THE COST OF DISARMAMENT: DISMANTLEMENT OF WEAPONS AND THE DISPOSAL OF MILITARY SURPLUS

by Susanne Kopte, Michael Renner, and Peter Wilke

Susanne Kopte is a Senior Researcher on a surplus weapons project for the Bonn International Conversion Center; Michael Renner is a Senior Researcher at the Worldwatch Institute in Washington, D.C.; Dr. Peter Wilke is Managing Director of ISA Consult in Hamburg, Germany.

The arms control and disarmament treaties made possible by the thawing of the Cold War have generated a volume of surplus weapons and other military equipment unmatched since the end of World War II. In addition, unilateral decisions to scrap unneeded equipment have further boosted the volume of surplus. This article analyzes the costs of disarmament and of dismantling surplus weapons. The data are derived from a variety of sources with differing degrees of reliability and precision. They are a composite of actual expenditures, amounts budgeted, annual averages of multi-year figures, and, in some cases, rough order-of-magnitude estimates. In some cases, data from different sources are inconsistent; in other cases, none are available. In many areas, only examples of an anecdotal nature can be given. These shortcomings notwithstanding, the data presented here do offer an estimate of the cost of coping with the Cold War arsenals in the coming decades. (A chart on page 43 summarizes these findings.)

The dismantling and disposal challenge can be broken into a number of categories. The first category is the weapon platform (such as a tank, warplane, or intercontinental missile), which provides the carrier system for an array of nuclear, chemical, or conventional warheads, bombs, projectiles, and munitions. The second category concerns the key materials (such as fissile materials in nuclear arms) contained in the different weapon systems. Finally, there is an assortment of fuels and propellants, many of which have been specifically developed for military purposes and therefore are quite distinct from civilian-grade fuels.

A number of considerations influence which methods are suitable for the dismantling and disposal of military equipment. Whichever technology is chosen, the expectation is that it should meet several criteria: 1) be easily verifiable; 2) make renewed military use difficult or impossible; 3) prevent the theft or diversion of militarily-usable materials released in the dismantling process; 4) meet the deadlines for completing weapons disposal and other stipulations of arms treaties; and 5) comply with local, national, or international safety and environmental standards. All of these criteria have an impact on the cost of dismantlement and disposal, but environmental concern is a particularly potent factor. Rising environmental awareness,

more stringent national and international laws, and growing public participation or protest render the careless practices of years past less and less acceptable.

Existing arms agreements typically provide little guidance regarding the final disposition of surplus items. Arms control has traditionally been focused on deployment (permitted numbers and types of weapon systems), but has given insufficient attention to the fate of weapons withdrawn from military service and the critical materials contained in them. In some cases, such as the Conventional Forces in Europe (CFE) Treaty or the Chemical Weapons Convention (CWC), permitted destruction techniques are specified or certain traditional methods outlawed. But generally, much is left to the discretion of the governments that are party to the different treaties, particularly regarding the final disposal of weapons or weapons materials.

Reluctant or financially strapped governments are eager to contain the associated costs. For example, the states of the former Warsaw Treaty Organization (WTO) simply are unable to devote any significant resources to dismantlement and disposal. They are tempted, therefore, to mothball surplus items rather than dismantle them, to let them become unusable over time, or to export them.

There are some attempts to convert armaments to peaceful uses rather than demolish them. In an age of (partial) disarmament, the question is, whether military surplus becomes waste material to be discarded or an asset that can at least pay for part of the costs of disarmament? Military hardware might be reconfigured for civilian tasks; materials can be reprocessed to make them usable for nonmilitary purposes; scrap from dismantled weapons and equipment can be salvaged. Confronted with both a massive disarmament task and a difficult economic transformation, Russia and other Soviet successor states are particularly eager to derive some financial benefit from dismantling their vast weapons stocks. However, in many cases, civilian re-use is likely to be technically difficult or economically marginal; most military hardware has little intrinsic civilian value.[1]

NUCLEAR WEAPONS

Fulfilling the obligations of the START (Strategic Arms Reduction Treaty) I and II will require decommissioning large numbers of ballistic missiles and missile silos, strategic bombers, and submarines. Although the agreements do not mandate the disassembly of the nuclear warheads mounted on these carrier systems, both the United States and Russia are moving ahead with the dismantlement of thousands of warheads. This, in turn, implies that hundreds of tons of plutonium and highly-enriched uranium (HEU) will need to be stored, processed, and ultimately disposed of. Since much latitude is given to the two governments, the precise quantities involved are not known, and costs can only be estimated in orders of magnitude. The Russian situation in particular is marked by great uncertainty.

Additional expenses will be incurred if and when the ongoing negotiations for a comprehensive nuclear test ban treaty (CTBT) are concluded successfully. Although many of the details of a CTBT, including monitoring and verification measures, are undecided, rough cost projections have been made. Start-up costs of an international CTBT implementing authority are thought to be about $100 million, and operating costs $60 to 80 million per year. Challenge inspections might each cost as much as $12 million.[2]

Disabling Weapons Delivery Systems

Between 1989 and 1995, the U.S. Navy spent about $780 million to dismantle ballistic missile submarines. It is planning to complete all START-related eliminations no later than January 2000.[3] The U.S. Air Force is decommissioning 148 of its B-52 bombers and destroying another 217; it has also mothballed 200 F-111 aircraft. Minuteman II ballistic missiles withdrawn from deployment are being placed in storage. A small portion of the more than 1,000 missiles that are expected to be taken out of service by the end of the 1990s are being sold for the purpose of launching commercial satellites—hence not only avoiding the cost of destroying missiles that cost more than $10 million each to produce, but also yielding some revenue. All in all, the Air Force will spend about $60 million on mothballing and dismantling surplus arms between 1993 and 2000.[4] In 1993, the U.S. Air Force started destroying the first of 500 excess missile silos (300 of these are to be destroyed at a cost of $35 million, while the fate of the remaining 200 is yet to be determined).[5]

Under START II, Russia is specifically required to eliminate its SS-18 missiles; it could retain, but

not deploy, all other surplus missiles. Even in the absence of START, however, Russia would have been forced to decommission a large portion of its intercontinental ballistic missiles, strategic bombers, and ballistic missile submarine fleet due to physical obsolescence. Reportedly, a total of 208 aircraft (Tu-95s, Tu-16s, and Tu-22s) are to be destroyed at the Engels Airbase before the year 2000. Seventy of these have to be eliminated in accordance with the CFE Treaty and START I and II. The remainder are aircraft that completed their service lives and were brought to the base from all corners of Russia and the other former Soviet republics. In current prices, the disassembly of one Tu-95 will cost about 7 million rubles. Additionally, it costs 300,000 rubles to remelt one ton of pure metal (some 37 to 40 tons are obtained per aircraft).[6]

Unclassified assessments by the Russian military estimate that implementing START might cost Russia 90 to 95 billion rubles. Expressed in 1992 prices, this would have been equivalent to roughly $6 billion, though the ravages of Russian inflation render any current dollar estimates somewhat arbitrary.[7]

Disposal of Missile Propellants

Most Soviet-made missiles are liquid-fueled, whereas U.S. missiles are primarily solid-fueled. The manner in which the fuels are discarded is critical—not only do they contain highly hazardous materials, but the older or less well maintained a missile, the more dangerous and costly the dismantling job becomes.[8] Soviet-made missiles use unsymmetrical dimethyl hydrazine (UDMH) as a propellant and nitrogen tetroxide (NTO) as an oxidizer. But the Soviet Union never developed any means of disposing or reprocessing these materials, because they were always recycled into new missiles. At present, several tens of thousands of metric tons of these hazardous substances are stored in tanks, awaiting disposal or recycling. As the military business shrinks, propellant manufacturers are becoming more and more interested in fuel demilitarization programs.

In November 1993, for instance, a U.S.-Russian team initiated a demonstration project for the demilitarization of Russia's liquid- and solid-fueled ballistic missiles and the conversion of recovered materials to chemicals and other products. The ICBMs' nitrogen tetroxide oxidizer could be processed into nitric acid and used to produce fertilizer and other products, but possible civilian applications are limited compared with the size of the existing stockpile. UDMH fuel from liquid- propellant ICBMs could be processed into ammonia and demethylamine, both viable commercial products with significant industrial consumer demand. Demethylamine, for example, has a market price in the United States of about $1,000 per ton and can be used as a surfactant.[9]

Burning these fuels would be the cheapest, yet also environmentally most objectionable, disposal option.[10] The United States has conducted routine open air burning of obsolete missile fuel for many years, involving several hundred tons a year. Growing protests against this practice, however, led the U.S. government to initiate a research program to develop alternative disposal technologies.[11]

Decommissioning of Nuclear Submarines

Some 300 nuclear-fueled submarines worldwide—including strategic (ballistic missile-bearing) and non-strategic (attack) submarines—will need to be taken out of service by the turn of the century, because they are reaching the end of their life-cycles.[12]

The U.S. Navy is planning to decommission about 60 nuclear submarines between 1992 and 2000, at a projected cost of $2.7 billion. (A total of 165 U.S. submarines have been built since 1954.) Prior to 1992, 42 submarines already had been deactivated, most of them since 1986. During 1988 to 1990, the average cost to complete a deactivation and reactor compartment removal and disposal was $23.6 million. During 1990 to 1992, costs were in the $12.8 to 21.4 million range, depending on the shipyard where the work was performed. From 1992 on, deactivations were undertaken exclusively at the Puget Sound shipyard in Washington, the yard with the lowest costs.[13]

Before 1989, when the toxic material PCB was discovered in submarine hulls, the U.S. Navy had planned to dispose of the hulls at sea. Instead, the hulls are now being recycled and sold for scrap. The recycling cost per unit is estimated at $3.5 to 4.5 million, after taking into consideration the roughly $1.5 million value of the scrap materials. But recycling the hulls is still cheaper than storing them.[14]

With adequate funding, production facilities, and infrastructure, the United States was able to initiate an integrated program for the dis-

posal of nuclear-powered submarines in the early 1990s. To date, the United States has decommissioned 69 of these submarines, of which 32 are completely dismantled and 37 deactivated awaiting final disposal. The estimated cost of deactivating and scrapping one nuclear submarine is about $38 million.[15]

Between 1989 and 1993, more than 80 Soviet/Russian submarines were retired from service, and, due to arms control treaties, a similar number is likely to be removed by the year 2000. In the past, the Soviet government had gotten rid of at least some obsolete submarines by sinking them.[16]

The naval nuclear support infrastructure in the former Soviet Union was already in poor condition prior to the massive write-off of submarines. It is now stretched to its limit, with decommissioned submarines with their fuel still on board accumulating at bases and shipyards in the North and Far East.[17] Although Russia has developed a concept and adopted a program for complete disposal of nuclear-powered submarines, a key problem has been the lack of financing and actual implementation of the program. For example, a detailed plan has been drawn up at Severodvinsk for a submarine scrapping infrastructure, including the construction of more dry docks, a fuel assembly removal plant, and storage and transport facilities. The plan involves a total projected cost of almost 23 billion rubles.[18]

According to Vice Admiral Viktor Topilin, chief of the Russian Navy's Main Technical Directorate, breaking up a single nuclear vessel costs more than 5 billion rubles. To date, funds for the work are being provided by cutting expenditures on maintaining the combat readiness of the Navy's ships. But the Navy's budget has already been cut to the bone and the available funds for decommissioning will be insufficient.[19] Russia especially lacks adequate facilities to dispose of submarine reactors and their spent fuel properly. By early 1993, only one-third of the submarines slated for decommissioning had their spent fuel removed. Reactor vessels removed from Pacific Fleet submarines are left floating at the Pavlovsk naval base, as storage facilities on land are unlikely to be available before the year 2000. It may take as long as 30 to 40 years to dispose of all the Russian submarines that will be pulled out of service during the 1990s.[20]

The 1995 budget of the Russian government provides for expenditures to handle nuclear waste to the tune of 450 billion rubles. If the fleet were to receive at least half of this money, there would be hope that the problem of salvaging nuclear submarines slowly could start to be resolved.[21]

Dismantling Nuclear Warheads

The U.S. Department of Energy (DOE) has been dismantling between 1,000 to 1,600 nuclear warheads annually in recent years. The Congressional Office of Technology Assessment estimated annual costs for dismantlement and fissile materials disposition to be $500 million to $1 billion over the next decade.[22] A more recent estimate puts the annual costs closer to the high end of this range.[23] Russia is probably dismantling fewer than 2,500 warheads per year, according to Western nongovernmental analysts.[24] Ministry of Atomic Energy (Minatom) head Viktor Mikhailov stated in 1994 that Russia is spending up to 1 trillion rubles on dismantling warheads; he put the cost to dismantle a single one at $100,000. Hence, Russia may be spending the equivalent of some $200 to 250 million per year.[25]

The other former Soviet republics with nuclear arms on their territories have agreed to ship them to Russia for dismantlement. In 1993, Ukrainian officials estimated the dismantling and withdrawal cost at $1.5 to 5 billion.[26]

Converting Highly-Enriched Uranium (HEU)

Following warhead disassembly, the fundamental question is how to dispose of the dangerous fissile materials contained in them. The options are more straightforward for HEU than for plutonium. The generally accepted path is to blend HEU with depleted or natural uranium, in effect diluting it from weapons-grade enrichments of 90 to 95 percent to below five percent. This dilution makes it usable as commercial reactor fuel.

Under a 1992 agreement, the United States is to purchase 500 tons of HEU derived from Russian warheads over the next 20 years. (Russia is believed to have 1,200 tons of HEU.) Diluted to some 15,000 tons of low-enriched uranium, this would be enough to run U.S. nuclear reactors for roughly a decade. The entire deal is estimated to be worth about $11.9 billion.[27] In each of the initial five years, the United States is to purchase 10 tons of HEU, bringing Russia some $240 million annually; the amount will then rise to

30 tons per year, with an implied value of about $725 million annually. The first shipment was received in June 1995, but implementation of the agreement has been clouded by pricing and trade disputes.[28]

In November 1994, another purchase of weapons-grade material was completed. Details of "Operation Sapphire," the code name for the secret transfer of more than 1,320 pounds of weapons-grade uranium from Kazakhstan to the United States, were disclosed only after completion of the transfer. According to U.S. Defense Department officials, President Nazarbayev of Kazakhstan had learned early in 1994 of the existence of the large stockpile of HEU at a metallurgical plant in Ust-Kamenogorsk. Although Kazakhstan was guarding the material, which had been intended for use in military naval reactors, the effort was a drain on its meager resources. Moreover, the uranium posed a temptation for any terrorist group or renegade nation in the market for nuclear arms components. After extensive negotiations, the United States agreed to provide cash and material support to Kazakhstan, with different sources reporting the value of assistance at anywhere from $30 to 100 million. The cost of the transfer itself was $7 million.[29]

The U.S. government has begun to convert some of its own military HEU into civilian nuclear reactor fuel. The volume involved—13.2 tons—is equal to only a little more than one percent of its stockpile of 994 tons. An additional 50 tons, with a market value of $500 million and reprocessing costs of $100 million, are currently scheduled for dilution. Additional amounts of HEU may be converted to civilian use in the future.[30]

Plutonium Problems

Plutonium poses a much greater disposal challenge than HEU. Although a variety of options are being discussed, none will be available for many years to come. Arjun Makhijani, president of the Institute for Energy and Environmental Research in Maryland, explained that DOE "is extending its definition of interim [storage] to longer and longer periods. Before, 'interim'... was six to 10 years. Now, they're talking about building 50-year storage facilities."[31] Thus, the surplus plutonium will need to be placed in guarded storage for an extended period, at an estimated cost of $2 to 3 billion for a decade.[32]

Most discussed are proposals to blend the plutonium with uranium into so-called MOX fuel to be used in adapted or newly-built light water reactors, to burn it in breeder reactors, or to encase it in glass (vitrification) for burial in so-called geological repositories. Though none of these paths is entirely satisfactory, vitrification appears far preferable from the perspective of disarmament, economics, public safety, and the environment.[33] The costs are rather speculative at this juncture; they are likely to range from several hundred million to a few billion dollars. A November 1993 RAND study suggested that vitrification might be the least costly option.[34]

Russia is determined to derive some economic benefits from dismantling its nuclear arsenal; with Japanese and German aid, it is exploring the MOX and breeder reactor options. Also, in 1993, Russia and the U.S. company General Atomics signed an agreement to build a $1.5 billion fission reactor.[35] But the country is so cash-strapped that its plans may remain just that. The United States has not yet officially decided what to do with its plutonium. But whereas Moscow regards its plutonium as a treasure, Washington is inclined to see it as a dangerous waste that needs to be discarded.[36] White House Science Advisor John Gibbons has stated that "Plutonium has essentially a negative economic value."[37]

Planned U.S. facilities to vitrify military high-level nuclear wastes are large enough to accommodate all U.S. weapons plutonium, should the decision to do so be made. However, plans to construct and operate two vitrification facilities have experienced repeated delays, technical difficulties, and cost overruns. At one of the two facilities, at Savannah River, Georgia, costs have escalated from $1.53 billion to nearly $4 billion.[38]

Regardless of what is done with the plutonium, eventually it will have to be placed in some kind of repository. Identifying proper and acceptable permanent burial sites remains an unresolved and highly controversial endeavor. Projected opening dates for U.S. repositories in Nevada and New Mexico, for example, continue to slip further into the future. Cost estimates are of necessity speculative and are likely to grow significantly (already, some $4 billion has been spent at the Nevada site).[39]

The other declared nuclear powers—China, France, and the United Kingdom—are not part of the U.S.-Russian dismantlement process. To the extent that they dismantle any carrier systems or warheads, it is

primarily for reasons of obsolescence rather than disarmament. In its 1994 budget, the French government revealed for the first time how much it spends on disassembling warheads. At 65 million francs ($11 million), the expense was equivalent to less than two percent of the French nuclear weapon program during the same year.[40]

CHEMICAL WEAPONS

The CWC was completed in late 1992 and is expected to come into force within the next year. It mandates the destruction of all stockpiles and production facilities. To date, only the United States, Russia, and Iraq formally have declared the possession of chemical arsenals. Iraq, despite being forced to destroy its chemical stocks under U.N. supervision as a condition of the 1991 Persian Gulf ceasefire, did not sign the CWC. However, the destruction of Iraq's 125,000 chemical munitions and 600 tons of bulk chemical agents is virtually completed.[41]

Chemical Weapons Disposal in the United States

Destroying chemical weapons is estimated to cost up to 10 times as much as producing them.[42] The United States has considerable experience in chemical weapons destruction, but the amounts disposed of to date nevertheless pale in comparison with the volumes now awaiting destruction—some 31,400 tons. The U.S. Army has adopted high-temperature incineration as the sole destruction method. It has operated two test facilities at Tooele, Utah, and at Johnston Atoll in the Pacific Ocean, and is in the process of constructing incinerators at the eight locations where chemical warfare agents are stored (avoiding the need to transport any weapons).[43]

But the prototype facilities have experienced persistent mishaps. The target date for completing the destruction of stocks has slipped from September 1994 to December 2004; and total cost estimates have soared from the original $1.7 billion in 1985 to $11.9 billion currently.[44] Annual funding for the U.S. Army's Chemical Material Destruction Agency has risen from about $200 million in the late 1980s to about $600 million by 1995.[45] In addition to the weapons stockpile, there are large amounts of old, buried chemical munitions. The Army estimates that disposing of them properly will cost another $17.7 billion over the next 40 years.[46]

Costs of Chemical Weapons Disposal in Russia

In 1993, Russian President Boris Yeltsin said that destroying his country's stocks of chemical weapons (officially put at some 40,000 tons, though some have charged that the stocks are much higher) could cost more than all of Russia's other disarmament programs combined. While the United States has begun to destroy small numbers of chemical weapons, Russia's program has been delayed by technical difficulties, lack of money, and popular opposition to possible environmental consequences that is at least as strong as that in the United States. Russia planned to have three facilities operating by 1997; however, these plants would be able to eliminate only 43 percent of existing stocks by 2004, the likely deadline imposed by the CWC.[47]

In October 1995, the Russian government approved a federal program for chemical weapons elimination for the period from 1996 to 2009. According to this program, Russia will start eliminating 7,500 tons of blister agents in newly-built facilities in the city of Kambarka (Udmurtia) and the village of Gorniy (Saratov region). The annual capacity will amount to 1,850 tons.[48]

In a second stage, chemical artillery shells and aviation bombs with phosphorite-organic agents will be dismantled. Stocks are estimated at 32,500 tons. New facilities for this purpose will be built in the Kurgan region and near Kizner (Udmurtia). Elimination of weapons should be completed by 2005. Work to decontaminate and close down facilities for dismantling is expected to be finished by 2009.[49]

It is, however, next to impossible to come up with any reliable cost projections for Russia. Official Russian cost estimates have varied widely; in 1994, a Russian expert put the cost in the range of $1.3 to 2.8 billion. This does not include the cost of demolishing production facilities.[50] Even aside from the difficulties of expressing costs adequately in U.S. dollars or other Western currencies, ruble estimates differ considerably: In March 1994, during State Duma hearings, an estimate of 2.5 trillion rubles was mentioned.[51] The plan approved in October 1995, by contrast, is thought to involve expenditures of 16.6 trillion rubles.[52]

Costs for International Verification

In carrying out the stipulations of the CWC, the United States, Russia, and all other signatories will

have to bear an additional cost. Unlike in the realm of nuclear and conventional disarmament, a whole new body, the Organization for the Prohibition of Chemical Weapons (OPCW), is being set up to oversee the implementation of the treaty.

The 1994 and 1995, OPCW budgets were $29.7 million and $32.5 million, respectively. Once the CWC enters into force and the organization is fully operational, annual costs may rise to $75 to 100 million.[53] Still, these expenses are considerably lower than anticipated. Initial plans foresaw a staff of up to 1,000 (compared with the current plan of 365) and an annual budget of $150 to 180 million. Western governments successfully insisted on curtailing costs despite possibly compromising the OPCW's ability to detect, and hence deter, treaty violations.[54]

CONVENTIONAL WEAPONS

Conventional arms control, by and large, has been limited to the European continent, much of it being enshrined in the CFE Treaty. Beyond Europe, considerable amounts of mostly small arms have become surplus with the end of a number of long-standing conflicts, including those in Nicaragua, El Salvador, Haiti, Namibia, Ethiopia/Eritrea, and Mozambique. In many cases, it is far from clear what actually happens with this hardware. A substantial danger exists that much of what is still usable may find its way to new zones of conflict rather than being dismantled and destroyed. United Nations peacekeeping missions have played important roles in terminating almost all these conflicts, yet overseeing disarmament all too frequently remains an unfulfilled mandate. In El Salvador, for instance, a great part of some 300,000 weapons distributed by the army to civilian supporters are still in circulation.[55] There have been several disarmament and demobilization efforts and a few weapons buy-back programs, such as in Haiti, but their success is limited and their contribution to long-term peace and security unclear.

Conventional Force Reduction in Europe

The CFE Treaty came into force in 1992 and was to be fully implemented by November 1995. To comply with the treaty, arsenals from the Atlantic to the Urals had to be slashed by almost 15,000 tanks, more than 10,000 armored vehicles, about 5,000 artillery pieces, and a much smaller number of combat aircraft. As much as 90 percent of these cuts had to be made by members of the former Warsaw Pact.[56] The treaty, however, gives considerable leeway as to how the reductions in deployed weaponry may be achieved. A substantial portion of the surplus equipment is not being destroyed, but instead relocated outside the geographical area covered by the treaty (an option available to Russia, the United States, and Canada), exported, converted to civilian use, or recategorized. Given the range of options, the share of the excess equipment actually destroyed is unclear.

Any effort to track down CFE-related expenditures is hobbled by the poor availability of relevant data, in part due to inadequate record-keeping by government agencies. However, generally speaking, the scrapping and dismantling of conventional weapons is comparatively cheap. The whole CFE disarmament process is not expected to cost more than $1 to 2 billion. NATO's Verification Coordinating Committee concluded in late 1994 that destruction or decommissioning is less costly than mothballing surplus equipment.[57]

Among members of NATO, Germany and the United States have by far the largest expenses in carrying out the CFE provisions. The annual expenditures of the other NATO states are far lower—typically not surpassing $5 million each.[58] Germany is disposing of about 80 percent of the equipment of the defunct East German armed forces and a projected 30 percent of that of the pre-unification Bundeswehr. All in all, close to 11,000 major weapon systems were targeted for elimination by 1995, and as many as 25,000 during the following 15 years.[59] The German government spent DM 864 million—slightly more than $500 million—during 1991 to 1994 on CFE destruction.[60]

Through the NATO Cascading Program, the United States (like Germany) transferred large numbers of treaty-limited equipment to other NATO members. Thus, during the first full year of the CFE implementation period, the United States avoided any binding obligation to eliminate equipment (though it made a voluntary decision to destroy more than 600 old tanks stored in Italy). During 1991 to 1994, the United States incurred $134 million in CFE-related expenditures (including destruction, verification, diplomatic, and bureaucratic costs).[61]

The former Warsaw Pact states have had to undertake far larger reductions in their arsenals

than NATO members, but they also have very limited financial resources for this task. Though their expenditures may not seem particularly large by Western standards, they are substantial for countries that are economically hard-pressed. Belarus, for instance, estimates its total cost at $33 million. During a 1994 meeting of the CFE Joint Consultative Committee, a number of Eastern states unsuccessfully called for the creation of an international fund to support weapons destruction. Russia in particular has repeatedly complained about its CFE costs. It would prefer to let its surplus tanks rust away rather than undertake the expensive process of cutting them apart.[62] Russia does not even have enough money to keep a Soviet-era promise to scrap military equipment withdrawn from western parts of Russia and stored east of the Urals as well as in former Central Asian republics. The Soviet Union moved the weapons to avoid their being counted against CFE limits. By November 1995, Russia had destroyed 19 percent of the 6,000 tanks, 40 percent of the 1,500 armored vehicles, and 39 percent of the artillery systems in question—most of them obsolete. Russia estimates that it needs three more years to complete the task and puts the cost at about 100 billion rubles, or about $21 million.[63]

Sales of scrap from destroyed pieces of equipment are offsetting at least part of the costs incurred.

Conventional Surplus and Arms Export

Even after fulfilling the reduction liabilities under CFE, most NATO and former Warsaw Pact states still have large amounts of conventional surplus. As a result of cuts in defense expenditures and reduction in armed forces, military holdings must be further downsized.[64] During the last five years, much of this surplus has been offered on the international arms market. In fact, since 1989 a growing number of all major arms sales have involved transfers of surplus stocks. In 1994, second-hand sales accounted for 30 to 40 percent of all major arms exports. The Stockholm International Peace Research Institute (SIPRI) estimates trade in used weapons at $6.1 billion for 1994 with roughly 80 percent of all major weapons coming from the United States and Germany.[65]

In the coming years, even more second-hand weapons and equipment will be offered for sale. Particularly in the United States and Russia, surplus stocks include a large number of highly sophisticated weapons: combat aircraft, battle ships, submarines, and tanks. Some of these weapons are given away for free or at very low prices (ships are often leased to foreign countries). While this reduces the revenue gained, it also avoids or reduces the cost of mothballing or scrapping the weapons.

Russia faces far greater difficulties in using exports as a way to get rid of surplus. One illustrative example is its Navy. Russia is unable to maintain the sizable armada that the Soviet Union had built up. Much of the Russian (and Ukrainian) Navy is wasting away. Because Russia is unable to sell the ships on the world arms market, it has decided to sell them for scrap. A South Korean company will buy as many as 259 ships from Russia's Pacific Fleet (including 220 surface vessels, 39 submarines, and two Kiev-class aircraft carriers, which were among the most sophisticated in the Russian Navy). The contract prohibits military use of the vessels; they are to be disarmed before the sale and dismantled under Russian supervision. Precise financial arrangements are not known, but the carriers' scrap value is estimated at about $100 per ton. There has been some speculation that the sale might be offset against Russia's $1.5 billion debt to South Korea.[66]

Scrapping of Conventional Ammunition

None of the presently existing arms control or disarmament treaties concern themselves with ammunition. However, in the wake of the end of the Cold War and in parallel with CFE equipment reductions, a number of governments are reducing their holdings. The United States, Russia, Belarus, Ukraine, and Germany are among the countries with the largest amounts of surplus.

By far the largest amounts of ammunition are held by governments in the former Soviet Union. Russia apparently has some 35 million tons, some of it dating back to the early parts of the 20th century and entirely obsolete. Belarus has one million tons, and Ukraine at least 750,000 tons. In the United States, more than 500,000 tons of ammunition are slated for demilitarization.[67] The U.S. military has a stockpile of more than 5.6 million tons of conventional munitions.[68] In 1990, Germany had about 295,000 tons of ammunition left over from the East German Army.[69]

Dumping at sea was the preferred option in the past, and this practice has still not entirely stopped. At the

beginning of 1993, new international restrictions under the Convention for the Protection of the Marine Environment of the North East Atlantic came into force. Most NATO members have, in accordance with the London Dumping Convention, agreed to stop dumping obsolete bombs at sea by the end of 1995. Currently, open air burning and detonation—as questionable environmentally as ocean dumping—appear to be the most common methods.[70]

In the second half of the 1980s, the U.S. Army demilitarized an average of about 24,000 tons of ammunition each year. But with the end of the Cold War, the stockpile slated for demilitarization grew substantially. About 340,000 tons of ammunition were demilitarized during 1990-95, at a cost of about $300 million—almost $900 per ton. The annual budget grew from $15 million in 1990 to $100 million in 1995.[71]

The case of the former East German ammunition stocks offers an interesting example for the disposal of surplus ammunition. Approximately 295,400 metric tons of ammunition had been handed over to the West German Bundeswehr in 1990. Out of this amount, only 14,000 tons were kept in service. Roughly 40 percent or 118,172 metric tons were exported—the bulk of that amount simply being given away or sold at extraordinarily cheap prices. By the end of 1995, 175,000 metric tons had been dismantled and destroyed in three facilities.[72]

Initial estimates of the costs were on the order of DM 1.5 billion (or $1 billion). Depending on the type of ammunition, estimates ranged from DM 1,000 to 15,000 per ton, with the average cost somewhere around DM 5,000 per ton.[73]

A cost-neutral alternative to ammunition destruction is being pursued by Ukraine in a joint venture with the U.S. company Alliant Techsystems, the largest supplier of munitions to the Pentagon. The venture involves the scrapping of 220,000 tons of surplus ammunition. Operations started in January 1995 and are to continue for five years. After the munitions are taken apart, the propellants and explosives are removed and put to commercial use in mining and construction or converted into fertilizer. Scrap metal from munitions casings—copper, steel, brass, and aluminum—is to be sold by another venture participant, the British metals trading company Rapierbase. Sales are expected to generate more than $100 million in revenue over five years, while the total cost of dismantling is estimated to be $57 million. Alliant is investing $17 million.[74] However, adding the costs of dismantling ammunition in Germany makes the cost projections by Alliant Techsystems appear to be very low and overly optimistic.

ENVIRONMENTAL RESTORATION

The full costs of meeting the surplus weapons dismantlement and disposal challenge can only be guessed at. A factor of considerable uncertainty relates not to the weapons *per se*, but the industrial facilities at which they were manufactured and the bases where military equipment is deployed, stored, and maintained. Management of wastes generated and decontamination of land and facilities are pressing, and very expensive tasks.

Specifically, the facilities of the nuclear weapons complex in the United States and the former Soviet Union (and presumably also in the other nuclear weapons states) are severely contaminated. In the United States, official projections of waste management and environmental restoration costs now run anywhere from $200 billion to 350 billion.[75] Other estimates suggest that they may very well range as high as $1 trillion.

No matter how much money is made available, however, the unpleasant truth is that a real "cleanup" is virtually impossible. The most that can be expected is that the contamination problem will be contained without any disastrous accidents. There is, hence, a considerable non-monetary cost in the fact that certain areas will have to be closed to human use permanently.

Little information is available for Russia, but it is clear that Moscow devotes insufficient resources to cope with contamination that is at least as severe as that faced by the United States. In 1994, Alexei Yablokov, head of the Interagency Commission on Ecological Security of Russia's National Security Council, estimated the need for military cleanup spending "without chemical and radioactive polluted areas" (i.e., contamination related just to conventional military activities) at about $2 to 3 billion. Actual spending appears to be only a miniscule fraction of the requirements.[76] The Russian government budget contains a provision for "cleanup of nuclear accidents" of 275 billion rubles in 1993 and 838 billion rubles in 1994.[77]

In all countries, expenditures to address the environmental aspect of weapons production and disposal are

still in an early stage. For example, 1994 was the first year that the U.S Department of Defense spent more money on actual remedial activities than on investigations and studies.[78] Expenditures, in the United States and elsewhere, are likely to grow as cleanup efforts gather momentum.

MILITARY EXPENDITURES AND DISARMAMENT EXPENDITURES

The availability of disarmament expenditure data in many countries is poor, but the number of disarmament commitments and the size of their respective surplus arsenals would suggest that the United States, Russia, and Germany are incurring by far the largest expenses. Germany's expenditures are in the realm of conventional arms, whereas the United States and Russia are concerned with the entire range of armaments. Of these two, data availability is incomparably better for the former. And the United States has substantially greater resources at its disposal to tackle the challenge of dismantlement and disposal.

Compared with spending for military research and development (R&D) and the procurement and maintenance of weapons and equipment, worldwide expenditures for the dismantlement and disposal of surplus weapons are still very small. Identifiable and estimated expenditures for nuclear, chemical, and conventional disarmament rose from $1.5 billion in 1989 to $3.4 billion in 1994.[79] Clearly, these figures do not capture the entire range of spending that is taking place. But they leave no doubt about the enormous discrepancy between budgets devoted to disarmament and those devoted to traditional military purposes.

Since many countries face similar types of technical challenges, a cooperative international program to investigate, develop, and share promising technologies to dismantle and dispose of military equipment and materials safely is vitally important. A series of pilot projects and workshops have been conducted within the framework of the North Atlantic Cooperation Council (NACC). However, they are relatively limited in scope and are not accessible to the large number of non-NACC countries. A more global undertaking could easily be financed out of world military R&D budgets—which still absorb tens of billions of dollars each year—devoted to developing new weapons dismantlement technologies.

Given the economic difficulties of many former members of the WTO and the uncertainties whether treaty deadlines, such as the one imposed by the CWC will be met or whether surplus items will be disposed of in a responsible manner, it would seem that there is a strong need for improved financial aid to the countries in question. The United States and other Western countries have pledged aid, but the amounts involved are insufficient and disbursement is often slowed by bureaucratic obstacles.[80] Instead of a piecemeal approach, it would be sensible to establish a well-endowed international disarmament fund. This fund might be established for a variety of disarmament and peacebuilding endeavors worldwide. Since sufficient funding for weapons dismantlement and disposal provides a clear boost to international security, this fund would best be financed out of military budgets—thus helping to establish more of a balance between military and disarmament expenditures.

Overall Costs of Dismantling Weapons and Disarmament

Country	*Selected Programs (examples)*	*Time Period*	*Estimated total costs in U.S. dollars)*
Nuclear			
United States	• Dismantling ballistic missile submarines (Navy)	1989-95	780 million
	• Air Force mothballing and dismantling	1993-2000	60 million
	• Dismantling 500 missile silos	n.a.	50 million
	• Dismantling warheads and fissile materials	10 years	5-10 billion
	• Buying HEU from Russia	20 years	12 billion
	• Storage of HEU/plutonium	10 years	2-3 billion
	• Vitrification or similar technology		3-5 billion
	• Overall costs	**10 years**	**20-30 billion**
	• Cleaning and safeguarding militarily used nuclear facilities and sites	n.a.	400-1,000 billion
Russia	• Implementing START I	10 years	6 billion
	• Overall costs	**10 years**	**8-15 billion**
	• Cleaning and safeguarding nuclear sites and facilities	n.a.	n.a.
Ukraine	• Withdrawal and dismantling of nuclear weapons	10 year	1.5-3 billion
Chemical			
United States	• Dismantling, storing, and burning materials	10-20 years	11-15 billion
	• Environmental clean-up	20 years	15-20 billion
Russia	• Dismantling, storing, and burning materials	20 years	5-15 billion
	• Environmental clean-up	n.a.	10-30 billion
All countries	OPCW-related costs	20 years	1.5-2 billion
Conventional			
All CFE countries	• Dismantling, scrapping of weapons	5 years	1-2 billion
	• Verification	10 years	500 million
Ammunition			
All countries	• Dismantling, scrapping, storage of old ammunition	10-20 years	5-10 billion

[1] Michael Renner, "Cleaning Up After the Arms Race," in Lester R. Brown et al., *State of the World 1994, Worldwatch Institute* (New York and London: W.W. Norton & Co., 1994), pp. 137-155.
[2] Eric Arnett, "The Comprehensive Nuclear Test Ban," in Stockholm International Peace Research Institute (SIPRI), *Yearbook 1995* (Stockholm: SIPRI, 1995), pp. 697-724.
[3] Captain F. G. Leeder, deputy chief of information, Department of the Navy, Office of Information, Washington, D.C., private communication with author, May 6, 1994.
[4] Major Cindy Scott-Johnson, Department of the Air Force, Public Affairs Office, Media Relations Division, Washington, D.C., private communication with author, September 30, 1994, and Edmund L. Andrews, "New Careers for World War Relics," *The New York Times*, April 15, 1994, p. D1.
[5] Institute for Defense and Disarmament Studies (IDDS), *Arms Control Reporter* (Cambridge: IDDS, 1994), and Scott-Johnson, *Ibid.*
[6] Leonid Kostrov, "Guillotine Being Tried Out at Engels. American Satellites Will Track the Dissection of Russian Aircraft From Orbit"; in FBIS-SOV-95-136 (17 July 1995), pp. 14-15.
[7] Alexei Arbatov, ed., "Implications of the START II Treaty for US-Russian Relations," Report No. 9 (Washington, D.C.: Henry L. Stimson Center, 1993).
[8] Jordi Molas-Gallert, "Disposal of Surplus Missiles: Technical Difficulties and Commercial Interest," in Edward J. Laurance and Herbert Wulf, "Coping with Surplus Weapons: A Priority for Conversion Research and Policy" (Bonn: Bonn International Center for Conversion (BICC), June 1995), pp. 23-30.
[9] Jeffrey Lenorovitz, "U.S./Russian Team Bids For ICBM Demilitarization," *Aviation Week & Space Technology*, November 1, 1993, pp. 89-90.
[10] Robert Darst, "Disposal of Liquid Missile Propellants," in Graham Allison *et al.*, eds., "Cooperative Denuclearization: From Pledges to Deeds," CSIA Studies in International Security No. 2 (Cambridge: Harvard University, 1993), pp. 79-86.
[11] William J. Broad, "New Methods Sought to Dispose of Rockets With No Harm to Earth," *The New York Times*, September 17, 1991, p. C4.
[12] Jackson Davis and John M. Van Dyke, "Dumping of Decommissioned Nuclear Submarines at Sea," *Marine Policy* (November 1990).
[13] General Accounting Office (GAO), "Nuclear Submarines: Navy Efforts to Reduce Inactivation Costs," GAO/NSIAD-92-134 (Washington, D.C., GAO, 1992).
[14] *Ibid.*
[15] Samuel Loring Morrison, "US Naval Battle Force Changes: 1 January 1994-31 May 1995," U.S. Naval Institute, Naval Proceedings, Vol. 121/6/1108, p. 47.
[16] Joshua Handler, "No Sleep in the Deep," *The Bulletin of the Atomic Scientists* 49 (April 1993).
[17] Oleg Bukharin and Joshua Handler, "Russian Nuclear-Powered Submarine Decommissioning," *Science & Global Security* 5 (1995), p. 245.
[18] Thomas Nilsen, "The Nuclear Threat From the Russian North Fleet," Bellona Working Paper No. 2 (Oslo: Environmental Foundation Bellona, 1993), p. 84.
[19] Vladimir Maryukha, "Obsolete Nuclear Vessels Leave Us No Choice - Either We Bury Them or They Will Bury Us"; in JPRS-TEN- 94-023 (28 September 1994), p. 32.
[20] Sergei Leskov, "Lies and Incompetence," *The Bulletin of the Atomic Scientists* 49 (June 1993) and Joshua Handler, "Trip Report: Greenpeace Visit to Moscow and Russian Far East, July to November 1992. Subject: Russian Navy Nuclear Submarine Safety, Construction, Defense Conversion, Decommissioning, And Nuclear Waste Disposal Problems," Greenpeace Nuclear Free Seas Campaign (Washington, D.C.: Greenpeace U.S.A., 1993).
[21] Dmitriy Litovkin, "Decommissioned Nuclear Submarines Are Still Awaiting A State Salvage Program. But they Are Already Threatening To Cause a Disaster"; in FBIS-SOV-95-135 (14 July 1995), pp. 31-33.
[22] Office of Technology Assessment, "Dismantling the Bomb and Managing the Nuclear Materials" (Washington, D.C.: Government Printing Office, 1993).
[23] Stephen I. Schwartz, "Atomic Audit: What the U.S. Nuclear Arsenal Really Cost," A Preliminary Report by the U.S. Nuclear Weapons Cost Study Project, Washington, D.C., July 11, 1995.
[24] Robert S. Norris and William M. Arkin, "Nuclear Notebook: Estimated Russian (C.I.S.) Nuclear Stockpile September 1994," *The Bulletin of the Atomic Scientists* 50 (September/October 1994).
[25] IDDS (1994).
[26] IDDS, *Arms Control Reporter* (Cambridge: IDDS, 1993).
[27] IDDS (1994).
[28] William J. Broad, "Experts See Peril for U.S. Pact to Buy Up Russian Bomb Fuel," *The New York Times*, June 12, 1995, p. A1, and "Nuclear Deal With Russia Is Reshaped," *The New York Times*, July 9, 1995, p. 4.
[29] Mark Thompson, "Sapphire's Hot Glow," *Time*, December 5, 1995, pp. 38-39, and Schwartz, pp. 20-21.
[30] William J. Broad, "Quietly, U.S. Converts Uranium Into Fuel for Civilian Reactors," *The New York Times*, June 19, 1995, p. A10.
[31] Matthew L. Wald, "Today's Drama: Twilight of the Nukes," *The New York Times*, July 16, 1995, Week in Review, p. 5.
[32] David Rohde, "Disposal of Warhead Plutonium Awaits Federal Study of Options," *Christian Science Monitor*, June 14, 1994.
[33] Frans Berkhout *et al.*, *Disposition of Separated Plutonium* (Princeton, New Jersey: Center for Energy and Environmental Studies, Princeton University, 1992), and Arjun Makhijani, "Options for Plutonium from Dismantled Nuclear Weapons," *Science for Democratic Action* (Winter 1992).
[34] "Beyond the Bomb: Dismantling Nuclear Weapons and Disposing of their Radioactive Wastes," (Seattle: Nuclear Safety Campaign, 1994).
[35] William J. Broad, "A Plutonium Pact Will Aid Disposal," *The New York Times*, April 6, 1993, p. 11.
[36] *Ibid.*
[37] Matthew L. Wald and Michael R. Gordon, "Russia Treasures Plutonium, But U.S. Wants to Destroy It," *The New York Times*, August 19, 1994, p. A1, A10.
[38] Schwartz.
[39] *Ibid.*
[40] IDDS (1994).
[41] David C. Morrison, "Political Chemistry," *National Journal*, May 14, 1994, p. 1134.
[42] Perry Robinson, Thomas Stock, and Ronald G. Sutherland, "The Chemical Weapons Convention. The Success of Chemical Disarmament Negotiations," in SIPRI, *Yearbook 1993* (Stockholm: SIPRI, 1993), pp. 705-734.
[43] Office of Technology Assessment, "Disposal of Chemical Weapons: Alternative Technologies," Background Paper (Washington, D.C.: Government Printing Office, 1992).
[44] Thomas Stock and Anna De Geer, "Chemical Weapons Developments," in SIPRI, *Yearbook 1994* (Stockholm: SIPRI, 1994), pp. 315-342, and Mickey Morales, Department of the Army, Chemical Material Destruction Agency, Public Affairs Office, Aberdeen Proving Ground, Maryland, private communication with author, July 25, 1995.
[45] Morales, *Ibid.*
[46] U.S. Army, *Survey and Analysis Report* (Aberdeen Proving Ground, Maryland: Chemical Material Destruction Agency, Non-Stockpile Chemical Material Program, 1993).
[47] Stock and De Geer.
[48] FBIS-SOV-95-208 (26 October 1995)(on-line).
[49] *Ibid.*
[50] Sergei Kiselev, Deputy Head of the Delegation of the Russian Federation to the Preparatory Commission for the Organization for the Prohibition of Chemical Weapons, Embassy of the Russian Federation in The Hague, Netherlands, private communication with author, July 10, 1994.
[51] Thomas Stock and Anna de Geer, "Chemical and Biological Weapons: Developments and Destruction," in SIPRI, *Yearbook 1995* (Stockholm: SIPRI, 1995), pp. 337-357.
[52] FBIS-SOV-95-208 (26 October 1995)(on-line).
[53] Sergei B. Batsanov, Director for External Relations, Preparatory Commission for the Organization for the Prohibition of Chemical Weapons, Provisional Technical Secretariat, The Hague, Netherlands, private communication with author, April 7, 1994.
[54] Frances Williams, "Hopes High for International Chemical Weapons Treaty," *Financial Times*, August 26, 1992.
[55] *International Security Digest* 2 (April 1995).
[56] IDDS (1991, 1992).
[57] Z. Lachowski, "Conventional Arms Control and Security Dialogue in Europe," in SIPRI, *Yearbook 1995* (Stockholm: SIPRI, 1995), pp. 761-790.
[58] Michael Renner, "Budgeting for Disarmament: The Costs of War and Peace," Worldwatch Paper

122 (Washington, D.C.: Worldwatch Institute, 1994).
[59] Arthur Volmerig, "Die materielle Hinterlassenschaft der NVA," *Wehrtechnik Spezial* (May 1993).
[60] Bundeshaushalsplan 1991-1994, Einzelplan 14, Geschäftsbereich des Bundesministeriums der Verteidigung, Bonn, Germany.
[61] General Accounting Office (GAO), "Conventional Arms Control: Former Warsaw Pact Nations' Treaty Compliance and U.S. Cost Control," GAO/NSIAD-94-33 (Washington, D.C.: GAO, 1993).
[62] *Ibid.*
[63] Associated Press, "Russia Unable to Scrap Weapons," November 21, 1995 (as posted on CompuServ Electronic Forum "AP Online").
[64] For estimates, see Susanne Kopte, and Peter Wilke, "Surplus Weapons," in Bonn International Conversion Center (BICC), *Yearbook 1995/1996* (Bonn: BICC, 1996 (forthcoming)).
[65] *Ibid.*
[66] Agence France Press, "Russian Ships to South Korea for Scrap," April 7, 1995 (on-line).
[67] Matthew Kaminski, "US-Ukraine Venture to Recycle Munitions," *Financial Times*, January 20, 1995.
[68] Lenny Siegel, "EPA Circulates Draft Munitions Rule" (posted on the APC electronic conference bulletin board at "igc:cpro.military" on July 21, 1995).
[69] Otfried Nassauer, "An Army Surplus - The NVA's Heritage," in BICC, ed., "Coping With Surplus Weapons: Priority for Conversion Research and Policy," BICC Brief 3 (Bonn: BICC, 1995), pp. 37-67
[70] "Dumping of Arms at Sea Accelerated as January 1993 Restrictions Draw Near," *International Environment Reporter*, September 23, 1992, p. 597.
[71] "Army Looks for Ways to Reuse, Recycle Munitions," U.S. Army, *Environmental Update* 5 (A Quarterly Publication of Army Environmental News)(October 1993), p. 7.
[72] Nassauer.
[73] Michael Sirak, "The Problem of NVA Surplus Munitions," unpublished graduate student seminar paper, Monterey Institute of International Studies, 1995, p. 15.
[74] Eric Schmitt, "Selling the Shreds of War," *The New York Times*, July 28, 1993, p. D1.
[75] *Estimating the Cold War Mortgage. The 1995 Baseline Environmental Management Report*, Volumes I and II and Executive Summary (Washington, D.C.: U.S. Department of Energy, March 1995).
[76] Alexei Yablokov, Russian Federation National Security Council, Interagency Commission on Ecological Security, private communication with author, Moscow, August 1, 1994.
[77] Paul George *et al.*, "World Military Expenditure," in SIPRI, *Yearbook 1995* (Stockholm: SIPRI, 1995), p. 404
[78] Michael Renner, "Military Mop-Up," *World Watch* (September/October 1994), p. 27.
[79] Database on Worldwide Expenditures for Disarmament,Conversion, Peacekeeping, and Post-Conflict Peacebuilding, Worldwatch Institute, Washington, D.C., and New York, 1995.
[80] Michael Renner, "Budgeting for Disarmament: The Costs of War and Peace," Worldwatch Paper No. 122 (Washington, D.C.: Worldwatch Institute, 1994).