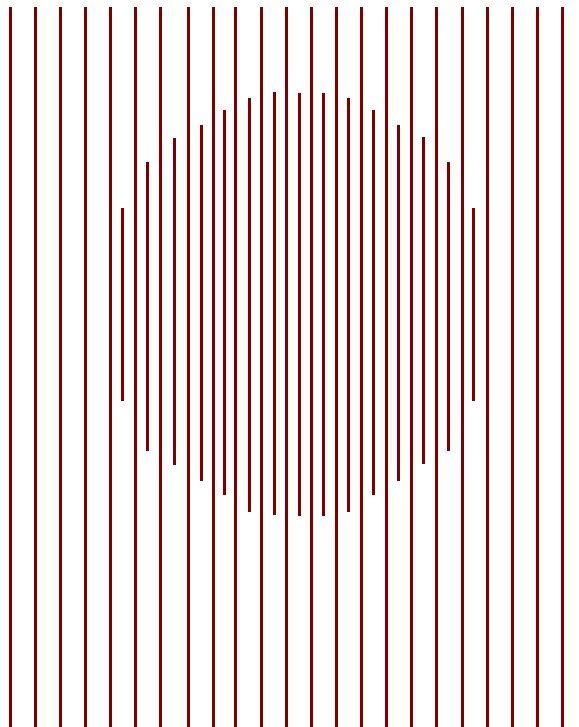


CBO PAPERS

ALTERNATIVES FOR THE U.S. TANK INDUSTRIAL BASE

February 1993



CONGRESSIONAL BUDGET OFFICE

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THE U.S. TANK
INDUSTRIAL BASE**

February 1993



**CONGRESSIONAL BUDGET OFFICE
SECOND AND D STREETS, S.W.
WASHINGTON, D.C. 20515**

NOTES

All costs are expressed in 1993 dollars of budget authority.

All years, unless otherwise noted, are fiscal years.

Numbers in tables may not add to totals because of rounding.

PREFACE

The U.S. military has no plans to purchase new tanks after 1992. Without U.S. sales, tank production in this country might cease, leaving in question the ability of U.S. tank manufacturers to produce tanks should they be needed during a crisis. This paper, prepared at the request of the House Committee on Armed Services, explores various options for maintaining the U.S. tank industrial base. The options differ widely in terms of their cost and the insurance they provide against an unforeseen need for new U.S. tanks. This information may be useful to the Congress as it debates the fate of the defense industrial base in this time of fiscal constraint. In keeping with the Congressional Budget Office's (CBO's) mandate to provide objective analysis, the paper makes no recommendations.

Frances M. Lussier prepared this paper under the general supervision of Robert F. Hale and R. William Thomas. William P. Meyers of CBO's Budget Analysis Division provided cost analyses. The author wishes to thank Wayne Glass for his assistance, as well as Sherry Snyder, who edited the report, and Cynthia Cleveland, who prepared it for publication.

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Director

February 1993

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SUMMARY

The shrinking of the U.S. military, coupled with the disappearance of a long-time foe and the unprecedented peacetime investment in modern weapons that occurred in the 1980s, has led to sharp reductions in the planned purchases of military weapons. In particular, the Bush Administration did not plan to buy any new tanks for U.S. forces for the next 15 or more years. Without U.S. purchases, the U.S. industrial base dedicated to producing tanks could close and would eventually atrophy.

The tank industrial base in this country involves facilities operated by several major contractors that are supported by some 18,000 subcontractors and suppliers. Some skills and machines used in producing tanks would not be maintained in the absence of ongoing tank production and could not be regained quickly if lost as a result of disuse. Uncertainty about future requirements, together with the delays associated with reassembling the skilled workers and lines needed to produce tanks, may argue for maintaining some U.S. capacity to produce tanks even if no new tanks are needed now. Maintaining such capacity by keeping the tank line open, however, would cost a minimum of \$250 million annually after 1995 and could cost up to three times more.

The Congressional Budget Office (CBO) examined three ways of preserving some or all of the components of the tank industrial base. The first would retain no active components but would preserve the plants and lines that are used exclusively to produce tanks or tank parts. The second alternative represents the other extreme and would keep the entire industrial base active by producing a small number of new tanks each year. The last alternative would keep most of the base active by upgrading older models of the Abrams M1 tank to the latest and most capable model, the M1A2. These options would all add roughly the same amount of capability to the U.S. tank fleet, but they vary greatly in cost and in the amount of insurance they would provide against an unforeseen need for new tanks sometime in the future. They would also differ greatly in the amount of employment they would provide in the defense sector, but CBO did not analyze this aspect of the issue.

Alternative I: Lay Away the Tank Industrial Base

With no further purchases of new tanks, one alternative would be to lay away and preserve the physical portions of the tank industrial base after all orders for tanks have been filled. Taking into account the Bush Administration's plan submitted in February 1992, Congressional action on the fiscal year 1993 budget, and current orders, this layaway process could begin in 1994 and could

be completed in 1997 with the shutdown of the assembly line. Additional foreign military sales could, however, delay the final layaway.

This plan, espoused by the Bush Administration as recently as April 1992, is consistent with the Army's lack of a requirement for new tanks. In 1995, the Army's inventory of 7,780 Abrams tanks will be sufficient to equip all Army units that the Bush Administration planned to field, to provide war reserves and prepositioned stocks, and to meet other support needs.

This required inventory of roughly 8,000 tanks would be more capable than almost any other tank fleet in the world in 1995, except that which Russia could field throughout its vast reaches. Based on a scoring system that reflects both the quantity and quality of a country's weapons, the Abrams tank fleet would be 12 times more capable than the total tank forces fielded by postwar Iraq, North Korea, or Libya. The Abrams fleet would also be five times more capable than the very large tank forces of China. Taken as a whole, the Russian fleet would be twice as capable as the U.S. Abrams fleet. When considered separately, however, the widely separated European and Asian Russian fleets would be much less formidable. The Abrams fleet would be almost 60 percent more capable than the relatively modern Russian tank fleet stationed in Europe and about two-thirds as capable as Russia's less sophisticated but larger tank fleet dispersed throughout its Asian region.

The Abrams tank fleet envisioned for 1995 will not only be very capable but also relatively young; the oldest Abrams tank will be only 15 years old. Given that the useful service life of a tank is typically assumed to be 30 years, the United States should not need to produce new tanks to replace aging vehicles until 2010 or later, again confirming the Bush Administration's plan to buy no new tanks for at least 15 years.

Laying away the tank line would be the least costly alternative examined in this paper, requiring a total of \$340 million for the five years from 1994 through 1998 (see Summary Table 1). (All costs in this paper are expressed in 1993 dollars of budget authority.) These funds would be used to preserve the physical portions of the tank industrial base--the plants, machines, and assembly lines--and for personnel costs associated with ceasing production of tanks. Thereafter, maintaining facilities in mothballed status and providing security would cost about \$40 million a year. The Army estimates that a line that has been laid away for more than two years would take about 72 months and \$1.1 billion to start producing tanks again at surge rates (defined as 120 tanks a month). Moreover, based on historical evidence, the first vehicles off a restarted tank line might not be of high quality.

Although the time required to produce significant numbers of tanks from a line that has been laid away far exceeds the length of any likely contingency operation, that would also be true for the other two alternatives. Unlike the other alternatives, however, the very long period of six years required to reach surge rates from a laid-away base could be of concern if a major new threat to U.S. security emerges, particularly if there is a significant delay before this country recognizes the threat's existence and responds to it.

Of more concern, perhaps, is the immediate loss of the ability to build or modernize tanks in this time of global uncertainty. In the aftermath of a highly armored confrontation in the Persian Gulf War and the breakup of a

SUMMARY TABLE 1. COSTS OF ALTERNATIVES FOR
PRESERVING THE TANK INDUSTRIAL BASE
(In millions of 1993 dollars)

	Cost, 1994-1998 ^a	Annual Cost After 1998 ^b	Cost to Reach Surge Capacity ^c	
			Time (Months)	Funds
Alternative I: Lay Away Tank Line	340	40	72	1,110
Alternative II: Produce at Low Rate	3,830 ^d	740 ^d	47	600
Alternative III: Convert Older Models	2,210 ^{d, e}	650 ^{d, f}	56	530

SOURCE: Congressional Budget Office based on Army data.

- a. Does not include \$15 million to lay away the assembly line at the Detroit Arsenal Tank Plant.
- b. Assuming the program continues indefinitely.
- c. Surge capacity is 120 tanks per month and would require two assembly lines operating on multiple shifts.
- d. Assumes additional production of 120 tanks per year to fill orders from foreign governments.
- e. The proposed budget revisions submitted by then Secretary of Defense Dick Cheney in January 1993 include an estimate of \$720 million as a minimum sustaining level.
- f. According to the proposed budget revisions submitted in January 1993, a minimum annual investment of \$250 million would sustain the program, but would convert only 60 tanks per year rather than the 198 funded in the alternative.

45-year empire in Eastern Europe, this may not be an auspicious time for the United States to be without the capability to produce tanks. Continuing to maintain the tank industrial base, at least until the new world order becomes more certain, might be a sound insurance policy.

Alternative II: Maintain Production, but at a Low Rate

To reduce both the risk of losing the ability to make tanks in the near term and the time needed to start producing tanks in large numbers at some time in the future, should they be needed, the United States could keep the entire industrial base active by producing new tanks at a low rate of 10 per month. Maintaining production at a low rate would ensure that workers trained in each of the skills critical to building tanks would be available at all times, though not necessarily in large numbers. Keeping the base warm would appreciably shorten the time needed to start producing new tanks at surge rates, from as much as 72 months from layaway to 47 months from low-rate production. Contractors would need this time to hire and train the additional personnel required to operate two assembly lines on multiple shifts. Although 47 months would still be longer than the duration of the most probable future contingencies, the shorter response time could be significant if a major new threat emerges that would require an increase in the size of the Abrams tank fleet.

This alternative would also provide the Army with 120 additional new tanks every year--tanks that the Army does not need to support the force planned for 1995. Because they would be a more recent and capable version, newly produced tanks could replace some of the older Abrams tanks in the inventory. The overall improvement in capability resulting from new tanks delivered to the Army by the year 2000 would be small, however--on the order of 2 percent.

The major disadvantage of this alternative is its high cost, which could total \$3.8 billion from 1994 through 1998--more than 10 times the cost of laying away the line (see Summary Table 2). In 1998 and thereafter, annual costs to produce 120 tanks each year would be more than \$700 million, compared with \$40 million for the previous alternative.

Alternative III: Convert Older Abrams Tanks to Newer Models

As a compromise between producing tanks at a low rate and laying away the tank industrial base, the United States could convert older and less capable models of the Abrams tank to the newest, most sophisticated configuration.

This latest model, designated the M1A2, has a bigger, more powerful cannon than the Abrams tanks produced in the early 1980s, as well as better armor protection, digital electronics, better electro-optics, and a system for preventing harmful nuclear, biological, or chemical contaminants from reaching the crew. Converting an original M1 to an M1A2 involves taking the tank almost totally apart and replacing all of the major components except for the engine and transmission. Thus, conversion would involve all parts of the industrial base except those that produce engines and transmissions. The Army currently plans to fund a program to upgrade 210 M1 tanks from 1993 through 1995. The converted M1A2 tanks, in addition to new M1A2 tanks already purchased, would equip one division in the Army's contingency force, which would fight in regional wars such as Operation Desert Storm. To equip the entire contingency force, the Army would need to upgrade a total of 1,002

**SUMMARY TABLE 2. ANNUAL COSTS THROUGH 1998
FOR VARIOUS ALTERNATIVES
(In millions of 1993 dollars)**

	1994	1995	1996	1997	1998	Five- Year Total
Alternative I:						
Lay Away Tank Line	50	30	140	80	40	340
Alternative II:						
Produce at Low Rate ^a	780	800	760	740	750	3,830
Alternative III:						
Convert Older Models						
Phase I	80	130	0	0	0	210
Phase II ^{a, b}	0	150	550	650	650	2,000

SOURCE: Congressional Budget Office based on Army data and Congressional action on the 1993 budget request.

NOTE: Costs do not include about \$15 million to lay away the assembly line at the Detroit Arsenal Tank Plant.

a. Assumes annual sales to foreign militaries of 120 tanks.

b. According to then Secretary of Defense Dick Cheney's proposed budget revisions submitted in January 1993, a minimum annual investment of \$250 million would sustain the program after 1995, but at 60 conversions per year rather than the 198 conversions funded in the alternative.

M1 tanks. Although the Army would like to convert an additional 792 tanks to the M1A2 configuration, it is not yet sure how it will structure or fund such a program.

However it is structured, a conversion program would avoid producing new tanks that would only be surplus to those the Army needs to support the forces proposed for 1995. By improving older models, a program that upgraded a total of 1,002 tanks in the next seven years would increase the capability of the entire required tank fleet by 3 percent by the year 2000, and that of the contingency force by 10 percent. The conversion process could also eventually lead to an Army inventory with fewer models of the Abrams tank, which should reduce operating costs. Perhaps most important, however, maintaining the unique components of the industrial base would provide some insurance in this time of uncertainty.

By other measures, this approach lies between the previous two. About 56 months would be needed to start producing new tanks at surge rates from a line dedicated to conversion. This period falls between the delays associated with the other two options and is sufficiently long so that large numbers of additional new tanks would not be available for short-notice contingencies. The costs would also fall between those of the previous two options. In 1994 and 1995, the Army plans to spend at least \$220 million on conversion, three times the cost of layaway but about one-seventh the cost of low-rate production. Beyond 1995, costs would still fall between those of the other two options, but the level of funding would depend on how the conversion program is structured. Under the Army's plan as of fall 1992, annual costs might total \$650 million, which would sustain the tank line and convert 198 tanks a year to the M1A2 configuration. Under the budget revisions submitted by then Secretary of Defense Dick Cheney in January 1993, conversion costs might amount to as little as \$250 million a year beyond 1995. This lower funding would sustain the tank line (assuming foreign sales of 120 tanks a year), but the Army has indicated informally that it is not clear how many tanks could be converted.

Should the United States Maintain Its Tank Industrial Base?

The Congress has directed that funds appropriated for fiscal year 1992 be used in 1993 to convert older tanks to newer models. The question it must now address is whether the conversion program should continue and, if so, at what pace and for how long.

If the overriding criterion is to limit costs, then the option to lay away the tank base should be pursued instead. In the next two years, 1994 and

1995, conversion would cost more than twice as much as layaway. Subsequently, depending on the pace of conversion, upgrading tanks could cost from as little as two to more than 10 times as much as layaway (see Summary Table 2). If the conversion program continues at a high pace after 1995, the United States could spend more in two years to convert tanks than it would to reactivate the base and attain a surge rate of production.

Closing down and laying away the tank line, especially during the next two years, involves risks that a program that sustains the tank base would avoid. Inability to respond to an unforeseen threat to U.S. security is one such risk. Russia could again become a highly militarized society, but that seems unlikely. The emergence of a developing nation equipped with sophisticated tanks obtained on the global arms market is perhaps a more likely scenario. U.S. responses to such threats could require additional tanks or upgraded versions of the Abrams tank in order to ensure that U.S. forces retain their superiority.

The time and effort needed to resurrect a tank line that has been laid away are also uncertain. If restarting production takes longer than is currently estimated, the risk of failure to meet an unanticipated threat is greater. Risks also increase if the ability of a reopened line to produce quality tanks has been overestimated. The risks associated with restarting the line may be greater than currently estimated because the planned shutdown is likely to be at least 15 years, a rather long time. A conversion program, or one that maintains low-rate production, would ensure the availability of quality components as long as it continued. Programs that maintained most of the base in active status might avoid the problems of quality associated with producing tanks from a restarted production line that had been long idle. Even if these programs were continued for only a few years, they would also provide additional time to study the issues related to closing down the tank line completely.

In conclusion, reducing risks by maintaining most of the tank base after 1995 through a conversion program could cost between \$250 million and \$650 million a year. The costs would represent a small fraction of the Army's total budget and would provide some insurance against unforeseen threats and risks. Such insurance might be worth buying for a few years until the trends in the former Soviet Union and other parts of the world become clearer. In the years to come, however, the risks incurred by ending support for the tank industrial base should continue to be weighed against the substantial cost of maintaining it.

INTRODUCTION AND BACKGROUND

During the 1980s, the Army embarked on an ambitious modernization program, purchasing--among many other things--more than 7,000 new tanks, more than 5,500 new fighting vehicles, 728 new attack helicopters, and 478 new multiple rocket launchers for a total cost of almost \$45 billion. These new lethal and sophisticated weapon systems were originally designed to counter the massive military presence of the Warsaw Pact in Europe. With the dissolution of that threat and, indeed, of the Soviet Union itself, the Army has little need for more expensive and sophisticated modern weapons. The Army will soon have considerably more tanks than it needs to equip its planned forces. Reflecting this excess, the Bush Administration's plan, as submitted in February 1992, included no funds to buy new tanks after 1992. At the Congress's direction, the Army will modify older Abrams tanks to a more capable configuration in fiscal year 1993. The future of the tank program after 1993, however, is undecided.

Although the lack of need for an active tank line may be welcome news in an age of constrained military budgets, it also causes concern about the possibility that the United States could, in the near future, be unable to produce tanks. This inability may be particularly troubling in a world that recently witnessed a major war in the Persian Gulf that featured the use of tanks and other armored vehicles. Questions have been raised regarding the continued ability of the United States to produce modern tanks in response to changing world conditions, should an unforeseen threat emerge. In response to these concerns, members of industry and the Congress have suggested options for maintaining all or part of the tank industrial base.

This paper describes the U.S. industrial base for producing tanks, outlines the tank requirements of the U.S. Army, and then presents and examines options for preserving the tank industrial base in either an active or a stored mode.

The Tank Industrial Base

The tank industrial base in the United States is an extensive network of facilities that contribute to the manufacture of the finished tank. The current base includes major corporations on contract to the government, known as prime contractors; government facilities, including Army arsenals and Department of Energy (DOE) plants; and companies, known as subcontractors, that have been engaged to supply parts and materials to the prime contractors. Table 1 lists the major facilities that the Army includes in its definition of the tank industrial base. Since 1987, the sole product of the U.S. tank base has been the Abrams tank--the Army's newest and most sophisticated tank.

TABLE 1. OVERVIEW OF THE U.S. TANK INDUSTRIAL BASE

Company or Facility	Location	Product
Contractors to the U.S. Government		
<i>Private Corporations</i>		
General Dynamics, Land Systems Division (GDLS)		
Lima Army Tank Plant ^a	Lima, Ohio	Tank, hull, turret
Scranton Plant	Scranton, Pennsylvania	Castings
Sterling Plant	Sterling Hgts., Michigan	Electric components
Central Office Complex	Sterling Hgts., Michigan	Management
Detroit Arsenal Tank Plant ^a	Warren, Michigan	Components
Textron Lycoming ^a	Stratford, Connecticut	Engine
Allison Transmission Division	Indianapolis, Indiana	Transmission
Hughes Aircraft Corporation	Culver City, California	Laser range finder, thermal sight
Computing Devices of Canada	Nepean, Ontario	Ballistics computer
FMC Corporation	Alabama	Track
Stanley Illinois	Final drive	
Urdan Israel	Road wheels	
<i>Government Facilities</i>		
Department of Energy	Idaho Falls, Idaho	Special armor
Rock Island Arsenal	Rock Island, Illinois	Gun mount
Watervliet Arsenal	Watervliet, New York	Cannon
Subcontractors		
Cadillac Gage	Detroit, Michigan	Stabilizationsystem
Rockwell International	Kansas	Race ring support
Garret AiResearch	Torrance, California	NBC protection system

SOURCE: Congressional Budget Office based on Army data.

NOTE: NBC = nuclear, biological, chemical.

a. Government-owned, contractor-operated facility.

The major contractor for the Abrams tank is General Dynamics, Land Systems Division (GDLS). As operator of the government-owned tank plants at Lima, Ohio, and Warren, Michigan, it is responsible for delivering finished tanks to the Department of the Army.¹ In addition, several other firms have contracts with the Army to produce major components such as engines or transmissions, which the Army then turns over to GDLS for incorporation into the finished tank. Some producers in this category are private companies such as Textron Lycoming, which supplies the tank engines. Others are Army installations such as Rock Island Arsenal, which provides the gun mounts, and Watervliet Arsenal, which makes the cannons. The facility that manufactures armor inserts out of depleted uranium is operated by DOE. Most of these facilities also produce other items or perform other services. A few, the DOE armor facility being one example, are supported solely by work related to tank production.

A final part of the industrial base is composed of subcontractors who work under contract to firms with contracts with the Army. This group forms the most numerous portion of the industrial base, although it may not employ the most people or do the largest volume of business. It comprises about 18,000 firms, large and small, that provide all kinds of components that go into the making of a tank, including ball bearings and electronic components as well as large cast pieces. In general, these companies are not supported solely by producing parts for tanks. Some units within these companies, however, may specialize in producing tank parts, and those units might close if tank production ceases.

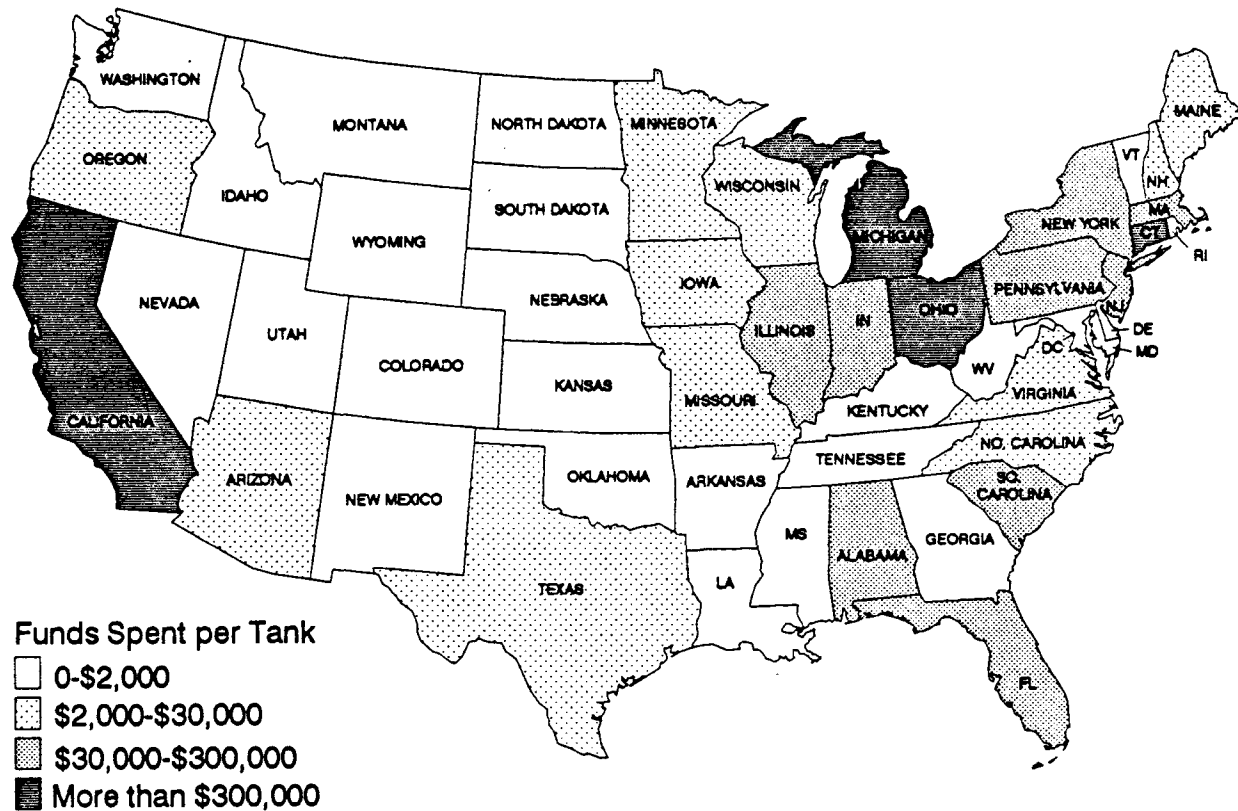
The industrial base that supports tank production is extensive and widespread, involving many facilities located in many parts of the country. Major facilities in the tank industrial base are spread over 24 states and Canada (see Figure 1). Facilities located in Michigan, Connecticut, Ohio, Indiana, and California receive the largest shares of production funding, but other states also derive significant revenue from tank work done within their borders (see Table 2).

The Army's Tank Requirements

To fully support its fighting forces, the Army needs many tanks in addition to those that equip its armored units. The Army must provide tanks for the Armor School to train tank crews, it must have sufficient spare tanks on hand to replace those that need repair, and it must maintain reserve stocks to be

1. The tank plant at Warren, Michigan, is also known as the Detroit Arsenal Tank Plant.

FIGURE 1. DISTRIBUTION OF M1A1 PRODUCTION FUNDS



SOURCE: Congressional Budget Office based on U.S. Army, "Tank Industrial Base Briefing" (February 20, 1992).

TABLE 2. FUNDS SPENT PER M1A1 TANK IN VARIOUS STATES

State or Region	Funds Spent per M1A1 Tank	
	Thousands of Dollars	As a Percent- age of Total
Michigan	561	18
Connecticut	550	18
Ohio	419	14
Indiana	392	13
California	314	10
New York	142	5
Pennsylvania	128	4
Illinois	93	3
South Carolina	83	3
New Jersey	58	2
Alabama	57	2
Canada	50	2
Massachusetts	45	1
Florida	34	1
North Carolina	23	a
Maine	16	a
Texas	16	a
Virginia	12	a
Oregon	12	a
Missouri	8	a
Iowa	4	a
Minnesota	4	a
Arizona	4	a
New Hampshire	2	a
Wisconsin	2	a
Remaining States	<u>68</u>	<u>2</u>
Total	3,097	100

SOURCE: Congressional Budget Office based on U.S. Army, "Tank Industrial Base Briefing" (February 20, 1992).

a. Less than 1 percent.

used in the event of war. Finally, the Army maintains extra sets of tanks overseas, primarily in Europe, that would be available for immediate use by combat units stationed in the United States. These additional requirements approximately double the number of tanks that the Army needs solely to equip its armored units in order to support its forces fully.²

Current Inventory. The U.S. Army now has almost 16,000 tanks of all types, about double the size of its tank fleet in 1974 (see Figure 2). This increase in the number of tanks was not necessitated by any increase in the size of the Army's armored forces. Rather, the Army needed the increased inventory primarily because the United States decided to preposition several divisions' worth of tanks in Europe, a policy designed to speed the deployment of U.S. forces in the event of a major war. Additional tanks were also needed to provide war reserves that were stored in Europe and would be used to replace tanks lost in combat.

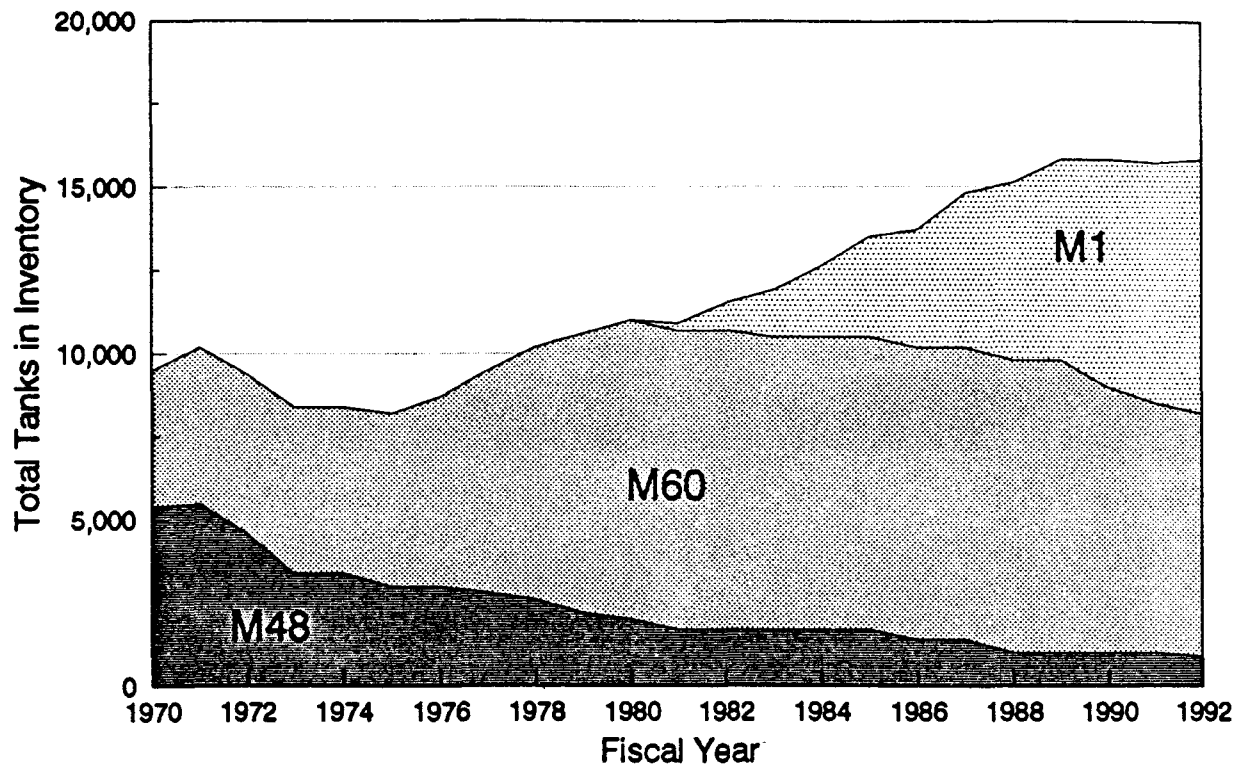
In addition to expanding its tank inventory during the last 20 years, the Army was purchasing better tanks--specifically, the Abrams, regarded by many as the best tank in the world.³ The Army's procurement of the Abrams, which started in 1979, ended in 1992. The Army's current inventory includes about 7,700 Abrams tanks, the oldest of which is 13 years old. The Army also has many older and less capable tanks, including about 7,300 M60 tanks that range in age from 10 to 27 years old, and slightly less than 900 M48s that are over 30 years old and obsolete (see Table 3).

Smaller Inventory Needed for 1995 and Thereafter. The Army estimates that it will have 7,780 Abrams tanks in its inventory in 1995. The Congressional Budget Office calculates that this number of tanks will suffice to equip the force proposed by the Bush Administration for 1995. Reflecting changed circumstances in the world, the Bush Administration proposed reducing the size of the Army so that by 1995 it would be about 30 percent smaller than it was in 1990. As a consequence, the number of tanks needed to equip the Army would also be reduced. CBO's analysis assumed current levels for equipping forces, and proportional requirements--based on current levels--for tanks needed for training, spares, and war reserves. Based on the Bush Administration's plans, CBO also assumed the need for 2 $\frac{2}{3}$ divisions' worth of prepositioned stocks. Using these assumptions, CBO calculated that the Army's need for tanks will decrease from approximately 11,100 to support

2. This estimate does not include tanks needed by the Marine Corps, which are not addressed in this paper.

3. In his testimony before the Senate Committee on Armed Services, General Colin Powell, the Chairman of the Joint Chiefs of Staff, stated that the Army's M1A1 tank is unmatched in the world.

FIGURE 2. U.S. ARMY TOTAL TANK INVENTORY



SOURCE: Congressional Budget Office based on John M. Collins, *U.S.-Soviet Military Balance: Concepts and Capabilities, 1960-1980* (New York: McGraw-Hill Publications, 1980); International Institute for Strategic Studies, *The Military Balance* (London: Brassey's, various editions); and Army data.

28 divisions in 1990, to about 9,600 for the current force. By 1995, the Army would need fewer than 8,000 tanks to support the 20 divisions that it plans to retain in its force structure, which includes 12 active, six reserve, and two cadre divisions.

Although the Army has not announced a formal plan regarding disposition of its excess tanks, a number of actions could be taken. Some older vehicles, particularly the M48s, could be scrapped or used for target practice. Of the 4,900 tanks currently stationed in Europe, almost 900 must be destroyed, transferred, or sold to allies within the North Atlantic Treaty Organization. Excess tanks stationed in the United States or Korea could be sold or given to non-European allies, and some of the excess vehicles could be retained as additional war reserves. Depending on the Army's approach, the total inventory of tanks in 1995 will probably exceed the minimum number needed to equip and support the planned forces. Nevertheless, the remaining analysis in this paper focuses on only those tanks needed to meet U.S. force requirements in 1995 and beyond.

The fleet of tanks required by 1995 could be composed entirely of Abrams tanks and be more capable, more sophisticated, and only slightly older than today's fleet. The fleet will be an average of 7.9 years old, compared with 7.4 years today (see Table 3). The required inventory in 1995 also will be more capable on a tank-for-tank basis than today's inventory.

TABLE 3. THE U.S. ARMY TANK FLEET

	Number of Tanks				Age (Years)			Capability ^a	
	M48	M60	M1	Total	Young- est	Old- est	Aver- age	Total	Aver- age
Total Inventory									
1993	896	7,311	7,660	15,867	0	32	12.9	71,000	4.4
Required Inventory									
1993	0	1,940	7,660	9,600	0	14	7.4	50,800	5.3
1995	0	0	7,780	7,780	2	15	7.9	44,600	5.7

SOURCE: Congressional Budget Office based on Army data and on The Analytic Sciences Corporation, *The TASCFORM Methodology: A Technique for Assessing Comparative Force Modernization*, 4th ed., rev. (Arlington, Va.: TASC, July 1991).

a. Based on TASCFORM scores.

This conclusion is based on a quantitative measure of each tank's capability developed by The Analytic Sciences Corporation using a method called TASCFORM.⁴ This method assigns scores to types of weapons--the M48, M60, and M1 tanks, for example--based on characteristics such as their firing range, type of armor, and fire control apparatus. Thus, an Abrams tank, which has a longer firing range and a more sophisticated fire control system than the M60 tank, would have a higher score than the M60. Tanks in the required inventory in 1995 will have an average TASCFORM score of 5.7, compared with an average score of 5.3 for tanks in today's required inventory (see Table 3).

Comparison with Tank Fleets from Other Countries. Even though the U.S. tank inventory may be shrinking during the next three years, it will still be more capable than the inventories of most other countries (see Figure 3). This advantage stems in part from the fact that each tank in the U.S. inventory will be highly capable, but also from the significant changes that are expected in the tank inventories of other countries. Just as the United States must reduce its European tank holdings to comply with the Conventional Forces in Europe (CFE) Treaty, so too must other European countries. Thus, for example, the size of Ukraine's and Russia's tank holdings in Europe will decrease significantly by 1995. And Germany will have to dispose of most of the equipment it inherited from the East German army.

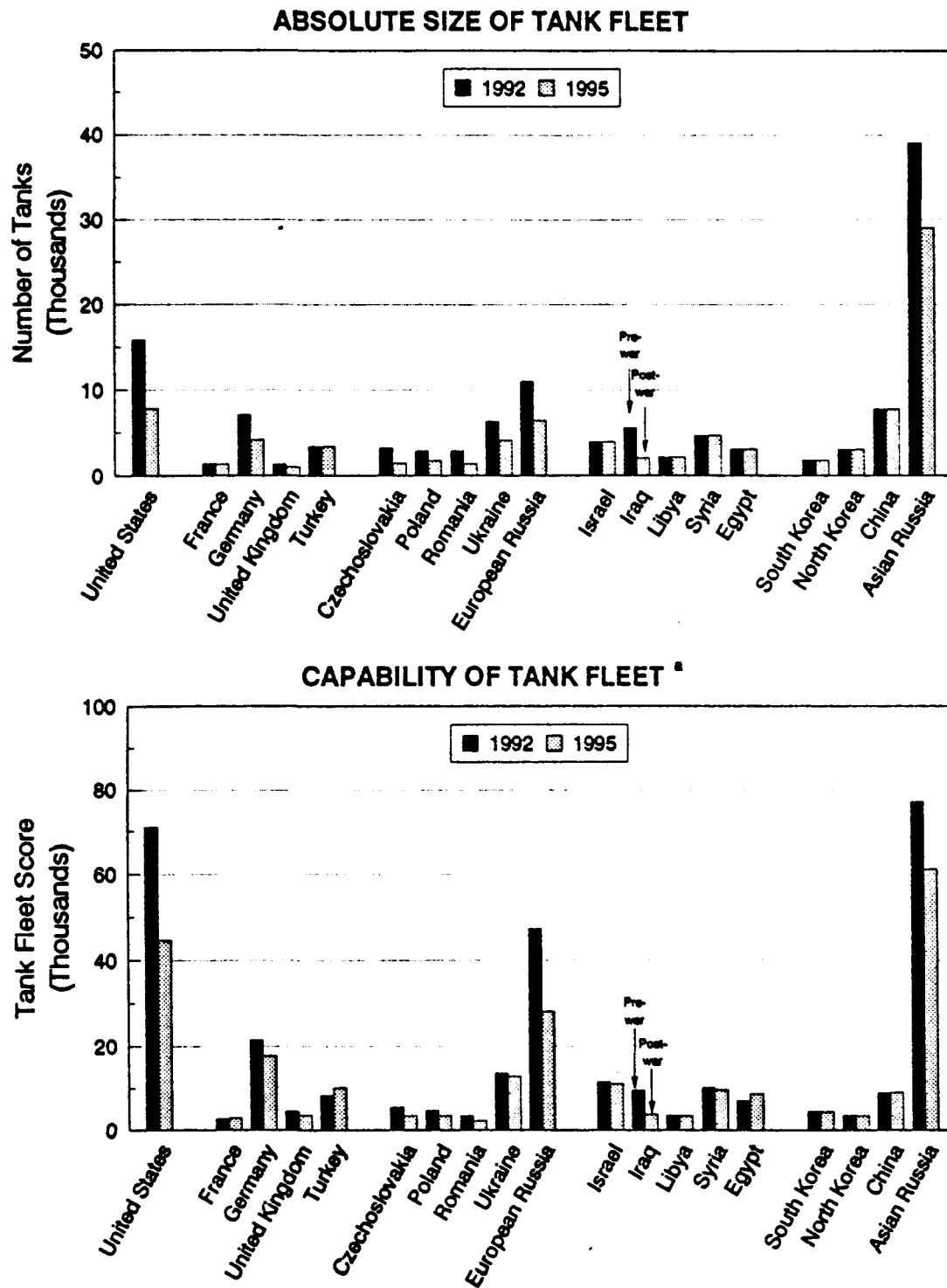
Based on sheer numbers and discounting the obvious advantage in technology held by the Abrams tank, the U.S. tank fleet should dominate most others in 1995. The United States' 7,780 tanks would roughly equal China's inventory and would be two to four times larger than the inventories of postwar Iraq, Libya, and North Korea.

The total capability of the U.S. required inventory in 1995--based on the TASCFORM methodology--would be about one-third less than today's total fleet because of the reduced number of tanks. Nevertheless, except for the Russian fleet, the U.S. fleet would still be preeminent in the world. The U.S. fleet would be five times more capable than China's and up to 12 times more capable than the tank forces of postwar Iraq, Libya, or North Korea.

Russia will be the only country to possess a tank fleet that will be larger and more capable than the U.S. Abrams fleet. In 1995, Russia could have 35,000 tanks, whose combined capability would be twice that of the U.S. fleet. This fleet will be dispersed over the entire Russian expanse, however, which stretches more than 5,000 miles from the Baltic countries to Siberia.

4. The Analytic Sciences Corporation, *The TASCFORM Methodology: A Technique for Assessing Comparative Force Modernization*, 4th ed., rev. (Arlington, Va.: TASC, July 1991).

FIGURE 3. COMPARISON OF VARIOUS TANK FLEETS



SOURCE: Congressional Budget Office based on data from the International Institute for Strategic Studies, *The Military Balance, 1992-1993* (London: Brassey's, Autumn 1992); The Analytic Sciences Corporation, *The TASCFORM Methodology: A Technique for Assessing Comparative Force Modernization*, 4th ed., rev. (Arlington, Va.: TASC, July 1991); and Army data.

a. Based on TASCFORM scores.

Furthermore, the country is divided geographically by the Ural Mountains, with the region east of the Urals considered Asia and that to the west considered Europe and subject to constraints of the CFE treaty. Transporting tanks from one end of the country to the other would require great effort, and forces stationed in Asia have generally been considered unavailable for use in conflicts in Europe and vice versa.

When considered separately, the two Russian fleets appear less formidable. Indeed, by 1995, the U.S. Abrams fleet will exceed the European Russian fleet by more than 20 percent in sheer numbers, and by even more--about 60 percent--in capability. Compared with the Asian fleet, which is composed of older and less capable tanks, the U.S. Abrams fleet will be outnumbered by a factor of almost four but will be at less than a 40 percent disadvantage in capability.

The U.S. Army therefore does not have an immediate need for new tanks. It can equip and support the planned forces with Abrams tanks that have already been purchased. Furthermore, the Abrams fleet is composed of new tanks; the oldest will be just 30 years old in 2010. Because the Army has retained tanks in its inventory for 30 years or longer, production to meet inventory requirements can, in theory, be delayed until 2010 or later. Finally, the superiority of these tanks was well established by their performance in the Persian Gulf War.

Future Trends and Their Potential Impact on the U.S. Tank Fleet. Two types of threat could emerge during the next decade that could compel the Army to buy new tanks before 2010, although neither seems probable. The first would be the reemergence of a military entity capable of fielding a large armored force similar to that of the former Soviet Union. The second would be the fielding, in significant numbers, of a tank that would be technologically superior to the Abrams tank. Either occurrence could force the United States to build and field more sophisticated tanks to counter those of a potential adversary.

The emergence of a potential foe with a large and threatening armored force might require the United States to buy more tanks before 2010, but that event seems unlikely. The former Soviet Union and its allies in the Warsaw Pact represented such a foe, but few countries in the world today fill this bill. The merger of several republics of the former Soviet Union into a belligerent entity could cause concern, but such a merger seems highly unlikely in view of the contentious relations among the republics and former members of the Warsaw Pact. Both Russia and China field large tank forces, but both forces are widely dispersed and, at least in Asia, are composed of relatively unsophisticated tanks. In Europe, Russian tank forces are limited by treaty

and must contend with the combined forces of the North Atlantic Treaty Organization.

Moreover, building many new tanks would not be the only way for the United States to respond to such a threat. A cheaper and more timely response would be to retain or reconstitute some of the forces scheduled to be eliminated in the next few years. Such units could be equipped with tanks currently in the U.S. inventory, such as the M60A3. Unless they are sold, given away, or destroyed, several thousand surplus M60A3 tanks, which are not part of the required inventory, will remain in the U.S. inventory for many years to come. Though not as capable as the Abrams, these tanks are nonetheless a match for many tanks currently fielded by the former Soviet Union and almost all tanks fielded by developing countries.

A more plausible scenario, and therefore one of greater concern, would be the proliferation of highly sophisticated tanks, capable of challenging the Abrams, in developing countries. Such a threat would take a while to materialize, however, because no such tank is currently being sold overseas. The French Leclerc, the German Leopard 2 Imp, and the British Challenger 2 are on a par with one of the later models of the Abrams tank--the M1A1--but they have not yet been fielded or produced in large numbers. When they become available, however, they could, if enough were bought, pose a serious threat. That would be particularly true in areas of the world where the United States does not have a continuing forward presence or the capability to deploy a large armored force.

Implications for the Tank Industrial Base

The question that needs to be answered, then, is will the United States need more than 7,780 capable tanks in the period before a successor to the Abrams is produced, probably sometime after 2010? Largely as a result of the diminished threat from the Warsaw Pact and the Soviet Union, the overwhelming need that motivated many Army programs for so long no longer exists. However, inasmuch as no one could have predicted the collapse of the Warsaw Pact and the Soviet Union two years ago, no one can say with certainty that no new or rejuvenated threat will emerge in their place in the next 15 years. Maintaining the ability to produce tanks, should they be needed, can be viewed as an insurance policy for these uncertain times. Whether it is worth the cost of the premium in this time of fiscal constraint and how long it is needed are questions that both the Administration and the Congress need to address. To help in this debate, CBO examined three options of various costs for maintaining some parts of the tank industrial base for the foreseeable future.

OPTIONS FOR MAINTAINING THE TANK INDUSTRIAL BASE

The options for preserving the tank industrial base range from putting it in mothballs after completing currently planned tank production to continuing tank production at a low rate. CBO examined both of these options but also considered an intermediate alternative that would modify tanks in the current inventory to make them more capable. The options would add similar capability to the active inventory, but they differ in their cost and in the amount of insurance they provide in retaining the ability to produce tanks if a crisis arises.

The options also vary in the impact that they would have on the jobs of people employed in the tank industrial base. Although this issue is of great concern to all involved, it was not the focus of this paper and so was not analyzed.

Alternative I: Lay Away the Tank Industrial Base

Realizing that the Army has no near-term need for new tanks, the United States drastically reduced its annual purchases of Abrams tanks for the Army from a total of 481 tanks in 1990 to 18 in 1992. After 1992, the Bush Administration's budget, as submitted in February 1992, includes no funds to buy new tanks. Following the pattern of declining purchases, the annual production of tanks has fallen significantly from the 718 produced in 1990 to the 484 produced in 1992. Assembly of tanks for the United States will continue through 1993. After that time, no new tanks will be produced to fill U.S. orders until the next generation is needed. At the Congress's direction, the Army will modify 54 older Abrams tanks to a more capable configuration starting in 1993.

Plans for the tank program during the next five years are uncertain. The Army has proposed a conversion program in two phases, the first of which would upgrade 210 tanks and would require funding in 1994 and 1995. The second phase would upgrade almost 800 additional tanks and would require funding for several years after 1995. The revised budget submitted by then Secretary of Defense Dick Cheney in January 1993 fully funded the first phase, but provided only minimal funds for the second. Furthermore, the Bush Administration did not set a firm date for when the Army will start producing its next tank, although the current inventory of Abrams tanks will begin to reach the end of its estimated useful life in 2010.

In the meantime, production to fill foreign orders will continue. General Dynamics' Land Systems Division is under contract to supply Egypt with 555 kits for producing Abrams tanks. Saudi Arabia has agreed to buy 465 Abrams tanks, and Kuwait has recently ordered 236 tanks. These sales could keep U.S. tank production going through at least 1996. The Bush Administration also investigated the possibility of additional foreign military sales--a total of 783 tanks--that would maintain production at least through 1999. Potential additional customers for these tanks are the United Arab Emirates and Sweden. None of these additional sales is firm, however, and even GDLS is not confident that they will all come to fruition. Furthermore, the political cost of adopting the role of arms merchant while calling for limits on worldwide arms sales would have to be weighed against potential benefits. Finally, the technological risk of proliferating sophisticated U.S. systems around the world should also be considered. Maintaining the U.S. tank base through foreign military sales may not be a prudent long-term solution.

Description. As production of tanks or their major components ceases, one option would be to put the government-owned production equipment and facilities into storage until needed again.⁵ This process, known as layaway, is a progressive one. For example, when production fell below 50 tanks per month, it was no longer necessary to continue operating the two tank assembly plants--the Detroit Arsenal Tank Plant in Warren, Michigan, and a plant in Lima, Ohio. Consequently, the assembly line in Warren was closed in September 1991 and is now being laid away. Furthermore, because the tanks sold to foreign buyers do not include the special armor found on the latest model of the U.S. tanks, the DOE facility for producing this armor will close in 1993 or 1994.⁶ The DOE equipment and facility will then be laid away until they are needed again.

Should the United States cease producing tanks in 1997, one option would be to lay away the additional major facilities associated with tank production that would no longer be needed. The manufacturing equipment unique to tank production would be stored in place and protected from the elements, if necessary. Government-owned buildings would be closed and guarded. Leased facilities would continue to be rented so that they would be available if needed. In short, the physical portions of the tank production base would be stored for future use. While preserving the production

5. The Bush Administration proposed this course of action in its February 1992 budget submission. The proposed budget revisions submitted in January 1993 by then Secretary of Defense Dick Cheney include funds for the tank conversion program described earlier. The Clinton Administration is currently considering its plans for the tank program.

6. Without the program to convert 54 tanks in fiscal year 1993, the DOE facility would have closed in December 1992. Because the facility can produce 20 armor sets per month, it could be ready for shutdown sometime in fiscal year 1993.

facilities, the Army could continue to develop a tank to replace the Abrams fleet starting in 2010.

Time and Cost to Restart Production. When production resumes and the industrial base is needed again, time will be needed to take it out of mothballs and to find and train the people to run it. If the line remains shut for more than two years, restarting it could take a long time. First of all, some skilled personnel in jobs that require extensive training would, according to the Army, have to be retrained to regain their skills.⁷ Retraining for some tasks, such as armor welding, could take six months, according to Army estimates.

Second, the Army claims that, after a hiatus of two or more years, the DOE facility could take two years to be recertified and start producing special armor. (Of course, if an urgent need arose for tanks to meet a national emergency, this recertification requirement could be waived or expedited.) After certification, producing the first set of armor would take another 18 months, for a total delay of 42 months. According to the Army's analysis, the special armor is responsible for the longest delays when restarting an inactive tank line. Thus, all the other components should be available when the armor is ready.

Finally, another nine months would be needed to assemble all the parts into the first tank. In all, it could take up to 51 months to rejuvenate the industrial base and produce the first tank. In a time of crisis, however, the Army will need tanks in large numbers. Increasing production rates takes time because more trained workers are needed and shifts are added. In fact, attaining a production rate of 120 tanks per month could take an additional 21 months. Thus, a total of six years might elapse before tanks would be produced in large numbers.

A one-time investment will be needed to take the production line out of mothballs. The one-time costs to restart production and achieve rates of 120 Abrams tanks per month, including training costs for people in highly skilled jobs, would be about \$1.1 billion in 1993 dollars, according to Army estimates.⁸

7. Retraining time might be minimized if the government developed and maintained an up-to-date list of the addresses of personnel with skills critical to the manufacture of tanks. Such a list might be maintained by offering people with critical skills a modest remuneration in return for keeping the government informed of their whereabouts. Alternatively, the contractors or the Army could establish schools to maintain the critical skills of people who would no longer be involved in tank production.

8. The estimate of \$1.1 billion includes only training and start-up costs. Production would require additional funds.

Cost to Lay Away. The Army estimates that laying away and storing the tank industrial base will cost \$340 million in 1993 dollars over the next five years (see Table 4). That amount includes \$200 million to meet the one-time costs associated with ceasing tank production and laying away the tank facilities (see Table 5). One-time costs would cover personnel separation, laying away facilities and equipment, managing the layaway, and environmental cleanup. Costs associated with management and personnel separation form the largest component of one-time costs (45 percent); the remaining 55 percent would be devoted to layaway and cleanup. The Army admits, however, that its analysis of potential environmental costs is not complete and that those costs could be much higher.

Laying away the tank production base would also create annual recurring costs for as long as the lines are in storage. From 1994 through 1998, recurring costs for security and maintenance of the laid-away facilities

TABLE 4. ANNUAL COSTS THROUGH 1998 FOR VARIOUS ALTERNATIVES
(In millions of 1993 dollars)

	1993 and Before	1994	1995	1996	1997	1998	Total 1994- 1998
Alternative I: Lay Away Tank Line	0	50	30	140	80	40	340
Alternative II: Produce at Low Rate ^a	0	780	800	760	740	750	3,830
Alternative III: Convert Older Models ^b							
Phase I	680	80	130	0	0	0	210
Phase II ^{a, c}	0	0	150	550	650	650	2,000

SOURCE: Congressional Budget Office based on Army data.

NOTE: Costs do not include about \$60 million to lay away the assembly line at the Detroit Arsenal Tank Plant.

- a. Assumes additional production of 120 tanks per year to fill orders from foreign governments.
- b. Includes estimates for research and development, procurement, and operations and maintenance costs to convert M1 tanks to the M1A2 configuration.
- c. According to then Secretary of Defense Dick Cheney's proposed budget revisions submitted in January 1993, a minimum annual investment of \$250 million would sustain the program after 1995, but at 60 conversions per year rather than the 198 conversions funded in the alternative.

TABLE 5. COSTS FROM 1994 THROUGH 1998 FOR ALTERNATIVE I (LAY AWAY THE TANK LINE), BY FUNCTION AND FACILITY (In millions of 1993 dollars)

Function	Detroit Arsenal Tank Plant ^a	Lima Army Tank Plant	GDLS ^b	Allison Transmission	Other ^c	DOE	Total
One-Time Costs							
Management and Personnel Separation	20	40	30	d	0	0	90
Layaway of Facilities and Equipment	10	30	20	d	10	0	70
Environmental Cleanup	<u>10</u>	<u>10</u>	<u>d</u>	<u>d</u>	<u>0</u>	<u>20</u>	<u>40</u>
Subtotal	40	80	50	d	10	20	200
Recurring Costs							
Security and Maintenance	d	20	10	20	d	90	140
Total							
One-Time and Recurring Costs	40	100	60	20	10	110	340

SOURCE: Congressional Budget Office based on U.S. Army Tank-Automotive Command, *Austere Abrams Closure Study* (August 1991); and personal communication with Tank-Automotive Command, March 1992.

NOTES: GDLS = General Dynamics, Land Systems Division; DOE = Department of Energy.

- a. Cost associated with laying away component machining only. Excludes an additional \$15 million associated with laying away the assembly line.
- b. Includes Central Office Complex, Scranton Plant, Sterling Plant, subcontractors, and vendors.
- c. Includes specific product lines operated by Textron Lycoming at the Stratford Army Engine Plant and other lines at Hughes Aircraft Company, Computing Devices of Canada, Rock Island Arsenal, Watervliet Arsenal, Kollmorgen, Plessey, and Singer-Kearfott.
- d. Less than \$5 million.

would amount to \$140 million, or 41 percent of the total five-year costs. After 1998, and until facilities would be needed to start producing parts for the next generation of Army tanks, annual costs for maintaining and preserving the base would total about \$40 million (in 1993 dollars).

Ceasing tank production in the United States would affect many facilities throughout the country, but the Army has compiled cost estimates for only the largest. A breakdown of the layaway costs by facility indicates that the DOE facility and the Lima tank plant would incur the largest costs (see Table 5). Closing, maintaining, securing, and cleaning up the DOE facility could cost \$110 million from 1994 through 1998, with the bulk of this amount devoted to caretaking. Closure and layaway of the Lima tank plant would cost \$100 million during this same period. The assembly line at the Detroit Arsenal Tank Plant (DATP) at Warren was closed in September 1991 when both it and the assembly facility at Lima were no longer needed to fill orders. The DATP still continues to manufacture some components. The Army estimates that \$49 million will be needed from 1994 through 1998 to lay away the entire DATP. Some portion of this amount, however, will be needed even if tank production does not cease, because the production rate has already fallen below the level needed to sustain two tank assembly lines. Indeed, about \$3 million will be needed annually to lay away the assembly line at the DATP as long as production remains below about 600 tanks per year. Since rates this high are not anticipated, even with the most optimistic expectations for foreign military sales or under any of the options examined by CBO, this cost would be incurred no matter which of the alternatives is adopted; it therefore is not included in the discussion of costs associated with the options.

The costs for closing and storing the remaining dedicated lines would be spread over several facilities. The major remaining facilities include the GDLS facilities (the Scranton castings plant and the plant at Sterling Heights, Michigan), the transmission line at Allison Transmission Division, and the engine line at the Stratford Army Engine Plant operated by Textron Lycoming. Finally, some smaller lines that produce parts that the government supplies to GDLS for incorporation into the tank, such as laser range finders from Hughes, would also have to be closed, stored, and maintained.

Alternative II: Maintain Production, but at a Low Rate

One way of maintaining the tank industrial base is to continue to produce tanks but at a lower rate. To maintain all parts of the base, including the DOE facility, some tanks will have to be produced for the U.S. military,

because tanks sold to foreign customers do not contain the special armor that the DOE facility produces.

Description. In this option, the Army would buy 120 of the latest model Abrams tank (the M1A2) per year for the U.S. military, starting in 1994. Production at the rate envisioned in this option will not guarantee that all parties currently producing tanks or their parts will continue to do so. For some of the 18,000 vendors who now supply or have supplied components for tanks, the low volume of business that would result from this option may not be sufficiently profitable to keep them in the tank business, particularly because many tank parts must meet exacting government standards.⁹ In fact, because the rate of tank production has decreased over the past two years, several vendors have already ceased their involvement in the tank program, and GDLS expects that several more will follow. Nevertheless, producing tanks at a low rate will sustain all major parts of the industrial base.

Costs. This alternative would be quite expensive to carry out. Low-rate production is inherently inefficient because facilities that were designed to produce items in large numbers--the active tank base has the capacity to produce 75 tanks per month--are not fully used at lower rates. The few tanks being produced, however, must bear the overhead costs for the unused capacity. The cost per tank therefore goes up, and relatively high prices are paid for just a few tanks. Based on Army estimates, the cost to produce one tank increases by almost 70 percent as the production rate decreases from 360 tanks per year to 120 tanks per year. The cost over the next five years to buy 600 tanks would be about \$3.8 billion. (These costs are based on the assumption that an additional 120 tanks per year will be produced for foreign buyers. Without the foreign sales, costs for U.S. tanks will increase above those cited here.) After 1998, annual costs would be about \$740 million. Should new tanks ever be needed in large numbers, the time and cost to reach a surge rate of 120 tanks a month would be 47 months and about \$600 million.

Alternative III: Convert Older Abrams Tanks to Newer Models

This alternative represents a compromise between laying away the components of the tank base and continuing production. It would maintain most of the industrial base by converting older, less capable versions of the Abrams tank to the newest and most capable model. The Congress has supported this approach for several years and has provided funds to carry it

9. The government-owned tank assembly facility at Lima, Ohio, has the capacity to produce 75 tanks a month (900 tanks a year)—much more than the number of tanks envisioned in this alternative.

out. Neither the Bush Administration nor the Army included such a program in the budget submitted in February 1992 or advocated conversion during subsequent hearings on the fiscal year 1993 budget request. In the fall of 1992, however, the Army began to evaluate a program that would upgrade 1,002 Abrams tanks and has since submitted its proposed program to the Office of the Secretary of Defense for approval. The Bush Administration had approved only the first phase of the program by the end of its tenure, and the Clinton Administration has not yet made its position on this program known. This alternative would carry out the Army's plan.

A conversion program might spur prospects for foreign military sales, which would ensure support for those parts of the base not needed for a conversion program. It would also provide a hedge against unforeseen circumstances that would require the Army to modernize its tank inventory. Finally, this alternative, though costing more than laying away the industrial base, would cost less than keeping the production lines open; if pursued for a sufficient length of time, it would bring almost all tanks in the active inventory up to the same high level of capability.

Description. Four models of the Abrams tank have been produced since 1979. In chronological order and order of increasing capability, they are the M1, the IPM1, the M1A1, and the M1A2. The first two models have a 105mm cannon, and the last two a 120mm cannon with longer range. Other improvements have been added over the years, including armor made with depleted uranium (see Table 6). All M1A2 tanks and about half of the M1A1s have this special armor.

This option would include a program to convert the oldest Abrams tanks--the M1s--to the M1A2 configuration. Such a modification would entail replacing the entire turret, including the gun; installing new electro-optics; modifying the hull so that it can accept the active nuclear, biological, and chemical (NBC) protective system; and replacing the armor packages and the entire electrical system.

Such a conversion process would involve most components of the tank industrial base. According to analysis performed by GDLS, this modification process would require 88 percent of the critical skills involved in producing tanks and would maintain 100 percent of the unique manufacturing elements now employed in tank production.¹⁰ The engine and transmission in the

10. GDLS's analysis identified the processes that are unique to tank production and not easily transferred to civilian application. Those processes would not include engine and transmission work that, though different for use in tanks, is not sufficiently different to make it unique.

TABLE 6. CHARACTERISTICS OF THE ABRAMS TANK INVENTORY

Characteristic	M1	IPM1	M1A1	M1A2
Years Produced	1979-1985	1984-1986	1985-1993	1992-1993
Number in Army Inventory in 1995	2,374	894	4,430	62
Weight (Tons)	60	61	67	69
Caliber of Main Gun (Millimeters)	105	105	120	120
Armor	Standard	Standard	Standard/ Special ^a	Special
Stored Rounds (Main gun)	55	55	40	40
Maximum Road Range (Miles)	280	310	275	265
Improvements over Previous Model	n.a.	Improved Suspension Improved Armor	Further Improved Suspension Active NBC Protective System	Commander's Independent Thermal Viewer Digital Electronics SINGARS Radio ^b
Improvement in Capability over M1 Model ^c (Percent)	n.a.	4	7 ^d	22

SOURCE: Congressional Budget Office based on Christopher F. Foss, ed., *Jane's Armour and Artillery Systems* (Surrey, England: Jane's Information Group, various editions); Association of the U.S. Army, *Army, 1991 Greenbook* (October 1991); data from General Dynamics, Land Systems Division; and The Analytic Sciences Corporation, *The TASCFORM Methodology: A Technique for Assessing Comparative Force Modernization*, 4th ed., rev. (Arlington, Va.: TASC, July 1991).

NOTES: NBC = nuclear, biological, chemical; SINGARS = Single Channel Ground and Airborne Radio System; n.a. = not applicable.

a. Standard armor on 2,266 M1A1s and special armor on the rest.

b. If available.

c. Based on TASCFORM scores.

d. With special armor.

Abrams is common to all models, however, so no new engines or transmissions would be needed to upgrade M1s to the M1A2 configuration. Some analysts have argued that if the United States employs a significant number of the M1A2 model in its forces, other countries will be interested in buying new M1A2 tanks. Indeed, Saudi Arabia and Kuwait have already ordered a total of 701 M1A2s. Thus, foreign sales of new M1A2s might keep Allison Transmission and Textron Lycoming in the tank transmission and engine business, at least for a while.

The Army, in response to Congressional prodding, designed a specific program in the fall of 1992 that would convert 1,002 Abrams tanks to the M1A2 configuration starting in 1993 and ending in 2000. The goal of the Army's proposed program is to provide the best tanks for potential regional contingencies. To that end, the converted tanks would be used to equip part or all of the Army's contingency force, which includes the units that would be used first in a regional war such as Operation Desert Storm.

The Army has broken its proposed program into two phases. The first phase would provide enough M1A2 tanks to equip and support one division within the contingency force and would be funded from 1993 through 1995 (see Table 7). The Army needs almost 300 tanks to equip one mechanized division and provide tanks for training. The Army has already bought 81 new M1A2 tanks and plans to convert 210 tanks to the M1A2 configuration in the first phase of its conversion program. The Army's second phase would convert an additional 792 tanks and would require funds beginning in 1995. The length of the second phase depends on the rate at which tanks would be upgraded. The earliest completion date likely is 2000, which requires conversion of 198 tanks a year from 1996 through 1999. A less ambitious program would take longer. Upon completion of both phases, the Army would have enough M1A2 tanks to equip its planned contingency force (which includes five divisions plus one brigade afloat) and to provide extra tanks for training.

Time to Restart Production. The time required to start producing new tanks from a line that had been engaged in upgrading M1s to M1A2s would be between the requirements of the previous two alternatives. All portions of the industrial base would be active except those that produce engines and transmissions. Of these two, engine production would take longer to restart, with a delay of 20 months before the first engine could be delivered. Delivery of the first tank could occur nine months later, for a total delay of 29 months to produce the first tank. About one year later, production rates of 60 tanks a month could be expected, and surge rates of 120 tanks could be achieved about two years after the first tank rolled off the production line. All in all,

it could take 56 months to reach surge-rate production from a line that had been engaged in upgrading M1s to M1A2s.

Costs. Because the conversion of M1 tanks to the M1A2 model requires such extensive reworking of each tank, this upgrade would be expensive. In fact, the total cost of the 210 upgrades in the Army's first phase is \$890 million (see Table 7). If the Army pursues the second phase at a rate of 198 upgrades per year, then the cost for the conversion program from 1994 through 1998 would be about \$2.2 billion, with annual costs as high as \$650 million (see Tables 4 and 7). Additional annual costs after 1998, if the program were continued indefinitely at a rate of 198 tanks a year, would be about \$650 million. (As with the previous alternative, these costs are based on assumed sales to foreign governments of 120 tanks per year. Without these sales, costs could increase.)

TABLE 7. COSTS THROUGH 1998 FOR ALTERNATIVE III
(CONVERT M1s TO M1A2s)

	1993 and Before	1994	1995	1996	1997	1998	Total
Cost^a (Millions of 1993 dollars)							
Phase I	680	80	130	0	0	0	890
Phase II ^b	0	0	150	550	650	650	2,000
Number of Tanks Modified							
Phase I	54	101	55	0	0	0	210
Phase II ^b	0	0	0	198	198	198	594

SOURCE: Congressional Budget Office based on Department of the Army, "Abrams Upgrade Program" (September 10, 1992); Congressional action on the 1993 budget request; and proposed budget revisions submitted by then Secretary of Defense Dick Cheney in January 1993.

- a. Does not include about \$60 million to lay away the assembly line at the Detroit Arsenal Tank Plant. Includes costs of research and development, procurement, and operations and maintenance to convert M1 tanks to the M1A2 configuration. The costs of the tanks that will be converted in 1994 and 1995 and perhaps 1996 will include some of the funds provided in Congressional appropriations from 1993 and prior years. Also, the Army assumed that it can sell 120 new tanks to foreign customers every year and that producing these tanks will lower U.S. costs. CBO estimates that if no additional new production from foreign sales occurs after 1995, total costs could increase by 10 percent to 25 percent.
- b. According to then Secretary of Defense Dick Cheney's proposed budget revisions submitted in January 1993, the conversion program could be maintained with minimum funding of \$250 million per year—enough to convert 60 tanks, assuming that foreign military sales account for 120 new tanks produced annually.

The costs of the conversion program could be lower if the Army pursues the second phase of the program at a slower pace. In then Secretary of Defense Dick Cheney's proposed budget revisions, submitted in January 1993, only \$250 million a year is set aside for tank conversion beyond 1995. Coupled with sales of 120 tanks per year to foreign governments, this funding should sustain the tank line. The pace of conversion might, however, be quite slow. The Army indicates informally that it has not yet determined how many tanks it could convert with \$250 million while it also pays the overhead and other costs necessary to sustain the tank production line.

It seems likely, therefore, that after 1995 the annual costs of a conversion program will be at least \$250 million and could be as high as \$650 million. The cost associated with gearing up to a surge rate of production of new tanks during a national crisis would be about \$530 million.

During the next few years, some of the costs of the conversion program may be financed using either funds from past appropriations or proceeds from sales of military weapons to foreign countries. For example, the Army proposes using almost \$200 million from the sale of surplus tanks and other equipment to help pay for the first phase of its conversion program. This financing approach would reduce the additional funds that the Congress would have to appropriate to carry out the conversion program. If the conversion program were not carried out, however, the funds used to finance it would be available to pay for other needs. The method used to finance the program therefore does not alter the true costs of converting tanks, which are the focus of this paper.

COMPARING THE ALTERNATIVES

The three alternatives vary little in the amount of capability they would add to the Army's tank force. They differ significantly, however, in their costs and in the amount of insurance each would provide against uncertainty about future threats to U.S. security.

Arguments in Favor of Layaway

Laying away the tank line offers some significant advantages, especially with regard to cost.

Least Expensive. Closing and laying away the tank line would require \$340 million in funding from 1994 through 1998, much less than the requirements for maintaining low-rate production (\$3.8 billion) or a conversion program (as

much as \$2.2 billion) (see Table 8). Annual costs after 1998 would also be much lower; those associated with layaway would amount to \$40 million a year compared with more than \$700 million a year for low-rate production and from \$250 million to \$650 million for conversion.

Moreover, the differences in costs could be even greater. In particular, the costs of low-rate production or conversion may grow beyond current estimates. Both of these options would require maintaining a company in business along with its subcontractors and vendors. Because the company would have to meet overhead costs, estimated costs could grow--perhaps sharply--if the company's other business (such as foreign military sales) declines. In contrast, the costs of layaway are less likely to increase. Layaway involves mothballing equipment and continuing leases and security protection. Therefore, estimates of these costs should not be subject to much unanticipated growth.

TABLE 8. COSTS AND RESTART TIMES OF VARIOUS ALTERNATIVES

	Cost, 1994-1998 ^a (Millions of 1993 dollars)	Time to Restart (Months)		Cost to Reach Surge Capacity (Millions of 1993 dollars)
		First Tank	Surge ^b	
Alternative I: Lay Away Tank Line	340	51	72	1,110
Alternative II: Produce at Low Rate	3,830 ^c	22	47	600
Alternative III: Convert Older Models	2,210 ^{c, d}	29	56	530

SOURCE: Congressional Budget Office based on Army data.

- a. Does not include about \$15 million to lay away the assembly line at the Detroit Arsenal Tank Plant.
- b. Surge production at 120 tanks per month.
- c. Assumes additional production of 120 tanks per year to fill orders from foreign governments.
- d. The proposed budget revisions submitted by then Secretary of Defense Dick Cheney in January 1993 include an estimate of \$720 million as a minimum sustaining level.

Improvements in Capability May Not Be Needed. Laying away the tank line would, of course, preclude making any improvements to the capability of the Army's tank fleet for the foreseeable future. Low-rate production or conversion would result in increased capability, but the improvements would be small and may not be needed to meet future threats to U.S. security.

The greatest improvement in the capability of the tank fleet required to equip and support Army forces would result from carrying out the conversion program that the Army proposed in the fall of 1992 (see Table 9). Replacing 1,002 M1 tanks with the M1A2 model would result in a 3 percent increase in capability by the year 2000. Low-rate production, because it could not deliver as many new M1A2 tanks by the year 2000 as could the modification program, would result in a somewhat smaller increase in capability (about 2 percent).

But does the Army really need to improve the overall capability of its tank fleet? Many defense analysts contend that the United States already has enough tanks to equip its planned forces and that the M1A1 is the most capable tank in the world. There is some basis for this assertion. First, as mentioned above, U.S. tank forces enjoy a substantial advantage when compared with tank forces of almost any other country (see Figure 3). Moreover, by its performance in the Persian Gulf War, the Abrams tank

TABLE 9. EFFECTS OF VARIOUS ALTERNATIVES ON THE ACTIVE INVENTORY AND CAPABILITY OF TANKS IN 2000

	Composition				Total Capability ^a
	M1	IPM1	M1A1	M1A2	
Alternative I: Lay Away Tank Line	2,374	894	4,453	62	42,900
Alternative II: Produce at Low Rate	1,774	894	4,453	662	43,700
Alternative III: Convert Older Models	1,372	894	4,453	1,064	44,200

SOURCES: Congressional Budget Office based on Army data and on The Analytic Sciences Corporation, *The TASCFORM Methodology: A Technique for Assessing Comparative Force Modernization*, 4th ed., rev. (Arlington, Va.: TASC, July 1991).

a. Based on TASCFORM scores.

demonstrated that it is more capable than its widely deployed counterpart from the former Soviet Union, the T-72 tank. By all accounts, the Abrams tank outranged and outmaneuvered the T-72, which is not equipped to fight effectively at night.

Restart Times May Be Acceptable. If the tank line is laid away, the time and investment required to restart production and reach production at surge rates of 120 new tanks a month would be substantial--a full six years and more than \$1 billion (see Table 8). The delays and initial investments associated with the other two alternatives would be smaller--56 months and \$530 million to achieve surge-rate production from a line upgrading tanks, and only 47 months and \$600 million from low-rate production.

The differences in restart times may not, however, be critically important. Even with low-rate production--the alternative resulting in the shortest delay--the Army would not be able to add significantly to the tank force within the likely duration of a brief conflict that developed with little warning, such as Operation Desert Storm. If a major new threat emerges, such as a resurgent threat from the republics of the former Soviet Union, it may well appear with enough warning so that the differences in restart times are not of great importance.

Having assessed these various arguments, the Deputy Secretary of Defense in the Bush Administration concluded in April 1992 that the tank line should be laid away. Donald Atwood stated that the United States now has enough capable tanks to meet any contingency and that there is enough time to reconstitute the tank industrial base if a global threat emerges.¹¹

Arguments in Favor of Low-Rate Production or Conversion

Although laying away the tank line has advantages, particularly relating to cost, low-rate production or conversion provides a hedge against uncertainty about future threats and other factors. Of the two approaches, conversion may be preferable because it would maintain much of the industrial base but would cost at least 40 percent less during the 1994-1998 period. The remainder of this discussion therefore focuses on a program to convert M1 tanks to the M1A2 configuration.

Insures Against Uncertainty About Future Threats. In this period of international instability, when European and Asian peoples long suppressed by authoritarian regimes are expressing and acting upon nationalist feelings,

11. Testimony of Donald Atwood before the House Committee on Armed Services, April 28, 1992.

no one can be sure if or when a serious new threat to Western security might emerge. If a new threat emerges, a relatively rapid return to production of high-quality tanks could be important, especially if considerable time elapses before the United States recognizes the emergence of and acts to counter a new military power. A conversion program would require less time to achieve production of new tanks than would a line that had been laid away.

Even if the emergence of a major new threat is judged too unlikely to justify long-term maintenance of the tank base, the situation in the republics of the former Soviet Union could argue for maintaining that base for at least a few years. Russia alone has about 11,000 tanks in Europe, some of which are reasonably capable. If a military dictator regained power, Russia could conceivably reemerge as a military threat to the West within a few years.

Perhaps the most troublesome scenario involves the arming of developing nations with sophisticated and modern tanks from the global arms market. As U.S. allies reduce the size of their ground forces, European arms makers will look outside Europe for potential buyers. Some of the European manufacturers will eventually be able to produce significant numbers of tanks sophisticated enough to challenge the M1A1 on the battleground. Thus, nations in regional hot spots might be willing and able to amass large inventories of these technologically advanced vehicles.

Compared with these developing nations, the United States will almost certainly maintain a large numerical advantage in terms of total tank inventories. The United States might not, however, be able to bring its entire tank inventory to bear. In regions of the world where the United States does not maintain a significant forward presence, small units with limited numbers of U.S. tanks might have to oppose an adversary who threatens U.S. security interests. Alternatively, the United States might need to split its forces in order to deal with two or more contingencies simultaneously. In such a scenario, having U.S. tanks that are superior on a tank-for-tank basis may be important. U.S. actions in Operation Desert Storm--in which the U.S. military tried to ensure that its forces used the latest model M1A1, equipped with special armor--underscore the importance of such superiority.

Converting older M1 tanks to the M1A2 configuration would increase the chances that U.S. forces would have an advantage on a tank-for-tank basis in any limited conflict. Indeed, the Army plans to use M1A2s from the conversion program to equip its contingency force, which includes the units most likely to fight in a regional war. A conversion program would also maintain most of the industrial base, thus insuring that the United States will be able to continue to upgrade its tanks and always equip its forces with the world's most capable tank.

Insures Against Uncertainty About Time to Restart. Maintaining a tank conversion program might also hedge against uncertainty regarding the time required to resume production of quality tanks. The United States does not have any recent experience in restarting tank production and so has no way to predict reliably how long it would take to retrain workers and, perhaps of even greater concern, to reestablish the ability to produce tanks with few or no defects.

If more vendors than expected go out of business, finding suppliers for all the parts needed for tanks could take even longer. Moreover, after being reactivated, a line that has not been producing tanks for a number of years could take some time to produce quality tanks in large numbers. A couple of years might be needed to work out the production bugs and to establish a vendor base capable of providing components of high quality so that tanks without defects could be produced. Recent production experience with the Abrams reinforces this concern. According to GDLS, the defect rate for Abrams tanks coming off the production line has decreased 82 percent during the past six years. Many problems are associated with starting up new production lines, to which this would be akin. A high rate of defects in tanks produced for use in a crisis is obviously an outcome to be avoided.

The uncertainty concerning the ability to resurrect the tank base will certainly increase the longer the base is shut down. Inasmuch as the United States will probably not be building new tanks before 2010, the hiatus between shutdown and reopening may be very long. If restart takes longer than the Army estimates, then the risks of failing to meet a future threat are greater than the Administration currently acknowledges.

A conversion program would ensure the availability of quality components as long as it continued. Even if it continued for only a few years, a conversion program would also provide additional time to study the issues related to closing down the production line.

CONCLUSION

In its defense authorization act for 1993, the Congress approved the use of \$225 million--funds that had been appropriated for 1992 but not spent--for converting older Abrams M1 tanks to the newer A2 version. Thus, at least through 1993, the Congress opted to insure against possible future threats to U.S. security by sustaining most of the tank industrial base.

This decision, however, raises the question of how long the United States should continue to buy insurance. Should it continue until it needs to

produce a new tank, which might not be until 2010 or even later? Or will this insurance be needed for only a few years until the international climate, particularly the situation in the former Soviet republics, becomes clearer?

If costs are the key criterion, the tank line should be allowed to close as soon as all foreign orders are filled. The Army's planned conversion program would require more than four times as much funding over the next two years as layaway. Subsequently, depending on the pace of conversion, upgrading tanks could cost from as little as two to more than 10 times as much as layaway costs in a given year. Indeed, annual costs for conversion after 1995 could be as high as \$650 million. The Army estimates that the one-time cost of restarting and reaching surge-rate production from a line that has been laid away is only slightly more than \$1 billion. Thus, if conversion is pursued at a high pace after 1995, the United States would spend in two years as much to convert tanks as it would to restart a line that had been laid away.

In contrast, completing the first phase of the Army's conversion program would cost a total of only \$140 million more in 1994 and 1995 than layaway, and would result in a useful number of M1A2s. By completing the first phase, one division of the contingency force could be equipped and supported with the improved M1A2 by 1996. Ending the conversion program short of providing enough M1A2 tanks for an entire division would leave the Army in a dilemma concerning how to employ the M1A2s in its tank fleet. To ease maintenance and operations in time of war, combat units are equipped whenever possible with only a single version of each type of weapon. It would be difficult, therefore, for the Army to use less than a full division's complement of M1A2s.

After 1995, annual costs for the conversion program could rise to between \$250 million and \$650 million. Such costs would represent a small fraction of the Army's total budget. Sustaining the capacity to produce tanks through conversion or low-rate production provides some insurance against an unforeseen event--the emergence of a major new threat to U.S. security--and other risks associated with closing the tank line. Continuing this program may therefore be reasonable, particularly until uncertainty about the situation in Eastern Europe and other parts of the world diminishes.

In the years to come, however, the risks incurred by ending support for the tank base should continue to be weighed against the costs. This judgment may be particularly important if external factors, such as a decline in the volume of foreign sales of tanks, cause the price of the conversion program to increase.