companies that violate U.S. export regulations. Short of criminal indictments, the United States may also impose trade sanctions on foreign firms that it believes are violating internationally agreed export controls.[4] Some of the laws also provide for trade sanctions against foreign individuals or companies that export items of types restricted by the United States (whether they are U.S. goods or not) when the parties know that their exports

[4] For example, the United States determined in 1992 that the Russian company Glavkosmos was violating the terms of the Missile Technology Control Regime by agreeing to sell cryogenic rocket motors to India; it then imposed U.S. export and import sanctions both on Glavkosmos and on the Indian Space Research Organization.

Table 3-3-(Continued)

Agreement	Provisions or Comment
Missile Technology Control Regime (MTCR)	Group of supplier nations agreed in 1987 not to transfer complete rocket systems or subsystems, or production facilities for them. Group now consists of 23 states, plus 2 "partners"; other states, including Argentina, Israel, Russia, and China, have separately promised United States that they will abide by MTCR constraints. Members also agree to restrain exports of other components, material, or technology that would be useful in missile production. Applies to missiles of range over 300 km; also applies to any missiles which the member government judges to be intended for use with weapons of mass destruction. Agreement is subject to no formal coordination, monitoring, or enforcement.
Coordinating Committee on Multilateral Export Controls, (CoCom)	Group of U.S. allies in 1949 agreed not to export listed items (including some related to missiles and weapons of mass destruction) to Communist countries. Controls have been relaxed after collapse of the Soviet bloc. CoCom is unique among supplier agreements in attempting to establish common standards of enforcement of national export controls among the members; however, it is ill-suited to control proliferation-sensitive technology because the very states that were its targets-Communist and former-Communist states—would have to be members of any nonproliferation export control regime. CoCom might serve as model for other agreements.[1]
U.S.-foreign bilateral arrangements	As noted above, in some cases the United States obtains bilateral agreement with individual nations to abide by supplier group restraints. State Department also issues diplomatic demarches, urging individual foreign governments to impose controls on specific exports of concern discovered by the United States.

[1] See United States General Accounting Office, *Export Controls: multilateral efforts to improve enforcement: Report to the Subcommittee on International Economic Policy and Trade, Committee on Foreign Relations* (Washington, DC: GAO/NSIAD-92-167, May 18, 1992).

SOURCE: OTA and Congressional Research Service (see table 3-1).

contribute to proliferation. Some other supplier nations have legal sanctions comparable to those of the United States.

In some cases, the U.S. laws provide for aid or trade sanctions (e.g., cutoffs of economic aid, military aid, or nuclear cooperation) against *countries,* rather than just companies or persons, that supply the wherewithal for proliferation to other countries. Finally, the President may also take diplomatic actions to try to punish countries that defy U.S. nonproliferation policies. Table 3-4 surveys U.S. laws that authorize or require sanctions against foreign suppliers.

Other sanctions against suppliers-including *nations,* not just "persons' '-contained in legislation proposed in the 102nd Congress and likely to be reintroduced in the 103rd ares:

- denial of most-favored nation trade status,
- forfeiture of property and assets,
- denial of assistance from international institutions in which the United States participates,
- denial of arms transfers from the United States,
- denial of U.S. Export-Import Bank credits,
- termination of codevelopment and coproduction agreements,
- blocking of international financial transactions,
- suspension of aircraft landing rights, and
- prohibition of loading and unloading of cargo from sanctioned countries in U.S. ports.

The President can already take several of these actions at his own discretion under his powers to

[5] See U.S. Congress, Congressional Research Service, Foreign Affairs and National Defense Division, ***Weapons Nonproliferation Policy and Legislation: 102nd Congress, 92-429*** F (Washington, DC: Congressional Research Service, July 3, 1991, Updated May 5, 1992).

Table 3-4--Legislative Bases of U.S. Sanctions Against Suppliers

Law	Description or Comment
Atomic Energy Act	Requires cutoff of nuclear cooperation with states that transfer U.S.-supplied nuclear materials or technology without U.S. permission. Requires cutoff of nuclear cooperation with nuclear-weapon states that assist, encourage, or induce a non-nuclear-weapon state to engage in activities that involve nuclear materials and are significant for the making or acquisition of a nuclear explosive device.
Glenn (1977) and Symington (1977) amendments (sections 669 and 670) to Foreign Assistance Act of 1961 (FAA)	Require President (unless he issues waiver) to cut off economic and military aid to countries that supply the wherewithal for enriching uranium or extracting plutonium from spent nuclear fuel when all the recipient's nuclear facilities are not under IAEA safeguards.
Chemical and Biological Weapons Control and Warfare Elimination Act of 1991	Requires President (unless he issues waiver) to deny U.S. Government procurement or any U.S. imports from 'foreign persons' (individuals or firms) knowingly and materially contributing to chemical or biological weapons proliferation through the export of goods or technologies either covered by the Act, or that would be covered by the Act if they were produced in the United States.
MissileTechnology Control Act, 1990 (Title XVII of the FY 1991 National Defense Authorization Act, which added a chapter to the Arms Export Control Act and sections to the Export Administration Act of 1979)	Denies U.S. Government contracts or export licenses to U.S. or foreign persons who improperly export missiles or major components; Denies U.S. Government missile-related contracts or export licenses to those who improperly export missile components, materials, or test and production equipment; Provides for Presidential waivers of sanctions.
Iran-Iraq Nonproliferation Act of 1992 (A section of the FY 1993 Defense Authorization Act)	Extends sanctions to Iran that already apply to Iraq: a variety of sanctions against individuals, companies, and countries who knowingly assist Iran or Iraq to acquire weapons of mass destruction.

SOURCE: Adapted by OTA from Congressional Research Service, 1992 (See table 3-l),

conduct foreign policy. In November 1990, President Bush vetoed the revised Export Administration Act (since reinstated on an interim basis) that would have mandated sanctions in some circumstances. He nevertheless announced, in an Executive Order dealing with chemical and biological weapon proliferation, that the United States would implement trade sanctions against violators of U.S. law. In December 1990, the Bush administration issued its Enhanced Proliferation Control Initiative, which (among other things) formalized the President's commitment to impose sanctions without a statutory requirement to do so.

Hampering Transfer of Expertise

Exports of equipment and blueprints are one way to transfer weapon technologies; export of experts is another. Proliferants may hire the services of foreign experts to work directly on their weapon programs, to advise their own personnel, or to train their own experts. Alternatively they may send their own scientists and engineers abroad for education and training applicable to weapon programs.

Supplier nations have some possibilities for control over such transfers of expertise. They can enforce secrecy laws that make it illegal for those with classified knowledge to transfer the information. They can make it illegal to aid or abet proliferants (e.g., only since the Foreign Trade and Payments Act of 1992 have German courts been able to impose prison sentences on German engineers abroad whose activities promote the development or manufacture of nuclear, biological, or chemical weapons; the U.S. Atomic

Energy Act has long prohibited U.S. nationals from sharing nuclear technology with others.)

Another way to restrict the outflow of experts is not to punish, but to reward. For example, Western nations are attempting to establish science and technology centers to employ some of the unemployed or underemployed former Soviet weapon scientists who might otherwise be tempted to emigrate to proliferant countries to work on weapons of mass destruction.

It is much more difficult to limit education of foreigners in disciplines that could in principle be applied to weapon development. For example, nuclear physics, chemical engineering, and biochemistry may be useful for nuclear, chemical, or biological weapon programs, but they also have fully legitimate civilian applications. Indeed, the Non-Proliferation Treaty (NPT), the Chemical Weapons Convention (CWC), and the Biological Weapons Convention (BWC) all stress the obligation of advanced countries to extend peaceful technical training to less developed countries.

Brains are multiuse instruments. To bar foreign nationals from educational institutions on the grounds that they might someday work on weapons would exact a high cost: it would damage the openness in which scholarship thrives, and it would deprive developing countries of legitimate technical advancement.[6] On the other hand, somewhat less draconian policies might be considered. First, governments could record and analyze the subjects of research and study of foreigners to see if suspicious patterns emerge for particular countries. Such a measure might yield additional information about proliferation activities, even if it did not itself serve as a means of control. Second, the citizens of specific countries could be singled out for denial of educational services if their countries were suspected of developing weapons of mass destruction, or if their countries failed certain criteria, such as joining and adhering to the NPT or the CWC. Such a policy, however, would require putting nonproliferation above other concerns about relations with those countries-it would amount to treating those states as international pariahs.

Forcible Interference

Perhaps the first clear example of a military response to a proliferation threat was the Israeli bombing of the Iraqi Osirak nuclear reactor in 1981. This step set back the Iraqi nuclear weapon program but did not end it. The bombing did cause Iraq do a better job of concealing it. In 1991, as part of Operation Desert Storm, the U. N.-backed coalition against Iraq attacked and destroyed facilities believed to be connected to Iraqi mass-destruction weapon programs. The U.N. Security Council, as part of the cease-free it imposed on Iraq, required elimination of all such facilities (see below).

Other types of forcible interference besides direct military attack might include:



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In the wake of Operation Desert Storm, the U.N. Security Council ordered the destruction of Iraqi facilities connected with weapons of mass destruction. A nuclear facility at Al-Atheer was demolished on May 31, 1992.

[6] Since a significant proportion of U.S. college engineering teachers are of foreign origin, U.S. education might also pay a price for such a policy.

- sabotage of equipment or materials before transfer, either on the territory of its supplier or in transit;
- military interdiction of equipment or material;
- sabotage of equipment or materials after import; or
- assassination of key personnel (explicitly forsworn by the United States).

While the latter measure is not appropriate for the United States, it is not unheard-of in international affairs. Canadian ballistics expert Gerald Bull, who helped Iraq design its ''supergun," was murdered in Brussels in 1990. Later, when U.N. inspectors requested the names of people in the Iraqi nuclear program, Iraqi officials refused, saying they feared these people might be targeted for assassination.

The U.N. Security Council declared in January 1992 that the proliferation of weapons of mass destruction ". ., constitutes a threat to international peace and security. " This phrasing, referring to a key clause in the United Nations Charter, makes it conceivable that sometime the Council might approve the use of military force to destroy facilities for producing or storing weapons of mass destruction. Even so, such authority is likely to be highly circumscribed, lest states interpret it as license to attack others with impunity. Moreover the necessary steps of deliberation, approval, and preparation would likely give considerable advance notice to the targeted state. Such an internationally sanctioned strike would therefore be poorly suited for missions requiring surprise.

As a result, states believing their vital interests to be at stake may decide to take unilateral military action against some cases of proliferation. However, if such actions are not sanctioned by the international community-at least after the fact—they risk damaging the international consensus on cooperative nonproliferation efforts. Nations committing the action may find themselves accused of violating international law. Moreover, an attack may even build sympathy for the victim, ultimately lessening the obstacles to his weapon program.

Whether such an attack were internationally sanctioned or not, it would also risk retaliation or even full-scale war by the target country against either the attacking nations or their allies.

It seems unlikely that international authorities will ever sanction covert activities like sabotage, let alone assassination, as means of nonproliferation. Almost by definition, covert actions are ones that states are unable or unwilling to defend before the international community. Countries may decide to take such measures for the same compelling reasons they would use military force unilaterally. In doing so, however, they risk exposure and loss of credibility as members of an international community that opposes proliferation on grounds of the common good.

Imposing Obstacles: The Special Case of Iraq

Export controls and other nonproliferation measures-at least as administered in the 1980s—failed to prevent Iraq from deploying and using chemical weapons or from trying to develop nuclear and biological weapons as well as indigenously produced ballistic missiles. In the wake of the war to liberate Kuwait, the United Nations Security Council undertook to reverse the proliferation of these weapons to Iraq. As a condition of cease-free, the Security Council decided that Iraq should:

- give up all chemical and biological weapons, all stocks of agents, and all related subcomponents, as well as all related research, development, support and manufacturing facilities;
- give up all ballistic missiles with a range greater than 150 km as well as related major parts and repair and production facilities;
- agree not to acquire or develop nuclear weapons or nuclear-weapon-usable material or any subsystems or components or any

research, development, support or manufacturing facilities related to them;
- declare the locations, amounts, and types of all the banned items;
- submit to unrestricted U.N. inspections and supervision of the elimination of the banned items; and
- submit to future ongoing monitoring of verification of its compliance with the U.N. conditions.[7]

The sanctions for noncompliance with the cease-fire agreement are discussed below. The United Nations Special Commission established to oversee Iraqi compliance, along with the International Atomic Energy Agency, appears to have exposed and seen to the elimination of most of the Iraqi facilities and items covered by the resolution. Throughout, Iraq has tried to conceal what it could and in other ways obstruct the U.N. inspections; it has also refused to acknowledge its obligation to submit to long-term monitoring of its continued compliance with the cease-fire terms. For its part, Iraq has made it clear that it sees the United Nations as a tool of United States policy to hamstring Iraq, not as a legitimate international authority. Few doubt that, given the opportunity, Iraq will attempt to rebuild its programs for weapons of mass destruction. **Moreover, elimination of such programs based on military conquest probably does not bear much promise as a global nonproliferation measure.**

Nevertheless, United Nations Resolution 687 did establish Security Council positions that conceivably could set precedents for future international cooperation to limit proliferation. In imposing the cease-fire conditions on Iraq, the Council:

- noted ''. . . the importance of all States adhering to . . . [the Biological Weapons Convention] and encouraged the forthcoming review conference' . . . to reinforce the authority, efficiency and universal scope of the convention. . .";
- stressed ''. . . the importance of. . . work on a Convention on the Universal Prohibition of Chemical Weapons and universal adherence thereto"; and
- declared its awareness of". . . the threat that all weapons of mass destruction pose to peace and security in the area and of the need to work towards the establishment in the Middle East of a zone free of such weapons.

IAEA



In a situation unlikely to be repeated in the case of other potential proliferants, the U.N. Security Council required Iraq to submit unilaterally to inspections of facilities relating to weapons of mass destruction. Iraq has frequently attempted to obstruct such inspection. Here IAEA inspector David Kay talks with Iraqi military authorities after they denied access to sites at Falluja in June 1991.

DISINCENTIVES TO PROLIFERANTS

Economic Sanctions

Related to the sanctions against suppliers (see table 3-4) is a set of sanctions aimed at deterring potential proliferants. Sanctions are one form of disincentive intended to make acquiring weapons

[7]U.N. Security Council, ***Resolution 687*** (S/RES/687 ***(1991),*** Apr. 3, 1991),

of mass destruction seem less than worthwhile. Should a country move toward acquiring the weapons, or violate provisions of agreements not to acquire them, other countries may apply sanctions in an attempt to enforce compliance with nonproliferation norms.[8]

Current U.S. laws and regulations stress economic, rather than other, sanctions toward potential proliferants. The Treaty on the Non-Proliferation of Nuclear Weapons (Nonproliferation Treaty, or NPT) implies a mild form of economic sanction by tying cooperation in civilian nuclear technology for non-nuclear nations to membership in the Treaty. In general, the multilateral agreements attempting to limit proliferation do not contain enforcement mechanisms, except for referral to the U.N. Security Council. In the case of Iraqi weapons of mass destruction, however, the United States and the United Nations have gone well beyond the provisions of the multilateral nonproliferation regimes in which abstinence is voluntary.

Table 3-5 summarizes legislative bases for U.S. sanction policies against proliferant nations.

Although the above discussions center on the legislative bases for sanctions against **suppliers and proliferants, the executive branch has wide latitude for discretion and leadership (or default) on those matters. In** addition, the President can act to mobilize international cooperation on nonproliferation. For example, only one (the NPT) of the international, proliferation related agreements listed in table 3-3 is a formal treaty subject to Senate advice and consent; the others are essentially executive agreements.

Through executive branch powers to conduct foreign aid and trade policies, the President can selectively apply what amounts to export controls to specific countries. Through bilateral diplomatic exchanges, he can encourage other nations to restrain their exports. Likewise, he can threaten potential proliferants with economic or other sanctions under his foreign policy powers. For example, U.S. diplomatic initiatives played a major role in the 1970s in persuading South Korea and Taiwan to reverse what seemed to be nascent nuclear weapon programs. On the other hand, the effectiveness of legislated export controls and sanctions depends on conscientious executive branch enforcement; moreover, the laws usually allow the President to waive sanctions at his discretion.[9]

In addition to his diplomatic responsibilities, the President also manages the U.S. intelligence agencies. Intelligence plays a key role in identi**fying which nations should be subject to special export limitations, in discovering the actual end uses of exported goods, and in monitoring the exports of other nations to potential proliferants.** Along with Presidential management, congressional oversight can help set U.S. intelligence priorities in these areas. (See box 3-A for discussion of the implications of using intelligence in nonproliferation policy.)

Stronger Diplomatic and Military Responses

Beyond the economic sanctions listed above (which could be applied to proliferant nations as well as to suppliers), disincentives might include a variety of threatened responses that would make owning and using weapons of mass destruction seem less attractive. The effectiveness of many of these threatened actions will depend, like other nonproliferation measures, on the degree of international cooperation behind them. The presence of a strong international norm against acquiring or using the weapons will be

[8] The IAEA Statute, the CWC, and the BWC all explicitly invite members to bring treaty violations to the attention of the U.N. Security council.

[9] See Carroll J. Doherty, "Foreign Policy Rules Riddled With Presidential Loopholes," *Congressional Quarterly,* Dec. 5, 1992, pp. 3753-3758. Presidents have frequently vetoed legislation that they believed infringed on their foreign policy prerogatives by limiting their discretion.

Table 3-5--Legislative Bases for U.S. Sanctions Against Proliferant Countries

Law	Description or Comment
Nuclear Non-Proliferation Act of 1978 amendment to the Atomic Energy Act	Termination of nuclear exports if nation: . detonates a nuclear explosive device, . terminates or abrogates IAEA safeguards, . violates an IAEA safeguards agreement, . engages in activities involving nuclear materials and having direct significance for manufacture or acquisition of a nuclear explosive device. Prohibits sales of nuclear reactors and fuel to non-nuclear-weapon states that do not accept IAEA full-scope safeguards on all their nuclear installations.
Glenn-Symington amendments to Foreign Assistance Act (FAA), 1976 and 1977	Cutoff of military and economic assistance to nations: ● receiving wherewithal for enriching uranium or reprocessing plutonium, unless all such facilities and materials are placed under IAEA safeguards, . receiving a nuclear explosive device, or . detonating a nuclear explosive device.
Solarz Amendment to FAA, 1985	Requires President (unless he issues waiver) to cut off aid to any country that illegally exports, or attempts to export, from the United States nuclear wherewithal that would "contribute significantly" to the ability of a country to construct a nuclear device.
Pressler Amendment to the FAA, 1985	In the 1980s, Presidents Reagan and Bush waived (as allowed by congressional amendments to the Act) the requirements of the Foreign Assistance Act to cut off aid to Pakistan because of its nuclear weapons program; In 1985, Congress added an amendment requiring the President to cut off aid to Pakistan unless he declared in writing that "Pakistan does not possess a nuclear explosive device and that the proposed U.S. assistance program will reduce significantly the risk that . . . [it will]"; in 1990, the President stopped such certifications, and aid stopped (although commercial military sales continued).
Chemical and Biological Weapons Control and Warfare Elimination Act of 1991	Requires President, on request of Chairman of House Foreign Affairs Committee or Senate Foreign Relations Committee, to report whether a specified government has used chemical or biological weapons; If use determined, mandates sanctions including: foreign aid cutoff, arms sales and military financing cutoff, cutoff of U.S. Government credit or other financial aid, cutoff of exports of any controlled national security goods and technology; If, within 3 months, President does not certify that country has ceased using the weapons, provided assurance that it will refrain in the future, and allowed outside inspections, additional sanctions are at least three of the following: U.S. opposition to multilateral financial or technical aid, prohibition of U.S. bank loans, ban on all exports (except agricultural), ban on imports originating in the country, downgrading of diplomatic relations, suspension of aviation rights; Presidential waivers of the sanctions are possible.

SOURCE: Office of Technology Assessment, 1993.

especially important to getting that cooperation in the cases of those more severe measures.

Preparations to carry out such measures maybe seen as efforts not only to deter further proliferation, but to manage the consequences of proliferation when it occurs (see section below, ''When Nonproliferation Fails"). Coercive--or threatened—responses to proliferant states include:

- adversaries equipping themselves with comparable weapons or with effective defenses against them,
- countervailing military alliances,
- diplomatic isolation,
- trade embargoes,
- bilateral or multilateral promises to defend or assist victims of aggression or use of weapons of mass destruction,

Box 3-A-intelligence Dilemma

Acquiring weapons of mass destruction is usually a clandestine activity. National intelligence agencies, particularly those of the United States, are likely to have the most complete information on who is trying to get what and who is selling what. However, publicly revealing this information increases the chances that the sources supplying it will be shut off. This principle has several implications for formulating nonproliferation policy:

- it increases the temptation to emphasize unilateral or bilateral steps to block specific U.S. exports or foreign transfers, as opposed to multilateral action, which requires broad sharing of information;
- . it challenges intelligence agencies and policy makers to find ways to share findings with multilateral organizations that monitor proliferation (e.g., the U.N. Special Commission on Iraq and the International Atomic Energy Agency);
- it places a premium on increasing the transparency of international transactions and national weapons programs by means of agreements among nations to report their actions to international bodies;
- it requires establishing the ability of international bodies to synthesize and act upon the data coming from transparency reports, unclassified sources, and individual national intelligence agencies;
- it forces intelligence agencies constantly to develop new sources of information when old sources are compromised by the overt use of their product; and
- it necessitates the development of unclassified sources of information that can be used in international fora.

SOURCE: Office of Technology Assessment.

U.S. NAVY



Under some circumstances, the international community may impose economic sanctions on a proliferant nation. The United Nations imposed an embargo on Iraq after its invasion of Kuwait. Here, the Navy's U.S.S. Pratt (in distance) has stopped a Turkish cargo ship bound for Iraq. The ship was found to contain only foodstuff and was allowed to proceed,

- collective international assistance to victims of aggression or use of weapons of mass destruction, and
- military response to acquisition or use of the weapons.

In 1991, U. S., Coalition, and U.N. actions toward Iraq illustrated a range of possible military responses to proliferation. (Although eliminating Iraqi weapons of mass destruction was not a direct cause of the Coalition military intervention, that goal did become an objective of the war and a condition of cease-fire.) As noted in the section above on imposing obstacles, one military response to proliferation is to attempt to destroy the means of production of the weapons before they can be fabricated and deployed. A second is to attempt to destroy weapons already built before they can be used. A third is to employ defensive measures to try to neutralize the weapons (either


VADIM MOUCHKIN/IAEA

One military response to proliferation is that taken by coalition forces during Operation Desert Storm: destruction of potential weapon facilities. Here, IAEA inspectors examine the bomb damage to the IRT-5000 research reactor at Al-Tuwaitha.

passive measures, e.g., gas masks and protective suits, or active defenses, such as antiballistic missiles). A fourth approach, embodied in Security Council Resolution 687 and related resolutions, is to use or threaten military force to coerce the proliferant into surrendering the weapons and their means of destruction. Finally, in a step not yet (July 1993) taken in Iraq, one might force a change of governmental regime to one that would voluntarily forswear the weapons of concern.

Benefits and Limits of Coercion

Imposed nonproliferation measures--obstacles and disincentives—may be necessary, and perhaps effective, in the short run. In the near term, the proliferation problem seems limited to a handful of countries in Northeast Asia (North Korea), South Asia (India and Pakistan), and the Middle East. Continuing and strengthening externally imposed obstacles may slow the movement of these countries toward visible arsenals of mass destruction weapons. It seems unlikely, however, that there will be more imposed reversals like that of Iraq, which was the byproduct of Iraq's overwhelming defeat in a war fought for other reasons.

Supplier-imposed obstacles and disincentives can significantly raise the costs of acquiring weapons of mass destruction, particularly nuclear weapons. In so doing, they can buy valuable time during which an aspiring proliferant may undergo changes of wealth, policy, or political regime that might arrest its weapon programs. Regional security environments can improve. States can reassess the cost and worth of weapon programs. The international community can strengthen the consensual nonproliferation regimes--the NPT, the CWC, and the BWC. Even so, in the longer term, states that remain determined to acquire these weapons will likely be able to do so. The technical knowledge and skills enabling their development will continue to spread through international education, communication, and emigration. Industrial technologies and equipment useful for military research, development, and production frequently have reasonable civil applications: preventing their spread even to countries of proliferation concern will not always be feasible.[10]

For the longer run, imposed obstacles to proliferation may turn out to be surmountable hurdles, not impenetrable walls, In the case of India, one analyst argues that although a policy of technology denial did create problems for Indian nuclear work,

> . . . the long-term effects of the policy have been to promote the indigenous development of nuclear and fuel-cycle technologies in the Third World. Technical constraints can buy time but they cannot resolve the proliferation problem or

10 Nevertheless, the rates of spread of, and the potential effectiveness of export control on, necessary technologies for nuclear, chemical, and biological weapons, and for ballistic missiles vary. See Aaron Karp, *Controlling Weapons Proliferation in the 1990s: The Role of Export Controls* (Ebenhausen, Germany: Stiftung Wissenschaft und Politik, Forschungsinstitut Fuer Internationale Politik und Sicherheit, September 1992). See OTA background paper on technologies underlying weapons of mass destruction for discussions of the relevant technologies.

> contain the indigenous forces of technology in the Third World.[11]

Moreover, coercive attempts to block proliferation maybe perceived as unfair challenges, not as programs to promote international peace and stability. A Pakistani diplomat has complained that U.S. sanctions against Pakistan unfairly single out his country but bring no pressure to bear on India. He went on to threaten that sanctions could have the opposite of their intended effect:

> To add insult to injury, some elements in Congress are focusing on the perfectly legitimate commercial sale of military spare parts to Pakistan. Achieving this short-sighted objective would cripple the operational functioning of the Pakistan armed forces and might impel the government of Pakistan to pursue other military purchases and resume development of its nuclear program.[12]

(It should be noted that there are no indications that Pakistan has suspended its nuclear program, which has very likely already produced weapons, so this threat to "resume development' is disingenuous.)

Insofar as domestic support for nuclear weapon programs is based on sentiments of national pride and autonomy, coercive measures may actually reinforce motivations to persevere.

Both Indians and Pakistanis have argued that export-control regimes are mainly an attempt to deny Third World countries access to nuclear and other technology needed for peaceful purposes. For example, the President of Pakistan, speaking at the Pakistan Institute of Nuclear Science and Technology:

> . . . we believe that the cherished and noble goal of non- proliferation must not degenerate into an essay in evolving a technical fix or a ploy to eternise technological imperialism, denying the fruits of science to those who genuinely want to use them for peaceful purposes.[13]

The best chance for nonproliferation in the long term lies in building a consensus among potential proliferants that it is in their interests to refrain jointly from acquiring the weapons.

REWARDS FOR ABSTENTION

Imposing obstacles to proliferation and threatening to punish potential proliferants are essentially coercive strategies. Another strategy is consensual: offer benefits in exchange for self--restraint. One such trade-support of peaceful applications of atomic energy in exchange for forgoing nuclear weapons-was promised in the NPT. Benefits offered in return for consent not to acquire weapons of mass destruction might include economic inducements, such as:

- financial assistance,
- technical assistance, and
- exemptions from nonproliferation export controls on dual-use items.

Another set of benefits could be broadly categorized as improvements in security that reduce the perceived need for or appeal of the weapons. Security benefits might include:

- agreement by potential adversaries not yet owning weapons of mass destruction that they also will forgo them,
- assurances by existing owners of weapons of mass destruction that they will not threaten to use them,
- reduction of the role of weapons of mass destruction in international relations,
- monitoring or confidence-buildi.ng measures to help verify that potential adversaries are forgoing the weapons,

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11 Brahma Chelaney, ''South Asia's Passage to Nuclear Power,'' *International Security,* vol. 16, No. 1, summer 1991, p. 53.

12 Ali Sarwar Nazvi, deputy chief of mission of Embassy of Pakistan, letter to the *Washington Post*, July 16, 1992, p. A-23.

13 Ghulam Ishaq Khan, text of speech of May 25, 1992, from the *Pakistan Times* of May 26, 1992, pp. 1-2, as reprinted in JPRS-TND-92-017, June 3, 1992, p. 12.

- broader regional or global arms control arrangements that reduce conventional weapon threats,
- foreign commitments to come to the defense of or otherwise assist a nation if it is attacked (with or without weapons of mass destruction),
- regional security arrangements that more broadly reduce the chances of war with local adversaries, or
- global security arrangements that reduce the chances of attack from regional or extraregional adversaries.

Following a general discussion of the question of addressing motivations for proliferation, this chapter section addresses each of these measures in turn.

Addressing Motivations

Persuading potential proliferants of the benefits of going without weapons of mass destruction has been partially successful in the past. More than 150 non-nuclear countries have ratified or acceded to the NPT, many of which are technically capable of building nuclear weapons; most that are capable are refraining. The CWC has been signed by numerous nations that could, but almost certainly will not, acquire chemical weapons. On the other hand, a few countries have refused to deny themselves the nuclear option, while one or two others (Iraq and possibly North Korea) have violated their agreement to abstain. Several have declined initially to join the CWC, although hope remains that they can be brought in. Several are suspected of violating their BWC obligations.

in its 1977 report, *Nuclear Proliferation and Safeguards,* OTA found that

> The technical and economic barriers to proliferation are declining as accessibility to nuclear weapon material becomes more widespread. Consequently, the decision whether or not to acquire a nuclear weapon capability has become increasingly a political one. The choice will turn on whether a nation views the possession of such a capability as being, on balance, in its national interest.[14]

The conclusion that, in the long run, motivations are key still holds true. It applies even more strongly to chemical and biological weapons than to nuclear weapons, because technologies for the former are so much more accessible. **Ultimately, nonproliferation policies will have to find ways of showing leaders still desiring weapons of mass destruction either that their goals can be met in other ways or that the price of the weapons route is too high.**

Factors that make it difficult to persuade some nations to forgo weapons of mass destruction include:

- the perceived value of the weapons,
- double standards applied to those who already have nuclear weapons and ballistic missiles and those who do not,
- domino effects, and
- the entrenchment of proliferation in conventional military rivalries.

The subsections below discuss these factors.

PERCEIVED VALUE OF WEAPONS

For different countries, the appeal of weapons of mass destruction may lie in the national pride or international status they seem to confer, their deterrent value, or their military utility. Nuclear weapons in particular have been associated with great power status (see table 3-6 for summary of nuclear proliferation motives). That the five permanent members of the U.N. Security Council are all nuclear powers, and show no signs of wanting to renounce that status, must enhance the perceived value of the weapons. Nuclear weapons played multiple deterrent roles during the Cold War. Their sheer destructive power makes them attractive to military planners. Even so, the apparent commitment of the two largest nuclear powers, the United States and the Soviet Union

[14] U.S. Congress, Office of Technology Assessment (Washington DC: U.S. *GPO,* 1977), P. 11.

Table 3-6-Possible Motivations for Nuclear Proliferation

Category	Motive
Military power	Deter nuclear attack
	Redress conventional arms asymmetries with rivals
	Seek military superiority over rivals
	Anticipate or match nuclear weapons of rivals
	Intimidate neighbors or rivals
	Deter intervention by extra-regional powers
International political status	Enhance regional political status
	Enhance global status
	Enhance image of technical prowess
Domestic politics	National pride or morale
	Satisfy military groups
Economic improvement	Scientific, technological or industrial spinoffs

SOURCE: Adapted from Stephen Meyer, *The Dynamics of Nuclear Proliferation* (Chicago, IL: University of Chicago Press, 1984), pp. 46-74.

(and now Russia), to dramatic reductions in their nuclear forces is at least a step in the direction of lowering the prominence of nuclear weapons in international relations.

As noted in chapter 2, South Africa added a reverse twist to the motive of deterring outside intervention: it hoped that its threat to use nuclear weapons in a southern African conflict would induce the United States to intervene in its favor to forestall that use.

Chemical and biological weapons programs are more likely to be influenced by military power motives than by the other factors cited in table 3-6. These weapons do not seem to hold much attraction as symbols of international status or national pride. Indeed, their possession is usually kept secret because of the stigma associated with them.[15] Nor do leaders of developing nations argue that they must pursue these weapons to enhance technical or industrial development.

On the other hand, Iraq used chemical weapons in the Iran-Iraq war with impunity and with some military success, albeit against poorly defended troops and undefended civilians. In addition, in 1990 Saddam Hussein attempted to invoke the deterrent value of chemical weapons by threatening to use them in response to Israeli nuclear threats or other (undefined) acts of Israeli aggression.[16] Many in the Arab world defended the Iraqi threat against Western criticism. It remains to be seen what lessons potential chemical weapon proliferants will draw from the ultimate inability of chemical weapons to save Iraq from catastrophic military defeat.

Some nations may seek chemical or biological weapons to deter the use of comparable weapons by other nations. Some may see one of those types of weapon as a "poor man's atomic bomb," deterring nuclear neighbors, conventionally superior neighbors, or intervening powers.[17] They may also simply seek these weapons as instru-

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15 Recent nuclear proliferants have also found it prudent to remain secretive about their weapon programs, while clearly @@ pride in the nuclear technology underlying those programs.

16 In a speech on Apr. 2, 1990, Hussein declared:

> Whoever threatens us with the atomic bomb, we will annihilate him with the binary chemical. . .we will make the fire eat up half of Israel if it tries to do anything against Iraq.

Baghdad INA, translation in FBIS-NEW-90-064, Apr. 3, 1990, p. 36.

When Western countries criticized this threat, many Arab spokesmen came to Hussein's defense, saying that Britain and the United States were trying to deny Iraq legitimate means of self-defense. For example, the Kuwaiti foreign ministry was quoted as saying:

> Kuwait, while deploring this campaign and its exposed intentions, sides with brotherly Iraq in the right to defend its safety and security of its people using all available means.

Kuwait KUNA quoting Kuwait News Agency, FBIS-NES-90-069, Apr. 10, 1990, p. 21.

17 See W. Seth Carus, "The Poor Man's Atomic Bomb?' Biological Weapons in the Middle East" (Washington, DC: The Washington Institute for Near East Policy, Policy Papers No. 23, 1991), p. 11.

ments of military advantage for dominating military rivals.

Among delivery systems, ballistic missiles are perceived as another symbol of technological and military prowess. The chances seem slim of building an international consensus that the status of current ballistic missile powers should be ''grandfathered' like that of nuclear-weapon states but that further missile proliferation should be illegitimate, More likely, although not a near-term prospect today, would be a global ban on these delivery systems.[18] If they are instituted at all, voluntary agreements to forgo or reduce ballistic missiles will probably be in the context of regional security and arms control arrangements rather than in a global nonproliferation regime.

DOUBLE STANDARDS

One problem in persuading aspiring ballistic missile owners to forgo them is that they are being asked to accept an international double standard: the advanced powers now deploying ballistic missiles have the right to do so, but newcomers to the club are not welcome.[19] Nuclear nonproliferation efforts suffer to some extent from the same problem. India has complained the most vigorously that it is hypocritical of the United States and the other nuclear powers to deny the rights of non-nuclear nations to acquire the weapons without giving up their own. Although Argentina and Brazil are moving toward participation in the Treaty of Tlatelolco (making Latin America a nuclear-free zone) and have accepted International Atomic Energy Agency (IAEA) safeguards on all their nuclear facilities (fill-scope safeguards), both have refused to join the NPT because it is discriminatory. On the other hand, the overwhelming majority of the world's nations *have* been willing to accede to the NPT as non-nuclear-weapon states.

The international community reached an unusual consensus on the unfitness of Iraq to own nuclear weapons. But neither Iraq nor India nor most other nations accept what they see as the implication that all but the five acknowledged nuclear powers are immature nations unqualified to handle the responsibilities of nuclear guardianship.[20] Thus, the nuclear aspirants are not likely to be persuaded by arguments to the effect that only grown-ups should have nuclear weapons.

A second perception of double standards stems from the variability of past U.S. nonproliferation policies. From the U.S. point of view, failing to make serious efforts to block Israeli acquisition of nuclear weapons or to enforce sanctions against Pakistan in the 1980s in response to its nuclear program reflect the dilemmas of conflicting policy objectives. From the point of view of some other countries, however, it reflects a willingness to look the other way when the proliferant is a friend of the United States—to select what proliferation is acceptable.

The history of double standards, real or perceived, will in some cases be an obstacle to international consensus on nonproliferation. Furthermore, enhancement of the nuclear nonproliferation regime may see the emergence of a triple standard: a way must be found to deal with the three undeclared nuclear powers,

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18 For a detailed proposal of such a ban, see *F.A.S. Public Interest Report,* vol. 45, No. 3, May/June **1992,** pp. 1-18. See also Alton Frye, "Zero Ballistic Missiles," ***Foreign Policy,*** fall 1992, pp. 3-20.

19 in addition, curbs on missile technology are complicated by its relationship to space technology. India, fOr example, has both space-launch and ballistic missile programs. It has expressed strong resentment at U.S, attempts to block foreign exports to its space program that might also be useful to its missile program.

20 In a speech to Pakistani nuclear scientists and engineers, the **President** of Pakistan noted that

> The bombs that devastated Hiroshima and flattened Nagasaki were not hatched by the "unstable countries" and the "irresponsible minds' of the Third World. .

From text of speech by President Ghulam Ishaq Khan in ***The Pakistan Times,*** May ***26,*** 1992, pp. 1-2, reprinted in JPRS-TND-92-017, June 3, **1992, p.** 11.

India, Pakistan, and Israel. Will they be treated as de facto nuclear states, or will they be asked to disarm themselves of weapons they do not admit having?

DOMINO EFFECTS

Proliferation occurs in the context of international conflict. China wanted nuclear weapons because the United States and the Soviet Union had them. India pursued them because China had them. Pakistan, aided by China, developed them to counter the Indian threat. Israel's adversaries want to catch up with Israel. In the latter case, Israel's adversaries also have pursued chemical, and probably biological, weapons in part to try counter the Israeli nuclear advantage-as illustrated by Saddam Hussein's April 1990 threats to use his "binary" weapon. Iran sought chemical weapons in response to Iraqi attacks during their war, and it may be seeking nuclear weapons.

In short, some countries might not be talked out of pursuing one kind of weapon of mass destruction unless they are convinced that their enemies will verifiably renounce not only that kind, but others as well. (In some cases, even that may not suffice: even if Israel's adversaries were to renounce chemical and biological weapons, it seems unlikely that Israel will give up its nuclear weapons unless its general military security is assured.)

CONVENTIONAL MILITARY RIVALRIES

Weapons of mass destruction are frequently seen as potential compensation for inferior conventional military firepower or personnel. This was the case for the United States and NATO during most of the Cold War.[21] Some vulnerable countries-such as Germany, Japan, and South Korea--clearly found it easier to forgo the nuclear option themselves because they enjoyed the nuclear protection of the United States. Not enjoying such an explicit commitment, Israel developed its own nuclear deterrent against its vastly more numerous (and Soviet-armed) Arab adversaries. North Korean nuclear nonproliferation negotiations, stalled as of this writing, had been taking place in the context of a broader political and military modus vivendi between North and South Korea.

Considering the special dangers that weapons of mass destruction present, it might be desirable to treat their proliferation separately from other political and security issues. In the current regions of proliferation concern, this compartmentalization may not be possible. Agreements to forgo weapons of mass destruction may depend on complementary agreements to reduce perceived conventional military threats.

Economic Incentives To Forgo Weapons of Mass Destruction

FINANCIAL AND TECHNICAL ASSISTANCE

Linking technical or financial assistance to nonproliferation began with President Eisenhower's 1953 Atoms for Peace Plan. That plan proposed the creation of the International Atomic Energy Agency, whose mission would be to make peaceful applications of atomic energy globally available while ensuring that nuclear materials were not diverted to weapons. In the NPT, parties agree to foster peaceful applications of nuclear energy for peaceful purposes, "especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world"; they also undertake to ensure availability of the benefits of peaceful nuclear explosions to non-nuclear-

21 The idea that Western superiority in conventional military technology-rather than U.S. nuclear weapons—could counter Warsaw Pact numerical advantage was emphasized mainly in the later years of the Cold War, especially as discomfort with the idea of extended nuclear deterrence grew. Until the very end, the United States declined to follow the Soviet example (however disingenuous it might have been) of declaring that it would not be the first to use nuclear weapons.

weapon states .22 The U.S. Nuclear Nonproliferation Act of 1978 also links assistance to nonproliferation, while recognizing that disseminating peaceful applications of nuclear technology cannot avoid the potential of contributing to weapon applications as well. The Act provides that the United States ". . . shall seek to cooperate with and aid developing countries in meeting their energy needs through the development of [nonnuclear energy] resources and the application of nonnuclear technologies . . .' and shall seek to encourage other industrialized nations to do the same.

The Biological Weapons Convention (BWC) calls for parties to facilitate exchange of equipment, materials, and scientific and technological information for the use of biological agents and toxins for peaceful purposes; parties able to do so also are to cooperate in contributing to the further development and application of scientific discoveries in the field of biology for prevention of disease or for other peaceful purposes.[23]

Article XI of the CWC specifies that its provisions will be carried out ". . in a manner which avoids hampering the economic or technological development of States Parties. " It also provides that the states ". . undertake to facilitate, and have the right to participate in, the fullest possible exchange of chemicals, equipment and scientific and technical information relating to the development and application of chemistry for purposes not prohibited under this Convention. "

A more comprehensive nonproliferation measure would be to tie a large portion of international development assistance to nonproliferation goals. (There is a precedent: during the Cold War, U.S. foreign aid policies were keyed closely to blocking Communist influence in the Third World.) One way to do this is to deny aid to countries that do not participate fully in the nonproliferation regimes (e.g., refusing to join and adhere to the NPT, the CWC, or the BWC). Another would be to offer increased aid to induce states to end the regional arms races that stimulate desires for weapons of mass destruction and to convert military efforts to peaceful development programs. (In the case of the former Soviet Union, discussed in a separate section below, foreign aid may be directed at stabilizing polities where the weapons already exist and at reducing incentives to export proliferation-sensitive goods and services.)


PETER WINKLER/IAEA

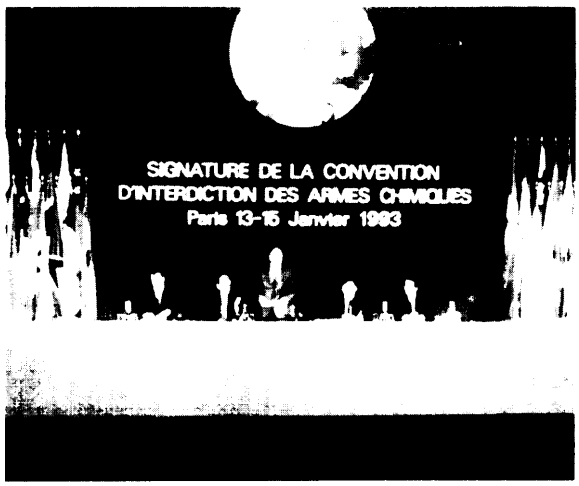
The International Atomic Energy Agency (IAEA) was created to help make peaceful applications of nuclear energy globally available while ensuring that nuclear materials were not diverted to nuclear weapons. IAEA headquarters are located in the Vienna International Centre, pictured here,

22 Peaceful nuclear explosions (PNE) were once a major bone of contention in nonproliferation debates, since there is no difference in principle between a device that could create a peaceful nuclear explosion and one that would create a destructive one. There now appears to be little political support in the world for maintaining the PNE option.

23 The BWC Second Review Conference in 1986 recommended measures for increasing such cooperation. However, the author of a 1991 book on the BWC asserts that no concrete results have been obtained:

> The recommendations [of the Second Review Conference] have served only as a formal recognition of the preoccupations of developing countries at the review conference.

Barend ter Haar, ***The Future of Biological Weapons (New*** York, NY: Praeger, 1991), p. 37



UN PHOTO BY CLAUDE MICHEL (UNESCO)

The opening ceremony of the Signing of the Chemical Weapons Treaty at UNESCO headquarters in Paris was attended by (from left to right) the Foreign Minister of Germany, the Secretary-General of the United Nations, the President of France, the Foreign Minister of France, and the Director-General of UNESCO.

EXEMPTIONS FROM EXPORT CONTROLS

U.S. export controls on items that might contribute to nuclear, chemical, biological, or missile programs require licenses for export to specific lists of countries of concern; countries not listed as proliferation risks are more likely to be eligible to receive goods and technology they want.

Security Benefits

MUTUAL AGREEMENTS NOT TO ACQUIRE WEAPONS

The central bargain of consensual nonproliferation agreements is that states give up their own rights to acquire weapons of mass destruction on the condition that such weapons will not be needed to deter the weapons of others. The non-nuclear-weapon states party to the NPT assure one another that they will not acquire nuclear weapons. Parties to the Treaty for the Prohibition of Nuclear Weapons in Latin America (Latin American Nuclear-Free Zone Treaty, also known as the Treaty of Tlatelolco) agree not to acquire or to permit the presence on their territory of nuclear weapons.[24] States have agreed to forgo biological weapons under the BWC of 1975. All parties to the Chemical Weapons Convention agree to abjure chemical weapons.

Bringing the undeclared nuclear weapon states—India, Pakistan, and Israel-into the nuclear nonproliferation regime will be a delicate task. In these cases, the first steps may have to be measures to cap or freeze nuclear weapon programs where they are-to keep the bombs in the basement, so to speak. Regional confidence-building measures might eventually persuade these nations to roll their nuclear weapon programs back, while assuring their neighbors that matching weapon programs of their own are unnecessary.[25] One delicate **question is whether rollback will be possible without prior formalization of nuclear status. In other words, the bombs might have to come out of the basements before they can be eliminated. If declarations of nuclear weapon possession and steps to eliminate the weapons are not closely linked, the nuclear nonproliferation norm might be weakened. One way of handling this problem was recently demonstrated by South Africa, which dismantled its nuclear weapons first, then afterwards admitted their existence and promised steps to verify that it no longer had them.**

Without addressing this question, Pakistan has for several years proposed a South Asian nuclear-

24 The Treaty of Rarotonga creates a nuclear-free zone in the South Pacific. In 1993, Waler U.N. auspices, a group Of experts is to draft a treaty for the 'denuclearization' of Africa. This effort seems to have a better chance of success than proposals, previously studied by the United Nations, for a Middle East nuclear-weapon-free zone. See Jon Brook Wolfsthal, "Nuclear-Weapon-Free Zones: Coming of Age?," *Arms Control Today*, vol. 23, No. 2, March 1993, pp. 3-9.

25 For discussion of confidence-building measures and roll-back, see Gregory F. Giles, "Nuclear Proliferation Contingency Planning: Ensuring Global Ordedr In a More Proliferated World," CNSN Paper, vol. 4, No. 2 (McLean, VA: The Center for National Security Negotiations (SAID)).

free zone; in November 1992 the U.N. General Assembly again overwhelmingly endorsed this proposal, but India voted against it.[26] India has repeatedly stated that it will consent to limits on its own nuclear weapon program only in the context of global nuclear disarmament.

Onsite verification measures, such as those provided for under the CWC, maybe necessary to build sufficient confidence in compliance among the participants in mutual nonproliferation regimes.[27] Efforts to strengthen verification of compliance with the NPT or the BWC will have to take into account the difficulties of balancing costs and possible benefits from onsite inspections. For further discussion of the issues, see the appendix to this chapter.

ASSURANCES FROM EXISTING OWNERS

In 1968 the U.N. Security Council passed a resolution recognizing that nuclear aggression or the threat of nuclear aggression would create a situation requiring immediate action by the Security Council, notably its permanent members. In addition, the United States, the Soviet Union, and the United Kingdom declared that they each intended to seek immediate Security Council action to assist any non-nuclear-weapon state party to the NPT that was the object of nuclear aggression or threats. Such *positive security assurances* could be strengthened in various ways. For example, the permanent members of the Security Council could each promise to seek Security Council action not only in cases of nuclear aggression, but also in cases involving chemical or biological weapons. Or, the Security Council could formally promise in advance to come to the aid of victims of such aggression.

In 1978 the United States issued a policy statement providing *negative* security assurances: that it would not use nuclear weapons against any non-nuclear-weapon state party to the NPT (or a comparably binding international agreement) except in the case of an attack on the United States or its forces or allies by such a state allied to a nuclear-weapon state or associated with one in the attack.

In the NPT, the parties (including nuclear-weapon states) agreed to ‘‘. . pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament . . .’ The United States and Russia have each declared that they have removed most tactical nuclear weapons from deployment and that they will destroy most of those; they have also agreed to deep reductions in their strategic nuclear forces; they have continued a moratorium on nuclear testing; the United States has ceased production of new nuclear-weapon material and Russia has indicated it will do likewise. Other proposed measures for cutting back the weapon programs of the nuclear-weapon states have included a comprehensive nuclear test ban and formal, verified cessation of production of nuclear weapon fissile materials.

If the spirit of cooperation between the two nuclear superpowers continues, even more dramatic steps are conceivable. The United States and Russia might engage in yet another round of nuclear force reductions, this time bringing France, Britain, and China into the process. All the nuclear powers might put even their weapons into “trust’ for the United Nations, pledging never to use them except in a case approved by the Security Council. Although the nuclear genie may never be fully rebottled, radically new institutions for containing it are no longer unthinkable.

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26 For discussion of a range of South Asian nuclear arms control proposals that would address situations anywhere from denuclearization to ambiguity to declared nuclear weapon status, see Steven Philip Cohen, “Policy Implications, ‘‘ in Cohen, cd., ***Nuclear Proliferation in South Asia: the Prospects for Arms Control*** (Boulder, CO: Westview Press, 1991), pp. 339-371.

27 Such measures might also build *over*-confidence: successful concealment of violations at (or away from) inspected sites could mislead states to conclude that others are complying with an agreement when they are not.

There are other examples of assurances from owners. The United States in 1969 voluntarily eliminated its own biological weapons; several other nations followed suit. The Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and their Destruction (Biological Weapons Convention, or BWC) became effective in 1975. Parties to the Geneva Protocol of 1925 agreed not to use ''asphyxiating, poisonous, or other gases" or ''bacteriological methods" in warfare. (The United States ratified the Protocol in 1975, at that time reserving the right to retaliate with chemical weapons against states not observing the Protocol; it has rescinded that reservation, effective with the signing of the CWC in January 1993.) The United States and Russia have agreed to destroy their stocks of chemical weapons and, under the CWC, agree to forgo such weapons permanently.

REDUCING THE INTERNATIONAL ROLE OF WEAPONS OF MASS DESTRUCTION

Nuclear nonproliferation policy entails persuading non-nuclear countries that they do not need nuclear weapons. One way to reduce the appeal of nuclear weapons is to retire them to the background of international relations, to dissociate them from perceptions of power and status. This is likely to be a difficult task for those who already possess the weapons. In the U.S. case, de-emphasizing the international role of nuclear weapons would logically mean weakening the credibility and utility of U.S. nuclear deterrence. That result might in turn prompt calls in some nations to reconsider their decisions to rely on U.S. deterrence rather than acquire their own nuclear weapons. On the other hand, in a world of generally lower perceived nuclear threat, such nations may now feel less dependent on U.S. nuclear deterrence for their security. In the long run, the nuclear deterrence paradox could be resolved by placing all nuclear weapons in the hands of a supranational organization and establishing a universal prohibition against national nuclear arsenals. However, such a world order still seems remote. Some argue the nuclear proliferation problem cannot be solved unless nuclear disarmament is taken even further-to total elimination of all nuclear weapons.[28]

Threatening to respond to *chemical* weapon attacks with nuclear retaliation would foster the idea that nuclear weapons are legitimate instruments of war, and that those lacking them are less than full players in the international arena. Attempting such deterrence would also have the effect of elevating the perceived significance of chemical weapons, implying that they are in some way equivalent to nuclear weapons as instruments of mass destruction. At the same time, a nation contemplating the use of chemical weapons might not believe that the United States would actually resort to so disproportionate a response as nuclear retaliation.

Biological weapons, effectively administered, could turn out to kill as many people as nuclear weapons. Nevertheless, retaining a nuclear retaliatory option against their use could have effects akin to those of trying to use nuclear weapons to deter chemical weapon use: that is, trying to apply nuclear deterrence to biological weapons could reinforce the idea that they are the ''poor man's atomic bomb," and it might just as well stimulate as discourage some countries from trying to acquire them.

BROADER ARMS CONTROL

As noted in ch. 2 and earlier in this discussion of nonproliferation incentives, nations now suspected of seeking one type of weapon of mass destruction are engaged in arms competitions with neighbors seeking not just the same type of weapon, but sometimes other types and sometimes conventional weapons; this is true in the

28 See, for example, Joseph Rotblat, et al., (eds.), *A Nuclear-Weapon-Free World: Desirable? Feasible?* (Boulder, CO: Westview Press, 1993).

Middle East, South Asia, and the Koreas. Limiting external threats of whatever character may reduce incentives for acquiring weapons of mass destruction. For example, North and South Korea have discussed verification of non-nuclear status in the context of wider arms control arrangements between the two sides.

The choices are among trying to negotiate regimes that limit various combinations of:

- a single type of weapon of mass destructions,
- all types,
- delivery systems, and
- conventional armaments and troop levels.

Casting the arms control net more narrowly may simplify negotiations. Argentina and Brazil seem to be an example of two nations arriving at reciprocal decisions not to develop nuclear weapons and to agree to some verification measures for mutual reassurance. Elsewhere—for example the Middle East—the pursuit of weapons of mass destruction may be too deeply embedded in the regional security problem and consequent across-the-board arms competition: renunciation of nuclear or chemical arms may not come without reductions in conventional military threats.

An important stimulus for limiting regional arms races could be collective agreements by the major suppliers of conventional weapons to restrain their exports. The United Nations has established an international registry of arms transfers, in the hope that greater transparency will lead to greater restraint. The five permanent members of the U.N. Security Council, who also account for the great majority of global m sales, have held talks to discuss the possibility of limiting sales to the Middle East, but have reached no agreement. (In the fall of 1992, China withdrew from these talks to protest the U.S. sale of F-16 aircraft to Taiwan.)

DEFENSE COMMITMENTS

U.S. alliance commitments to Germany and other NATO countries technically capable of building nuclear weapons, as well as to Japan and South Korea, probably contributed to their decisions not to acquire nuclear weapons. In the future, the United States, alone or in concert with other nuclear powers, might continue to offer a conventional or a nuclear deterrent umbrella to help persuade some countries to forgo the nuclear option. Offering a credible conventional deterrent, however, may be complicated by the worldwide reduction and return to the United States of U.S. military forces due to the Cold War's end. Offering a nuclear umbrella implies maintaining deployed nuclear forces that could credibly be used in retaliation for a nuclear attack on a third party .29 It also would expose the United States to the risk that the state it retaliated against would escalate to a nuclear attack against the United States. Another problem with the maintenance of such forces is that doing so would underscore the special status that nuclear weapons confer, and may contradict efforts to lower the profile of nuclear weapons in international politics. The existence of either conventional or nuclear defense commitments by the United States also risks persuading some countries of the need to develop their own nuclear forces as a counter-deterrent to external intervention in regional affairs.[30]

REGIONAL SECURITY AND ARRANGEMENTS

The long-run success of nonproliferation efforts is likely to depend in part on the reduction of security threats used to justify acquisition of weapons of mass destruction. Some analysts argue that regional conflicts are the ''root cause' of proliferation, and therefore that settling regional security problems is a sine qua non for

29 Some analysts argue that START-reduced U.S. strategic nuclear forces will more than suffice for this purpose, while others believe that smaller yield tactical nuclear weapons would be more credible.

30 Some have argued that the United States should develop nuclear weaponsspecially tailored for limited military purposes in otherwise conventional conflicts; however, arguments that the United States is entitled to special, advanced nuclear weapons, while others should have none at all, are not likely to have wide international appeal.

containing it. The security problems in each region of proliferation concern are different; each will require specially tailored arrangements if the parties are to trust one another enough to halt or reverse their military competitions. Such arrangements may consist of combinations of political agreements, economic steps, military confidence-building measures, and arms controls.

Middle East—Achieving a nuclear-weapons-free zone in the Middle East would probably entail extensive peace arrangements between Israel and its Arab neighbors. The current Middle East peace process aims in this direction. Israelis may see their undeclared nuclear weapons as the ultimate guarantor of Israeli deterrence against elimination of their vulnerably small nation by its more populous neighbors. At least some Arab states may see Israeli nuclear and other weapons of mass destruction as fully sufficient justification for obtaining the same.[31] As the Iran-Iraq war and the Iraqi invasion of Kuwait show, disputes among several Middle East states go beyond the Arab-Israeli conflict.

South Asia—Pakistan and India have both ethnic and territorial disagreements with one another. China and India, beyond their own territorial disputes, rival one another as regional great powers. As noted above, Pakistan has proposed a South Asian nuclear-free zone, but India insists not only that China would have to participate, but that all nuclear powers would have to complete nuclear disarmament.

Northeast Asia—Until recently North and South Korea seemed to be making some progress toward reconciliation between their deeply hostile regimes. At the end of 1991, they signed a "Joint Declaration for a Non-Nuclear Korean Peninsula." In that context, North Korea (a 1985 signatory of the NPT) finally concluded an overdue agreement with the IAEA for nuclear safeguards in 1992. It allowed some inspections in 1992, but in March 1993 it denied further IAEA access and announced its withdrawal from the NPT. After discussions with the United States in June 1993, North Korea agreed to postpone its NPT withdrawal, but at that time had not yet agreed to the special inspections requested by the IAEA.

Former Soviet Union and Europe—Ukrainian officials have promised in principle to give up the former Soviet nuclear weapons on their territory. But recently they have tied implementing that promise to, among other things, the kinds of security guarantees they have from (or against) their neighbors (chiefly Russia). See chapter 2 for discussions of concerns surrounding the breakup of the Soviet Union and see below in this chapter for a range of policies for limiting proliferation from that region. Several European states are technically capable of producing nuclear weapons, but have renounced the right to do so. In the long run, their adherence to their decisions may depend on their trust in regional security arrangements in a post-Cold-War world.

GLOBAL SECURITY ARRANGEMENTS

In many cases, regional groupings have been unable to establish workable security arrangements on their own. The United Nations could step in either instead of, or in support of, regional organizations-as it has recently in the Middle East, Cambodia, and Africa. Realization of lasting security arrangements in the other regions mentioned above will depend on cooperation from extraregional nations. In some cases, agreement not to interfere might be enough; in others, agreement to provide collective security[32] assurances may be necessary. Such cooperation will require that the world's great powers—particularly the permanent members of the U.N.

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31 For discussion of the Middle East nuclear problem, see United Nations, *Establishment of a Nuclear Weapons-Free Zone in the Region of the Middle East, Report of the Secretary-General A/45/435,* October 1990.

32 In this context, "collective security" implies the response of the international community to aggression by one of its members, not simply an alliance of some states against other states.

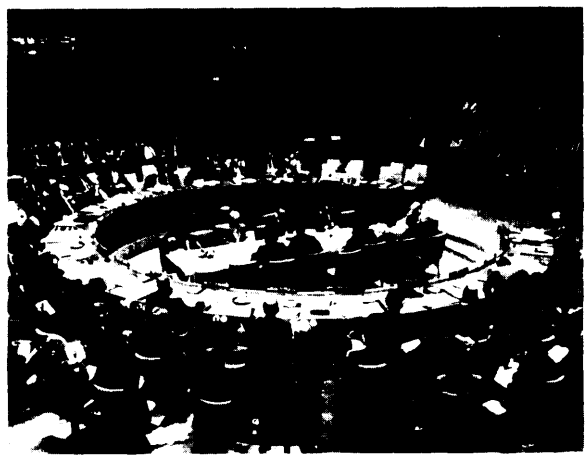
Security **Council**[33]**--work together.** For example, recent progress in regional security negotiations, particularly in the Middle East, is partly related to the end of the Cold War and the loss of Soviet patronage for some Arab states.

Some analysts argue that the *only* **way to** contain proliferation of weapons of mass destruction and other advanced weapons is to change dramatically not only regional security arrangements, but the whole basis of global security. They propose a concept of "cooperative security," the purpose of which is

> . . .to prevent war. . . primarily by preventing the means for successful aggression from being assembled, thus also obviating the need for states so threatened to make their own counterpreparations.[34]

These authors argue that proliferation is closely connected to cooperative security:

> In order to have any reasonable hope of inducing restraint among the many countries that have the inherent capacity and potential incentive to acquire advanced weapons, the major military establishments would not only have to subordinate their own national forces to international coalitions. . but also would undoubtedly have to shrink reciprocally their own forces, levels, and defense industries and would probably have to adopt deployment restrictions embodying the principles of defensive configuration. They would also have to radically de- emphasize weapons of mass destruction in their defense planning. Fortunately, historic contractions in military forces and investment of just this sort are taking place throughout North America, Europe, and the former Soviet Union. If carried out cooperatively, this contraction can set the standard for reduced *military* spending and for force and investment cuts in other regions. Contractions in defense industries and control of export sales should be transformed from politically charged national burdens into internationally shared obligations in pursuit of the benefit of lower levels of militarization everywhere.[35]



UN PHOTO M. TZOVARAS

international *security arrangements may reduce national incentives to acquire weapons of mass destruction. To succeed, both regional and global security arrangements will require cooperation among the world's great powers, particularly the members of the U.N. Security Council, pictured here deliberating in March 1992 over Iraqi violations of its cease-fire obligations.*

WI-EN NONPROLIFERATION FAILS

Some analysts argue that further proliferation of weapons of mass destruction is inevitable and that nonproliferation policy is, if anything, counterproductive.[36] Others say that although nonproliferation policies should continue, it is prudent to plan for at least some further proliferation, and to be prepared to try to mitigate its consequences for

33 Some have proposed that the permanent membership of the Security Council be enlarged to include other great powers—especially Germany, Japan, and India. On the one hand, such an expanded membership would add legitimacy to Security Council actions; on the other, the larger the Council becomes, the more unwieldy will be its operation, impairing its ability to respond rapidly to emerging crises. Should the veto rights now held by the current permanent members be extended to new permanent members, the Council might be less able to achieve the unanimity of its permanent members required for Council action.

34 Ashton B. Carter, William J. Perry, and John D. Steinbruner, op. cit., footnote 2, p. 7.

35 Ibid., pp. 3&37.

36 Ted Galen Carpenter, op. cit., footnote 1.

U.S. and international security .37 Modifying U.S. force plans and structures to cope with the possible further proliferation of weapons of mass destruction is unquestionably an important task **for U.S. policymakers.** Recognizing this fact, the Department of Defense has plans to create a new office of Nuclear Security and Counterproliferation to be headed by an Assistant Secretary of Defense.

As noted above in the section on creating disincentives for proliferants, some policies can simultaneously serve the purposes of deterring acquisition of the weapons in the first place and of deterring or militarily countering their use when nonproliferation fails. It is important to note, however, that some preparations to mitigate the consequences of proliferation might also exacerbate the process of proliferation.

One can make deterrent counter-threats to dissuade the proliferant from using his weapons. Analysts have variously hypothesized that Iraq failed to use its chemical weapons against coalition troops because it feared U.S. retaliation in kind, U.S. resort to nuclear weapons, or escalation of the conventional attack to the point of eliminating the Hussein regime; others suggest Iraq just calculated that there was no useful application available for chemical weapons. Some argue that the possibility of Israeli nuclear retaliation deterred Iraq from using Scud missiles with chemical warheads against Israel.

Noncoercive measures to try to manage the consequences of proliferation are also conceivable. Given a case in which weapons of mass destruction are deployed despite U.S. wishes to the contrary, it would be in U.S. interests to minimize the resulting dangers.

For example, the current nuclear states could implicitly or explicitly acquiesce in the deployment of nuclear weapons by India, Pakistan, Israel, or Ukraine. They could then offer the newcomers to the nuclear club help in developing stabilizing doctrines of deployment and deterrence. The help might be technical assistance to reduce the vulnerability of their nuclear forces to a disarming first-strike from others. Or, it might take the form of technology for tightening centralized control over the weapons themselves and for preventing unauthorized use, theft, or accidents. Promoting safer deployment of weapons of mass destruction would be inconsistent with a stated goal of a global ban on possession-as in the cases of chemical and biological weapons. But in the case of nuclear weapons, the policy might ''grandfather' nuclear arms deemed to be irreversibly deployed, as the NPT does those of the United States, Russia, Britain, France, and China.

A policy of acceptance might mitigate postproliferation risks, but it would also tend to encourage further proliferation by showing that successful evasion of the obstacles to proliferation can eventually lead to legitimacy as a member of the nuclear club.[38] Technical assistance on safety and security measures could also lead the new nuclear power to integrate its weapons more tightly into its military forces, keep them at higher levels of alert, and think of them as more usable instruments of force. And making the weapons more secure from preemptive first strikes from their neighbors would also make **them** more secure **from a** U.S. or multinational preemptive strike.

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37 For discussion of both nonproliferation measures and proliferation mitigation measures, see Giles, op. cit., footnote 25.

38 One answer to the problem of encouraging further proliferation would be to permit a one-time-only expansion of the nuclear club. The U.N. Security Council could set a deadline for states to declare themselves nuclear-weapon states, after which it would treat all further nuclear proliferation--including any existing but undeclared programs-to be a threat to international peace justifying a Council inspection and eliminati'on program. See David Kay, ''The IAEA-How Can It Be Strengthened?, ' Woodrow Wilson International Center for Scholars, Conference, "Nuclear Proliferation in the 1990s: Challenges and Opportunities," Dec. 1-2, 1992.

SPECIAL AND URGENT: LIMITING PROLIFERATION FROM THE FORMER SOVIET UNION

Most of the policy tools described so far in this chapter will be relevant to the republics of the former Soviet Union. But, as indicated in ch. 2, the breakup of the Soviet Union has led to new kinds of proliferation risks. The extent to which the former Soviet republics will disseminate technology, materials, and expertise for producing nuclear, chemical, and biological weapons (as well as ballistic missiles) is still far from certain. Nor is it certain that the former Soviet weapons themselves will remain under firm and responsible central control, or that the three non-Russian republics having some of the weapons within their borders will yield all of them up for elimination.

The situation in the former Soviet Union is only partially amenable to outside influences. Nevertheless, the United States and other nations can take steps to encourage favorable outcomes. In 1991 and 1992, Congress and the administration attempted to help limit these risks by budgeting $400 million each year (beginning with the Nunn-Lugar Soviet Threat Reduction Act of 1991) to assist former Soviet demilitarization. Listed below is a range of policy measures for addressing the risks identified in ch. 2. Some of these measures are already supported by the Nunn-Lugar and Freedom Support Act funds; others are possible future steps.[39]

Maintaining Central Control of Former Soviet Weapons and Materials

- The United States could lead in the creation of an international forum to coordinate efforts to help denuclearize the former Soviet republics.
- The United States and other nations can continue to insist (along with appropriate carrots and sticks) that Ukraine and Kazakhstan ratify the START agreement and the NPT, confirming their non-nuclear status. Belarus, which has done so, could be rewarded, and the countries providing economic assistance to the former Soviet republics could condition all types of aid on continued progress in promised denuclearization.
- Nunn-Lugar funds are supplying equipment for the secure transport of nuclear weapons to central locations. The money is also to be used to help build storage facilities for the plutonium from dismantled nuclear weapons.
- The United States could also encourage use of this money to accelerate current Russian dismantlement schedules; the United States could set an example by accelerating its own dismantlement process.
- The United States has agreed to purchase highly enriched uranium from Russian nuclear weapons for use, once diluted to lower levels of enrichment, as fuel in nuclear power reactors.

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[39] Several of the additional steps listed below were advocated by Senators Nunn and Lugar in December 1992; see Sam Nunn and Richard Lugar, "Still a Soviet Threat," *Washington Post, Dec. 22, 1992,* p. A-21. For a comprehensive collection of policy options for dealing with the nuclear risks posed by the breakup of the Soviet Union, see Graham Allison, Ashton B. Carter, Steven E. Miller, and Philip Zelikow, (eds.), *Cooperative Denuclearization: From Pledges To Deeds,* CSIA *Studies in* International Security No. 2 (Cambridge, MA: Harvard University, Center for Science and International Affairs, 1993); for discussion of U.S. nongovernmental efforts toward verified dismantlement of nuclear weapons, see Federation of American Scientists and Natural Resources Defense Council, *Report of the Fourth International Workshop on Nuclear Warhead Elimination and Nonproliferation,* held in Washington, *D. C.,* Feb. *26-27,* 1992 (Washington DC: Federation of American Scientists, 1992); see also Christopher Paine and Thomas B. Cochran, "Verifying Dismantlement" *Arms Control Today,* vol. *22,* No. 1, January/February 1992, pp. 15-17.

- The United States could propose internationally monitored storage or disposition of highly enriched uranium and plutonium from dismantled nuclear weapons in both the former Soviet Union and the United States.
- The United States could urge accelerated implementation of START strategic nuclear arms reductions; it could ratify promptly the START II agreement and also urge rapid implementation of those reductions.
- The United States and others can offer diplomatic support and, where appropriate, financial assistance to help settle ethnic and regional conflicts and promote regional security regimes.

Preventing Export of Weapons or of Weapon Components

If weapons of mass destruction remain under effective central Russian control, their export seems unlikely. But the same sorts of civil disorder and governmental breakdown that could lead to weapons or key components falling into illegitimate hands could also foster the sale abroad of such goods. With or without cooperation from officials in the former Soviet states, U.S. and other foreign intelligence services may be able to help monitor and stop illicit transactions.

Inhibiting Emigration of Technical Personnel

The United States and other nations have supported creation in Moscow and Kiev (Ukraine) of International Science and Technology Centers, intended to help establish meaningful, nonmilitary work for scientists and engineers who might otherwise be tempted to accept foreign weapons work to earn a living.[40] Joint projects **between U.S. and former Soviet laboratories and firms might be another contribution to that goal. Efficient enforcement of laws and regulations may help.[41] Overall improvement in the economies of the states that emerged from the former Soviet Union is probably the best hope for discouraging this kind of emigration.**

Controlling Export of Critical Information, Equipment, or Materials

The Russian Government has issued specific regulations on the export of goods that might be used to make weapons of mass destruction. Information about the regulations of other former Soviet republics is still spotty .42 But former Soviet military enterprises, new companies, and local and regional governments are striving to earn foreign hard currencies through exports of all kinds. In the transition to a market economy, there is reason to question how effectively controls on either declared exports or smuggled goods will be administered. Western governments with greater experience in export regulations may be able to offer technical assistance. U.S. and other intelligence agencies may be able to track questionable exports and direct the attention of authorities in the former Soviet republics to specific problems.

A private U.S. organization[43] is working with groups in the former Soviet Union on a project on "Building Communities of Nonproliferation Specialists in the Former Soviet Union. ' If such communities can be established, they may contribute to more rigorous implementation of nonproliferation policies in the former Soviet Union.

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40 Other centers may also open in Minsk (Belarus) and Alma-Ata (Kazakhstan).

41 *Izvestiva* has cited foreign reports that Russian authorities blocked some nuclear power specialists from traveling to North Korea. Russian officials confirmed to *Izvestiva* that border troops were instructed to detail "a certain category" of Russians thought to be "bearers of secrets." *Izvestiva, Dee.* 22, 1992, p. 2, trans. in FBIS-SOV-92-246. Dec. 22, 1992, pp. 15-16.

42 For what is publicly available, see Potter, *Nuclear Profiles of the Soviet Successor States,* loc. *Cit. inch. 2,* footnote 47.

43 The CIS Nonproliferation Project of the Center for Russian and Eurasian Studies at the Monterey Institute of International Studies, with grants from various U.S. foundations.

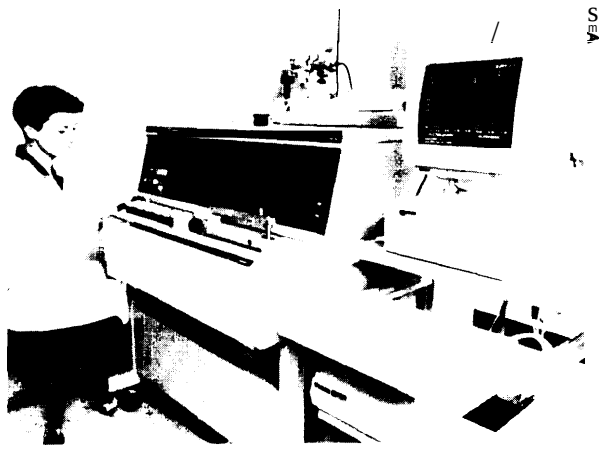
Appendix 3-A

Costs and Benefits of Onsite Inspections for Nonproliferation Regimes

Efforts to strengthen verification of compliance with the NPT or the BWC will have to take into account the difficulties of balancing costs and possible benefits from onsite inspections. Costs include the following:

- **Costs of inspecting: inspection teams, equipment, and operations, whether they are nationally supplied or work for international organizations, cost money.**
- **Costs of being inspected:** personnel of the government or industrial facilities undergoing inspections have to spend time and money preparing those sites to protect classified or proprietary information from exposure to foreign inspectors. The inspections themselves may to bring site operations to a halt, costing more time and money.
- Compromise of nonpertinent information: **preparations to protect information that can properly be concealed from inspectors may not always be successful or affordable. Officials worry about revealing military or industrial secrets or losing competitive advantages.**

The costs in the frost category are not too difficult to calculate; those in the second category are more difficult to estimate; those in the third are nearly impossible to quantify. Further complicating judgments about how high a price to pay for enhanced verification regimes is the fact that increments of intrusion and expense will not necessarily lead to correspondingly higher confidence in compliance. The United States, for example, in negotiating the CWC, judged that ''anywhere, anytime' challenge inspections would not bring sufficient returns in verification to justify the costs (primarily the third category of



Costs of onsite inspection are one issue in assessing the net value of verification regimes for nonproliferation agreements. Pictured here is an x-ray fluorescence spectrometer used to analyze samples from nuclear inspections in Iraq.

costs above: endangered military and intelligence secrets).[1]

Other verification enhancements also impose costs. For example, improved international export reporting to monitor flows of dual-use technologies could compromise legitimate competitive advantages for some of the companies involved.

A multilaterally conducted verification regime carries yet another risk: that the information collected by an international organization might prove useful to potential proliferants within the organization. This risk is greatest in the nuclear field, where significant weapons know-how is still difficult to acquire. Thus, in gathering details about the Iraqi nuclear weapons program, the IAEA has tried to restrict the information to members of the organization already possessing nuclear weapons.

To be weighed against the above costs is the question of how much verification is enough. Beyond the issue of the symbolic or psychic benefits of various verification measures, policymakers need to judge arms control regime verification requirements (e.g., those for the projected Chemical Weapons Convention) in at least three dimensions:

- the significance of potential violations,
- the verification measures that would be required to deter or detect significant violations, and
- the tangible and intangible costs of those verification measures.

Inevitably, judgments on these matters will be complex, subjective, and open to debate: no conclusive technical criteria will be possible. The discussion below shows why this is so.

Proponents of arms control or disarmament agreements for weapons of mass destruction (or, indeed any kinds of weapons) have generally acknowledged that no verification regime will be perfect: a nation that wants to cheat badly enough can probably get away with it at some level. Therefore, they suggest as a practical standard that verification measures should be able to detect "militarily significant" violations. The following two examples indicate how the Reagan administration framed this concept in its support of the Intermediate Nuclear Forces Treaty. Based on Cold War strategic calculations, these example do not directly pertain to the consequences of violating nonproliferation commitments. But they do illustrate issues important to any arms control agreement.

At that time presidential arms control adviser Paul Nitze said that the administration. . . .

> . . . would consider the standard to be whether or not the Soviet Union could covertly deploy a force which would be militarily significant and whether we could find that out. . .in a timely fashion, so that we could take offsetting actions ourselves in a timely manner.[2]

In written responses to questions, Secretary of State George Schultz outlined factors that would go into a determination of military significance:

- the **quantitative** level and overall threat presented to the United States and NATO;
- qualitative factors, including kinds of weapons and their capabilities;
- an assessment of the state of readiness and training of the cheating force;
- the extent to which other forces available to the cheater make cheating forces redundant or add significant capability;
- the extent to which existing U.S. or allied forces could permit an effective counter; and

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1 The Chemical Weapons Convention has the most extensive onsite inspection regime of any international nonproliferation commitment. For an analysis of some of the costs of implementing such a regime, see U.S. Congress, Office of Technology Assessment, *The Chemical Weapons Convention: Effects on the U.S. Chemical Industry,* OTA-BP-ISC-1O6 (Washington DC: U.S. Government Printing Office, August 1993).

2 Ambassador Paul Nitze in U.S. Congress, Senate Committee on Foreign Relations, *The INF Treaty, Hearings, Part I, Serial Number* 100-522, Pt. 1, 1988, p. 301,

. the overall political and military situation surrounding discovery of cheating (e.g., relative stability or tension).[3]

In other words, even in the limited case of long-range theater nuclear forces, the actual number of illegal missiles would be only one factor in a judgment of the military significance of a potential arms control violation.

In the nonproliferation context, the problem of defining militarily significant levels of violation is even more difficult. For example, while the possession of 10 illicit nuclear weapons might mean nothing between the United States and Russia, who each have thousands more, the same number might appear overwhelmingly decisive in a contest between, say, Iraq and Saudi Arabia.

In addition, when weapons of mass destruction are to be employed as instruments of threat or terror, how can one determine what is a militarily significant capability? In the case of biological weapons, for example, a small quantity of agent (much less than a ton), properly delivered, could kill hundreds of thousands of people; if used against protected troops, the same weapons might have little military effect.

Chemical weapons present comparable problems. One systematic attempt to assess militarily significant quantities of agents points out that estimates might depend on whether chemical weapons are being used in covert sabotage operations, mass destruction of civilian populations, or battlefield situations. The analysts in that study settled on tactical battlefield employment as their base case. They point out that in that setting, military significance could depend on:

- the toxicity of the agent,
- the degree of incapacitation or mortality sought,
- weather conditions,
- the degree of protection of the target troops,
- the delivery systems used, and
- the size of the target region.

These analysts then decided that a possibly militarily significant attack would be one against 10 battalions in a 100 km^2 area. In that case, significant quantities might be 30 tons of VX nerve agent or 1,000 tons of mustard gas. They caution, however, that ''these values cannot at this point be equated with detection goal quantities associated with treaty monitoring."[4]

[3] Ibid., pp. 470-471.

[4] Mark F. Mullen, Kenneth E. Apt, and William D. Stanbro, *Criteria for Monitoring a Chemical Arms Treaty: Implications for the Verification Regime (Los Alamos, NM: Los Alamos* National Laboratory Center for National Security Studies, Report No. 13, December 1991), pp. 5-7.

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