

Rethinking Governance of the Army's Arsenals and Ammunition Plants

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PREFACE

This report documents the results of an analysis of the Army's ordnance industrial base. It focuses on arsenals and ammunition plants. Specifically, it analyzes Watervliet and Rock Island arsenals and 14 ammunition plants, 11 of which are operated for the Army by contractors, and it considers alternative forms of governance and management for each class of installation. The work was sponsored by the Army G-8. It should interest those involved with the military industrial base or transferring government activities to the private sector.

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BACKGROUND AND PURPOSE OF THIS STUDY

The Army manages a large industrial base consisting in part of 14 government-owned plants that manufacture ammunition or are laid away to do so following hostilities, and 2 arsenals that manufacture ordnance materiel such as gun tubes, gun mounts, and other weapons-related items. These facilities occupy about 230,000 acres of DoD-owned land, about 1 percent of DoD's 24 million acres. They generate revenues of more than \$1 billion a year. The oldest of the 16, Watervliet Arsenal, dates to 1813. The ammunition plants are of more recent vintage; most represent the residual of 77 government-owned, contractor-operated plants and works built or expanded to meet the needs of World War II, although three were opened during the Korean War or since. Three of the ammunition plants and the two arsenals are operated by government employees rather than contractors.

Today, the Army retains more capacity than the nation needs or anticipates that it will need. Furthermore, much of the equipment in these facilities is old, and, partly as a result of this obsolescence, they are expensive to operate.

The Army has long recognized these problems, and it has asked RAND Arroyo Center to assess options for managing this part of its industrial base. Initially, the research focused on reducing excess capacity at the two arsenals. That research suggested that downsizing through elimination of excess equipment and manufacturing space, while worthwhile, leaves the facilities with certain disadvantages that are inherent in continued government ownership of these manufacturing activities, which are peripheral to the Army's primary missions and functions. Hence, the research led to the more central issue of governance and ownership.

Later, during the conduct of the research, the Army initiated a review of its entire industrial base and folded this research into the new effort, called the Industrial Base Program Review (IBPR). The IBPR has as its mission to identify

logistics infrastructure the Army can divest of without jeopardizing its ability to accomplish its national security missions. Hence, prudent divestiture and reliance on private manufacturing became an important objective of the assessment.

PROBLEMS WITH THE ORDNANCE INDUSTRIAL BASE

The research suggests the following problems with the ordnance base:

- It lacks a strategic vision and plan.
- Army ownership is a peripheral function that diverts managers' attention from more essential tasks.
- Reduced workload contributes to high unit costs.
- In the government-operated facilities, it is difficult to relate costs to outputs, and prices are distorted.
- It has difficulty competing for capital investment funds in the Army budget process.
- Ammunition receives low priority for funding, which has detrimental effects on the base.
- Extended time is required to dispose of excess facilities.
- Ammunition replenishment policy is in flux.

The Army has attempted to address the issues of the ordnance industrial base for a number of years; it has developed ideas, written plans, and reorganized. But it has not produced and adopted an overarching vision and plan for the base. The requirements determination process is faulty. Manufacturing is not a core competency for the Army. Army ownership of the manufacturing capability requires Army leaders, particularly logistics leaders, to attend to this peripheral function. However, doing so diverts them from their primary responsibilities, and it requires them to make decisions in areas that fall outside their primary areas of expertise. It has taken nearly a decade to dispense with excess plants. In the arsenals, workload associated with their principal products has declined to less than 10 percent of peak levels. Fixed costs spread over less output drives prices higher. Reductions in employment levels and elimination of excess equipment help but are insufficient to solve the problem. In the government-operated facilities, funding rules and budgeting methods distort prices and make it difficult to relate costs to outputs. In the contractor-operated ammunition plants, the problems, which are less severe than in the government-operated facilities, derive from the inability of capital investment to compete for resources against current expenditures in the Army's operating

budget, leading to obsolescence and inefficiency in the base. Further, government ownership of plants sometimes leads to inefficient sourcing decisions. Ammunition does not enjoy a high priority in the budget. Army funds allocated to ammunition have been level and declining as a fraction of the Army's total budget. The level funding masks the fact that within ammunition categories, procurement varies significantly, reducing the efficiency of production. Finally, the policy under which the Army replenishes ammunition is in flux. Because there is no clear policy, the Army does not know how much replenishment capacity to maintain.

In 1997, the Pacific Northwest National Laboratories (PNNL) issued a report on the ammunition industrial base. The report urged the Army to convert its government-owned assets to commercial activities, apply acquisition reform measures, focus government activities on accurately expressing the need for munitions, use the competitive marketplace, and establish a program executive office (PEO) for this important program. The Army has established the PEO but has not implemented the other recommendations.

STRATEGY TO RESOLVE ORDNANCE BASE PROBLEMS

Many of the problems with the ordnance base could be solved by transferring functions to the private sector, and such a step would be consistent with national policy. However, some risk exists that transferring functions to the private sector might result in a loss of a critical capability, and whatever plan is adopted needs to hedge against that risk. Taking into account the problems of the ordnance base and the national policy for the government to take greater advantage of the private sector, we believe that the following strategic vision for the ordnance base will help the Army chart a course for management:

Convert the organic base to a responsive, innovative, efficient manufacturing base, capable of meeting national security requirements while relying to the maximum practical extent on the inherent advantages of competition and private ownership of capital.

Given this vision, the next question becomes how to achieve it. We considered the following four options:

- Privatize facilities
- Create a federal government corporation
- Consolidate facilities and declare unneeded plants excess
- Recapitalize on multifunction posts

Privatize

Under this option, the plants would be sold as going concerns to ordnance manufacturers, who would agree to maintain a specific capability for a specific number of years. This method of privatization would be accomplished by declaring the property “excess to ownership but not excess to need.” Unlike consolidations and closures that render property excess to need, this excess-to-ownership but not excess-to-need method includes no legal requirement to offer excess property first to other government agencies, some of which may acquire it without paying compensation to the Army. Unlike excess-to-need transfers that require remediation to be completed before the property is sold, excess-to-ownership transactions permit transfer while remediation is ongoing. Further, environmental remediation may be conducted at the programmed rates, and to the maximum extent possible, the buyer performs remediation in exchange for a reduced purchase price. This frees Army funds programmed for remediation to be applied to other Army priorities. Both the Air Force and the Navy have employed excess-to-ownership divestitures. Purchase would be accompanied by a production and replenishment contract for a set number of years, probably five, after which the Army would select sources on the basis of full and open competition. Privatization under excess to ownership but not excess to need retains current capacity; it only changes the ownership of that capacity.

Create a Federal Government Corporation

The federal government corporation (FGC) option was conceived as a compromise between the privatization option, which would leave capability in private hands, and the consolidation and recapitalization options, which would leave it in Army hands. An FGC would combine the safety and stability of a government agency with many of the incentives and freedoms of private firms. FGCs operate at the boundary between the public and private sectors and possess some of the characteristics of both classes of organizations. Federal government corporations are relatively common; the Congress has created about one a year since World War II.

Federal government corporations have many of the characteristics of a private firm: they operate as commercial organizations but receive some government subsidies; have boards of directors; can raise capital by borrowing or issuing debt; have the right to sue (and be sued); are not bound by federal procurement regulations; and their employees are not necessarily subject to civil service rules.

For the ordnance activities at hand, an FGC might be chartered first to meet DoD's ordnance requirements but also to use the existing underused capacity

to manufacture commercial products. This dual authority would provide the greatest benefit at the arsenals, whose manufacturing equipment is suitable to commercial production in a number of markets, most notably machine shop, oil and gas machinery, industrial valves, and structural steel. Dual use of productive capacity would have the potential to greatly improve the efficiency of the arsenals by spreading the overhead burden across commercial products as well as Army products and converting indirect labor to direct. Both the spreading of the overhead and the labor conversion would reduce the cost to the Army of the ordnance materiel it would continue to procure from the FGC. The option would have the added benefit of stabilizing or even potentially increasing the levels of employment at the arsenals, where the workforces have suffered through repetitive employment reductions for a decade or more, destroying morale and causing a continuing hemorrhage of talent. For reasons explained in detail in the report, the FGC appears to be a less attractive option for the ammunition plants, particularly the contractor-operated ones.

Consolidate

This option would leave the ordnance base under the control of the Army. It would consolidate the needed capacity on fewer installations, declare the unneeded plants excess, and dispose of them under government procedures. The equipment would either move to the new site or be replaced. Employees would either move to the new site, transfer to other facilities, or be terminated. Consolidation could reduce overhead costs and result in more efficient operations, particularly if old equipment is replaced. While the capabilities at the various facilities are highly specialized and in some cases unique to each plant, in some cases it may be possible to combine similar processes at two plants onto a single line, achieving economies of scale. Consolidation would incur front-loaded costs to move capabilities and personnel, to build facilities at receiving locations, and often to conduct environmental remediation before transfer of property declared excess to need. Because it would involve the transfer of jobs, consolidation would incur political costs as well. Finally, consolidation of the government-operated facilities would require base realignment and closure (BRAC) legislative authority.

Recapitalize and Unify

This option envisions a long-term strategy of relocating the organic base entirely on multifunctional installations of the Army or the other services. Ideally it would be part of a broader Army or DoD base realignment strategy to eliminate the many single-function installations that today house such activities as headquarters, training, and industrial operations. It would share some of the

same benefits as consolidation in terms of reducing overhead costs. BRAC legislation would be required for the government-operated facilities.

ASSESSMENT OF OPTIONS

The status of the facilities needs to be taken into account in assessing the options. They fall into three categories: arsenals; government-owned and -operated (GOGO) ammunition plants; and government-owned, contractor-operated (GOCO) plants. An installation's category affects the attractiveness of options, because each category is subject to different statutes and rules.

The recapitalize-and-unify option is set aside for two reasons. First, it depends on two problematic events: the implementation of a fifth round of BRAC, which has been authorized for FY05 but may still be uncertain, and, within a broad BRAC strategy, the adoption of this option. The other options may be implemented, at least for part of the base, without BRAC legislation or similar broader authority. Second, the option does nothing to move the base in the direction of increasing private-sector reliance, an objective that, after analysis, appears appropriate.

Turning to the remaining three options, consolidation is not without merit, but it does not offer many advantages. It would help address the problem of expensive overhead, and it could meet the Army's demands. But it does not solve other problems. It still leaves the facilities under the control of the Army, which thus will continue to expend management attention. Installations declared excess to need risk divestiture without compensation to the Army. The history of BRAC indicates that the service does not realize much revenue from the sale (about 10 cents on the dollar of fair market value). Also, the Army may be required to clean up environmental hazards before the installation can be turned over for alternative uses, and the turnover process can be quite lengthy, on average about nine years. Furthermore, the Army would incur the front-loaded relocation and construction costs associated with consolidation with little prospect of achieving economies of scale in manufacturing.

On the other hand, the privatization and federal government corporation options offer many benefits that consolidation lacks, and both can meet mission requirements. The former gets both the DoD and the Army out of the business of managing a peripheral function for which they have no special expertise and places the function in the hands of those who do. It improves access to capital and provides incentives for the owners to raise capital and invest in the plants. It also generates revenue from the sale of the plants. Because the plant does not close, workforce issues are less of a problem. Nor does the Army have to pay any construction costs as it would under consolidation, and increased competition creates incentives to reduce overhead costs.

Table S.1
Legal Constraints on Options

Option	Category of Facility		
	GOCO Plants	GOGO Plants	Arsenals
Privatize		No enabling authority exists. Protective legislation in place ^a	No enabling authority exists ^b
FGC	Requires authorizing legislation	Protective legislation in place for Crane and McAlester	Requires authorizing legislation
Consolidate		Protective legislation in place for Crane and McAlester	Requires BRAC legislation

^aAn A-76 competition could be conducted for Pine Bluff.

^bAn A-76 competition could be conducted.

The federal government corporation offers most of the benefits of privatization, except that it does not completely divest the government of ownership of the plants in that they remain under a quasi-government corporation (although the Army would not own them).

As mentioned, each option faces different legal constraints. Table S.1 depicts these for the three types of facilities by option. A blank cell indicates no constraint.

The GOCO plants face the fewest constraints. The federal government corporation would require authorizing legislation. However, Congress has passed many of these, so, assuming that political leaders in the affected locations supported the proposal, passing the legislation should not prove overly difficult. The same point would apply to creating a federal government corporation for the arsenals. Privatizing the arsenals would prove more problematic because no authority exists to do that directly. Consolidating the arsenals would require BRAC legislation, which the Congress has authorized for FY05 but which it could also reconsider between now and then. The GOGO plants face the most constraints because two (Crane and McAlester) operate under protective legislation that prevents the conversion of work there to contract. At the third, Pine Bluff, the provisions of Office of Management and Budget Circular A-76 could permit the conversion of some workload to contract.

WHAT WE RECOMMEND

We recommend the Army adopt a mixed strategy. Specifically, we recommend that the Army:

- Sequentially privatize 10 of the 11 GOCO ammunition plants, retaining Mississippi AAP.
- Retain the three GOGO ammunition plants as government facilities, providing a hedge of government-owned capacity.
- Create a federal government corporation for the two arsenals. After five years of operation, privatize the FGC unless overriding considerations dictate continuance as an FGC.
- Withhold all further facility-use contract competitions pending decisions on this study.

The GOCO Plants

We recommend privatization of the GOCO plants, except for Mississippi AAP, which the Army does not own. Declare the plants excess to ownership but not excess to need, so that capability is retained, plants are sold as going concerns, and likelihood of sale revenue is enhanced. Use legal authorities to transfer property before environmental cleanup is completed, and trade sale revenue for agreement of buyers to conduct cleanup. Sell the plants in packages that maximize sale value. Sequence the sales so that early lessons learned can be applied to subsequent sales. In the meantime, we recommend deferring any further long-term commitments to facility-use contractors.

The GOGO Plants

We recommend that the Army retain the three GOGO ammunition plants along with Mississippi AAP as a hedge against unforeseen need for Army-owned facilities. Retaining these four installations retains more than half of the current government-owned acreage devoted to ammunition plants.

The Arsenals

For the arsenals, because there appears to be no authority for direct privatization, we recommend that the government create a federal government corporation to own and run them. The corporation will be chartered not only to meet DoD needs for ordnance materiel, but also to use its substantial capabilities and capacities to manufacture commercial products. The corporation may be chartered either as a permanent entity or with a provision for its board of directors to recommend at the end of a five-year period whether to continue the corporation or to privatize it. We favor an assumption of subsequent privatization, but experience could indicate continuance of the FGC as the preferred long-term option.

FALLBACK STRATEGIES

Many pitfalls dot the path of these recommendations, and it is quite possible that the Army may not be able to carry out all the recommendations for one reason or another. Should one of the primary strategies fail, the Army still has options.

If a particular GOCO plant does not generate a fair price, the Army still has both a short- and a medium-term option. In the short term, the Army could sell property and perhaps buildings while retaining land, which it would lease for a very long term to provide incentives for lessees to invest as if they owned the land. While falling short of complete privatization, such a fallback would bring some of the benefits of complete privatization. Manufacturing capital would be in the hands of a firm with access to capital and incentives to modernize. As simply a landowner, demands decline for Army management attention. But retaining the land forgoes the revenues from sale.

In the medium term, the Army might consolidate some of these facilities to achieve overhead savings. But, as pointed out above, consolidations entail large front-end costs. Further, they incur the human and political costs associated with moving the workload of hundreds of employees to new locations. Finally, the consolidation leaves the remaining assets in government hands, doing nothing to move toward the vision of private-sector reliance and forgoing the other benefits of private-sector reliance. Consolidation, while potentially worthwhile, represents an inferior solution.

Turning to the arsenals, if either the Army or DoD rejects the proposal to create an FGC to own and operate the arsenals or if the Congress looks unfavorably on an administration proposal to create one, there are alternatives to consider. An option available outside of BRAC authority would be to convert one or both of the arsenals to GOCO operation, but the small and uncertain anticipated demand makes this prospect unlikely. That leaves only consolidation or divestiture under a possible future BRAC as an option. As noted earlier, this is an inferior option. One other possibility for the arsenals would require a willing buyer, perhaps a consortium of local interests, with a proposal to buy one or both of the arsenals, maintain Army-required capability, and employ the available capacity to manufacture commercial products. If the proposal met with Army approval and could provide reasonable expectation of commercial success and employment, then the Army might submit a request for special privatizing legislation, meeting the congressional reporting and notification requirements of 10 USC 2687. The likelihood of this set of events occurring, however, seems small.

HOW DOES THE GOVERNMENT BENEFIT?

What benefits does the strategy offer the government? They are of two types: intangible and tangible. The intangible but very real benefits include those of freeing the Army from managing manufacturing operations and placing the responsibility in the hands of those who know more about it. Senior Army leaders no longer have to operate outside their primary area of expertise, and the arsenals and ammunition plants now operate under market forces, which should encourage innovation and efficiency.

The tangible benefits are cost savings, and they could be substantial, both over the POM years and over a 20-year projection. Tables S.2 and S.3 show the estimated net present value of savings from privatizing the 10 GOCO ammunition plants and creating an FGC for the arsenals. Table S.2 shows the figures for the budget and POM through FY09; Table S.3 shows the same figures for a 20-year time horizon, through FY22.

Savings from privatization of the 10 GOCO ammunition plants result principally from reduced ammunition costs due to improved productivity and greater competition; revenue from sale of property; reduced government staff; and savings from ARMS appropriations net of increased tenant revenues. While the unit price contractors charge may actually rise, total costs to the Army should fall as the costs associated with the government's ownership of facilities are eliminated. The three cases, pessimistic, base, and optimistic, vary assumptions concerning sale revenue, product prices, Armament Retooling and Manufacturing Support Initiative (ARMS) costs and benefits, contract termination costs, employee termination costs, and discount rates.

Savings from the creation of the FGC for arsenals result principally from the restructuring of the labor force to industry-standard ratios of direct to indirect labor and the sharing of overhead with commercial production. The three

Table S.2

Net Present Values of Savings to the Army from Privatization of GOCO Ammunition Plants and Creation of FGC for Arsenals: FY03–09
(\$ millions)

	3% Interest Rate			7% Interest Rate		
	Pessimistic	Base	Optimistic	Pessimistic	Base	Optimistic
Privatization	174	635	840	164	568	754
FGC	418	551	551	361	472	472
Total	592	1,186	1,391	525	1,040	1,226

cases vary assumptions concerning rate of conversion of commercial workload, employee retraining costs, transition costs, and initial working capital infusion.

A word of caution is in order. In privatizing the GOCO plants, there is substantial uncertainty in estimates both of sale revenue and future ammunition prices. While revenues are estimated here using conservative assumptions, one cannot know for sure what a competitive or negotiated sale will bring. But the risk is not great. In selling property, the Congress oversees GSA and will approve only sales that generate a reasonable market value. The Army can withdraw from transactions that fail to produce reasonable bids. Similarly, to the extent that competitive pressures fail to generate reasonable offers on concurrent agreements for future ammunition prices, the Army need not agree. Hence, while the uncertainty is substantial, the financial risk is small.

With regard to the creation of the FGC, the financial risk to the Army is similarly small. To the extent that the FGC is unable to fully restructure to commercial standards, even a partial movement in that direction will serve to reduce the prices the Army pays for its ordnance materiel. Even if the FGC is able to bring in only a fraction of the commercial work hypothesized in the business plan, the Army is still better off financially. Hence, the financial risk to the Army from creating the FGC is modest.

Thus, both the intangible and tangible benefits to the Army are considerable. This is not to minimize the difficulties of carrying out the recommendations. The history of the Army and its ordnance manufacturing base is long, and it has served the needs of the nation well. The changes proposed here are sweeping. Many involved with the base will be reluctant to make dramatic changes in institutions that have served their purpose well. However, the problems described above are real, and it will take major changes to resolve them. The vision and recommendations proposed here chart a feasible path for the Army to follow.

Table S.3

**Net Present Values of Savings to the Army from Privatization of GOCO Ammunition Plants and Creation of FGC for Arsenal: FY03-22
(\$ millions)**

	3.5% Interest Rate			7% Interest Rate		
	Pessimistic	Base	Optimistic	Pessimistic	Base	Optimistic
Privatization	-64	1,062	1,583	6	861	1,240
FGC	1,177	1,732	1,732	871	1,264	1,264
Total	1,113	2,794	3,316	877	2,125	2,504

A final word. The proposed strategy will not solve all the problems identified in the base. Regardless of who owns the manufacturing assets, the Army should resource ammunition procurement in ways that enhance the stability and efficiency of its base.

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ABBREVIATIONS

A-76	OMB Circular A-76
AAA	Army ammunition activity
AAP	Army ammunition plant
AFB	Air Force Base
AMC	Army Materiel Command
ANAD	Anniston Army Depot
AOR	Accumulated Operating Results
APFSDS	Armor Piercing, Fin Stabilized, Discarding Sabot
ARMS	Armament Retooling and Manufacturing Support
ASPI	Arsenal Support Program Initiative
ATACMS	Army Tactical Missile System
ATK	Alliant Techsystems, Inc.
AWCF	Army Working Capital Fund
BDM	Bunker Defeat Munition
BLS	Bureau of Labor Statistics
BOD	Board of directors
BRAC	Base realignment and closure
CAPM	Capital Asset Pricing Model
CFR	Code of Federal Regulations
CNC	Computer numerically controlled
COCO	Contractor-owned, contractor-operated
COR	Contracting officer's representative

D&Z	Day & Zimmerman
DA	Department of the Army
DCAA	Defense Contract Audit Agency
DCF	Discounted cash flow
DCSOPS	Deputy Chief of Staff for Operations
DLH	Direct labor hours
DoD	Department of Defense
DP	Dual purpose
EBIT	Earnings Before Interest and Taxation
EBITDA	Earnings Before Interest, Taxation, Depreciation, and Amortization
EPA	Environmental Protection Agency
ETO	Excess to ownership
EV	Expected value
FCF	Free cash flow
FGC	Federal government corporation
FMR	Financial management regulation
FMS	Foreign military sales
FY	Fiscal year
GAAP	General accepted accounting principles
GAO	General Accounting Office
GD	General Dynamics
GD-OTS	General Dynamics Ordnance and Tactical Systems
GE	General Electric
GOCO	Government-owned, contractor-operated
GOGO	Government-owned, government-operated
GSA	General Services Administration
GSE	Government sponsored enterprise
HAAP	Holston AAP
HMMWV	High mobility multipurpose wheeled vehicle
HMX	High Melting Explosive

HQDA	Headquarters, Department of the Army
IAV	Interim armored vehicle
IBPR	Industrial base program review
ICM	Improved conventional munition
IF	Industrial facilities
IMC	Industrial mobilization capacity
JDAM	Joint direct attack munition
JSOW	Joint stand-off weapons
LAAAP	Louisiana AAP
LAP	Load, assemble, pack
LCAAP	Lake City Army Ammunition Plant
LIF	Layaway of Industrial Facilities
LOSAT	Line of sight anti-tank
MACS	Modular Artillery Charge System
MIIF	Maintenance of Inactive Industrial Facilities
MLRS	Multiple Launch Rocket System
MTW	Major theater war
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National priorities list
NPV	Net present value
OMB	Office of Management and Budget
OPFOR	Opposing force
OSC	Operations Support Command
OSD	Office of the Secretary of the Defense
PBD	Program Budget Decision
PBP	Production base plan
PEO	Program Executive Office
PEP	Plant equipment packages
PL	Public Law

PNNL	Pacific Northwest National Laboratories
POM	Program Objective Memorandum
PP&E	Property, plant, and equipment
PV	Present value
QDR	Quadrennial Defense Review
R&D	Research and development
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive
RIA	Rock Island Arsenal
RIF	Reduction in Force
RRAD	Red River Army Depot
SADARM	Sense and destroy armor
SAG	Study Advisory Group
SIC	Standard Industrial Classification
SIC	Standard Industrial Classification
SLAP	Saboted Light Armor Piercing
SRAW/MIPM	Short Range Assault Weapon/Multipurpose Individual Mmunition
TAA	Total Army Analysis
TACOM	Tank-Automotive and Armaments Command
TNT	Trinitrotoluene
TOW	Tube Launched, Optically Tracked, Wire Guided
TOWF&F	TOW fire and forget
TPCSDS-T	Target practice cone-stabilized discarding sabot with tracer
TSDF	Treatment, storage, and disposal facilities
U.S.H.R.	U.S. House of Representatives
USC	United States Code
USDA	U.S. Department of Agriculture
USEC	U.S. Enrichment Corporation
USF	United States facilities
USOC	U.S. Ordnance Corporation

VSIP	Voluntary Separation Incentive Payment
WACC	Weighted average cost of capital
WVA	Watervliet Arsenal

The Department of the Army meets its materiel requirements principally through purchase from private sources. However, the Army produces certain ordnance-related items and performs some ordnance-related services in a set of arsenals, ammunition plants, other ammunition activities, and depots. The Army operates some of these facilities; contractors operate others. Although this set of facilities has been reduced since the end of the Cold War, the remaining facilities still operate at less than their full capacity today. The unused and underused capacity raises questions about how many of these facilities the Army needs, how large they need to be, and who should own and operate them. This report represents the third phase of a multiyear study that examines the Army's ordnance industrial base and makes recommendations about these issues.

SCOPE AND HISTORY OF THE STUDY

The Army defined the scope of this study to encompass the manufacturing activities of only 14 ammunition plants and 2 arsenals. It excluded depots. In April 2000, the Office of the Deputy Chief of Staff for Operations and Plans (DCSOPS) asked RAND's Arroyo Center to undertake the study.

Upon agreeing with RAND Arroyo to conduct the research, the Army created a study advisory group comprising representatives of OUSD(AT&L), OUSD(C), the Joint Staff, ODUSA(OR), OASA(ALT), OASA(FM), PAED, ODCSLOG, Center for Army Analysis, Army Materiel Command, and chaired by the director of Force Development, formerly in DCSOPS, recently transferred to the newly created DCS for Programs now redesignated the G-8.

As research progressed, a three-phase research project evolved. The study advisory group (SAG) endorsed the following approach:

Phase 1: Assessment of excess capacity at Watervliet and Rock Island arsenals.

Phase 2: Derivation and qualitative assessment of a broad range of options for all sixteen facilities.

Phase 3: Development of specific mixed strategies and quantitative assessment, to include recommendations.

In addition, the Army asked us to address a smaller, separate task, which is to assess duplicative capacity between the arsenals on the one hand and the depots on the other. The results of that task are provided in Appendix A.

STUDY PROGRESS TO DATE

Phase 1: Watervliet and Rock Island Arsenals

Phase 1 was completed in July 2000. That research conveyed three principal insights. First, both arsenals are maintaining plant capacity and manufacturing equipment well beyond their needs to meet either programmed or replenishment requirements. We endorse an earlier Army Materiel Command (AMC) analysis revealing excess capacity at both arsenals, and we recommend that Watervliet divest 43 percent of its equipment (reducing from 1,153 pieces to 653) and that Rock Island divest 22 percent (reducing from 1,606 pieces to 1,249). Similarly, we observe that the two arsenals could divest 31 percent and 29 percent of their manufacturing space, respectively. That divestiture is under way. A more thorough analysis would probably reveal that greater divestitures are possible but would be unlikely to improve efficiency substantially.

We also estimate that such divestitures would save little money, on the order of only \$5.2 million cumulatively, net of costs, between FY01 and FY07. The recurring annual savings represent less than one-half of one percent of the annual operating costs of the two arsenals. The research found, and the SAG agreed, that divesting excess manufacturing space and equipment, while worthwhile, did not solve the problems observed. This finding caused the study team and the SAG to reorient the research on to issues of governance and setting, because these appeared to offer greater promise.

Finally, we learned that the process that determines replenishment requirements is slow and conservative, yielding generous requirements that vary widely from year to year. Nevertheless, capacity at the two arsenals was considered to be more than adequate to meet anticipated needs.

Phase 2: Qualitative Assessment of Broad Options

Phase 2 research, completed in November 2000, resulted in a report (Hix et al., 2003) distributed within the Army in early 2001. That report is being published concurrently with the report at hand.

The Phase 2 report found that despite the uncertainty and variance surrounding the requirements process, the options set forth can be pursued without waiting for the process to improve. (Appendix B of this report amplifies issues related to the replenishment requirements process.) Such is the case because all these options permit the Army to meet any plausible range of requirements.

The analysis indicates that an important key to improving the production of ordnance items lies in changing the governance of the base. Accordingly, two of the four options transfer ownership of manufacturing assets from the Army to other entities; the other two offer ways to improve efficiency while remaining under Army control.

The Phase 2 report's four options, in addition to the status quo, are as follows:

- Privatize to divest functions that are not inherently governmental and to harness private incentives.
- Create a federal government corporation to divest noncore functions and harness private incentives, but retain government control of assets.
- Consolidate to achieve a more efficient base.
- Recapitalize and unify to meet new demands and to achieve efficiencies.

Privatizing means divesting the installation and the means of production and simply buying the products from private firms. The option permits consolidation of any assets considered inappropriate for privatization onto a smaller number of installations, but the imperative underpinning of this option is to privatize.

Creating a federal government corporation (FGC) transfers production assets to a congressionally chartered FGC. Implementation options would permit either the Army or the FGC to consolidate and divest unneeded assets. Because of its entrepreneurial freedom and bottom-line incentives, the FGC could be expected to find broader uses for the plants, equipment, and land than the Army does today.

Consolidating attempts to relocate functions on as few of the current set of properties as possible, divesting the facility of unneeded land, buildings, and equipment, thereby saving base support costs and achieving economies of scale

in manufacturing by collocating manufacturing operations. The remaining plants continue to operate as single-function installations.

Recapitalizing and unifying the base is driven by two assumptions, namely that in the long run, new manufacturing technologies will be required and that the Army will want to get out of small, single-function installations and consolidate onto more enduring, multifunctional installations, perhaps multiservice ones. Recapitalization may or may not result in consolidation of these manufacturing operations. It will, however, mean that manufacturing will no longer be accomplished on stand-alone ammunition installations.

The qualitative assessment involved weighing the options against a criteria set approved by the Army.

Phase 3: Development and Assessment of Specific Options

Upon approval of the Phase 2 research findings in November 2000, the SAG directed the Arroyo Center to postpone detailed Phase 3 analysis until the new administration had an opportunity to review and endorse the new options. In April 2001, the Vice Chief of Staff directed the Arroyo Center to resume assessment of the four options.

In September 2001, the Army created an ad hoc Industrial Base Program Review (IBPR) group with a more focused but closely related purpose to that of the ongoing study. The IBPR undertook two missions: (1) to divest the Army of logistics facilities that had already been declared excess and (2) to identify other logistics facilities for divestiture. The IBPR group includes the same Army organizations that made up the earlier SAG, but has added the Assistant Secretary of the Army (Installations and Environment). Further, the new group excluded the non-Army agencies. Finally, members were at the three-star and assistant secretary level rather than the two-star and deputy assistant secretary level. Because of the substantial overlap, in the fall of 2001 the Army decided to abolish the earlier SAG and fold the oversight of the research into the IBPR domain.

As a part of the integration of the two efforts, the Army also decided to limit the scope of the IBPR to the arsenals and ammunition plants under review in the ongoing study.

Further, the Army has expressed its desire to divest its non-mission-critical logistics infrastructure by FY07. Figure 1.1 illustrates the logic we proposed and the Army adopted in thinking through what infrastructure it needs to continue to own. The logic implies that to be consistent with 10 USC 2501 and 2535, even mission-critical infrastructure can reside in the private sector. The term "mission-critical" means simply that the capability is needed, not that the Army

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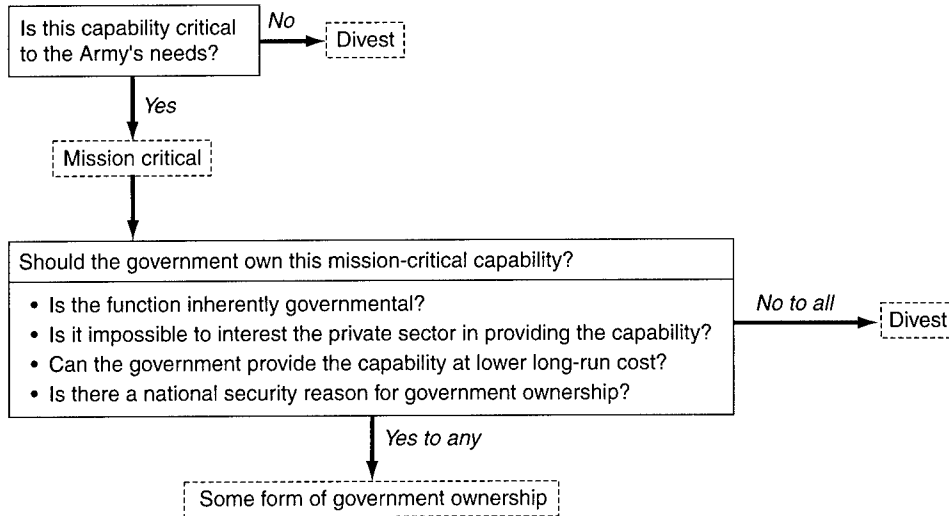


Figure 1.1—Logic Underpinning Determination of Ownership of Mission-Critical Capability

or even the government needs to own it. Today, the commercial side of defense industrial base includes many mission-critical capabilities that the government does not own and sees no need to own. Such mission-critical capabilities produce missiles, aircraft, ships, and other weapon systems. Many are one-of-a-kind and essential to DoD.

Hence, if a capability is needed but none of the four reasons for government ownership apply, the private sector is the appropriate setting for it.

THE ORDNANCE INDUSTRIAL BASE TODAY

This study focuses on the manufacturing activities occurring on a set of 16 government-owned installations: 2 arsenals and 14 ammunition plants (Table 1.1). It excludes 13 excess ammunition plants awaiting disposal as well as the Army's depots and other logistics-related industrial facilities.

While no two facilities have the same precise mission, they cluster according to three characteristics: (1) related missions, (2) whether the manufacturing is done by Army or private employees, and (3) their source of funding. Table 1.1 arrays installations according to these three characteristics. It also shows the principal products produced by each.

Ownership and Workforces

Although the Army owns 14 of the 16 facilities and is a tenant on the other two—NASA owns Mississippi Army Ammunition Plant (AAP) and the U.S. Navy owns Crane Army Ammunition Activity (AAA)—Army employees manufacture the products produced on only five of the facilities. These facilities are funded through the Army Working Capital Fund. Two of the five Army installations, Watervliet and Rock Island Arsenals, manufacture ordnance materiel such as gun tubes, cannon, gun mounts, and related nonammunition ordnance items. The other three produce different types of munitions.

Civilian contractors manufacture the ammunition in the other 11 plants. Two of these, Mississippi and Louisiana, are laid away for potential future use to replenish stocks after hostilities. In terms of the dollar volume of ammunition business, an array of roughly 70 private manufacturers of Army ammunition operating in completely commercial plants dominates this so-called “organic base” of 14 government-owned ammunition plants. These privately owned plants receive about two-thirds of the conventional ammunition dollars the Army manages each year for all the services. In the organic base, private employees operating on the 11 government-owned, contractor-operated (GOCO) plants produce about 30 percent of the dollar value of the ammunition; federal employees at the three government-owned, government-operated (GOGO) plants produce the remaining 5 percent (McManus briefing, 2001, slide 4). The GOCO ammunition plants have highly differentiated capabilities, as reflected in the distinct product lines shown in Table 1.1.

How the ammunition plants are managed—as GOGO, GOCO, or commercial—is largely historical. For example, Rock Island has a long history of manufacturing towed howitzers and recoil mechanisms. However, most of that business has now moved into the commercial sector as program managers seek to avoid high unit costs in the arsenals. In particular, the systems contractors for both the interim armored vehicle (IAV) and the lightweight 155mm howitzer have chosen commercial sources for their gun mounts. As a result, only a small part of Rock Island’s workload is the manufacture of its historically important products. The arsenal is surviving through a wide array of miscellaneous activities, including assembly of hand tool sets, fabrication of dummy turrets for opposing force vehicles at the National Training Center, and creation of mobile shop kits. Watervliet retains its reputation as a premier manufacturer of gun tubes and cannon despite spiraling costs. The arsenal will make gun tubes for both the IAV and the lightweight howitzer.

Table 1.1
Facilities Included in the Study

Installation	Contractor	Principal Products
Arsenals and Ammunition Plants Operated by Army Employees: Funded Through the Army Working Capital Fund		
Arsenals		
Watervliet Arsenal	N/A	Gun tubes, cannon
Rock Island Arsenal	N/A	Miscellaneous mfg, gun mounts
Load, Assemble, and Pack		
Ammunition Plants		
Crane AAA (Navy)	N/A	Navy munitions
McAlester AAP	N/A	Bombs
Pine Bluff Arsenal	N/A	Incendiary, illumination, smoke
Ammunition Plants Operated by Contractor Employees: Funded Through Procurement Appropriation		
Metal Parts		
Scranton AAP	Chamberlain Mfg	Large-caliber metal parts
Riverbank AAP	Norris Industries	Cartridge cases, grenade metal parts
Louisiana AAP	Valentec	LAID AWAY. Artillery metal parts
Mississippi AAP (NASA)	Mason Technologies, Inc.	LAID AWAY. Grenade metal parts
Load, Assemble, and Pack		
Ammunition Plants		
Lake City AAP	Alliant Techsystems	Small arms
Kansas AAP	Day & Zimmerman	Sensor-fuzed weapon (U.S. Air Force)
Lone Star AAP	Day & Zimmerman	Submunitions
Milan AAP	American Ordnance	Medium-caliber
Iowa AAP	American Ordnance	Tank and artillery
Energetics		
Holston AAP	BAE Ordnance Systems	Explosives
Radford AAP	Alliant Techsystems	Propellants

Funding of Ordnance Materiel

Here we turn to the recent and planned funding levels for conventional ammunition and the ordnance materiel produced in the two arsenals.

Conventional ammunition. In FY02, the three U.S. military departments will procure a total of just over \$2.5 billion in conventional ammunition.¹ The President has requested an increase of nearly \$800 million for FY03 (Table 1.2).

¹This figure excludes the far larger amount for procurement of missiles, which in FY02 will total \$5.4 billion. The term "conventional ammunition" is used to distinguish it from missiles rather than from nuclear weapons.

Table 1.2
Procurement of Ammunition
(billions of then-year dollars)

	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03
Army	1.111	1.127	1.037	1.066	1.204	1.221	1.200	1.159
Navy	0.430	0.290	0.398	0.484	0.525	0.498	0.461	1.015
Air Force	0.339	0.293	0.399	0.379	0.443	0.648	0.867	1.134
Total	1.880	1.710	1.834	1.929	2.172	2.367	2.528	3.308

SOURCES: U.S. House of Representatives, 1995, 1996, 1997, 1998, 1999, 2000, 2001; U.S. Department of Defense Budget, FY03.

NOTE: Figures exclude \$789 million of no-year funds appropriated in an FY01 supplemental appropriation following the terrorist attacks of September 11. These funds will be obligated in FY02 and beyond by the Military Departments as follows: Army, \$38M; Navy, \$495M; Air Force, \$257M. (From "Defense Emergency Response Fund Execution Report," submitted to the four Congressional Defense committees in accordance with reporting requirements described on page 425 of the Conference Report to the FY02 DoD Appropriations Act, PL 107-117.) Further, the FY03 President's Budget figure is likely to be augmented with a separate supplemental appropriation.

The dollar amount of ammunition procurement is growing both in real and in nominal terms and has done so since FY97. But today's ammunition procurement levels remain well below those of the Cold War. For example, even as recently as FY91 the Army alone bought \$2 billion in ammunition (Munitions Industrial Base Task Force, 1994, p. II-6).

Since FY00, Air Force ammunition funding has nearly tripled, accounting for most (about 60 percent) of the aggregate DoD growth. During the same period, the Navy and Marine Corps (shown together in Table 1.2) have almost doubled theirs, while Army ammunition funding remains essentially flat. The largest increases in both Air Force and Navy ammunition procurement fund joint direct attack munitions and laser-guided bombs, both of which were prominently used in Kosovo, Afghanistan, and Iraq.

In FY03 the Army will, as the Defense Department's single manager for conventional ammunition, manage the procurement of all its own ammunition as well as more than \$300 million of that of the Air Force and about the same amount for the Department of the Navy.² Hence, the Army will manage the procurement of more than \$2 billion of the total \$3.3 billion proposed for FY03.

²The level of detail in the FY03 budget documents publicly available at the time of this writing does not permit a precise estimation of the proportion of the Air Force and Navy ammunition budgets that the Army will manage.

Ordnance items. In addition to ammunition, the Army procures a wide array of weapon systems and combat vehicles. In FY03 the Army will spend about \$2.2 billion on these items, including spare and repair parts (U.S. Department of Defense, 2002, p. II). Less than 10 percent of the value of such items and the components that go into them is created in two government-owned and -operated arsenals, Watervliet and Rock Island. The two arsenals manufacture these items principally for the Army and the Marine Corps, but they also produce materiel for foreign nations. These items, which we term "ordnance items," include gun tubes, cannon, gun mounts and recoil mechanisms, towed howitzers and related spare parts, as well as an array of tool sets and other miscellaneous items. The annual revenues of these two arsenals amount to roughly \$200 million.

Replenishment

The industrial base, both organic and commercial, must meet more than the peacetime requirements placed on it. It must also be capable of replenishing stocks of ordnance materiel consumed during conflicts.

During the Cold War, the DoD planned to surge its industrial base during an assumed lengthy and large conflict. In recent years, the conflicts are assumed to be shorter and less stressing. Today, the DoD plans to fight with war reserve stocks procured before conflicts. The industrial base is assumed to ramp up to replenish consumed stocks only after the termination of hostilities.

When assessing any options that affect the industrial base, it is essential to weigh their implications for replenishment capability. Appendix B offers a detailed description of current replenishment policy as well as issues and options for meeting replenishment requirements. Chapter Eight recommends a strategy for meeting those requirements.

ORGANIZATION OF THIS REPORT

Chapter Two offers a detailed history of weapons and ammunition production in the United States.

Chapter Three describes contemporary problems and issues associated with the industrial base.

Chapter Four presents a strategic vision for the base, describes policy options for moving toward that vision, sets forth assessment criteria by which options may be assessed, and sets aside certain options for reasons of feasibility.

Chapter Five describes the option of privatization of the base and assesses in detail the risks associated with such an option. This chapter assumes the reader to be generally familiar with privatization.

Chapter Six describes the option of creating a federal government corporation to own and manage all or part of the base. Because federal government corporations are not widely understood, it spends some time providing the background on these organizations. It also provides detail on the financial aspects of an FGC that make it a potentially attractive option.

Chapter Seven summarizes the assessment of the options against the criteria and describes the range of implementation strategies should the highest-rated options be implemented.

Finally, Chapter Eight recommends a specific strategy for achieving the vision and lays out both the near-term and long-term savings the strategy should produce.

The report also has five appendixes. Appendix A addresses the issue of overlap between the arsenals and depots. Appendix B discusses in detail the replenishment policy for ammunition. Appendix C provides the underlying mathematical calculations for the model of GOCO competition with uncertainty. Appendix D contains detailed information about the arsenals and ammunition plants and spreadsheets that show the calculations used to estimate the savings under three sets of assumptions (base, optimistic, and pessimistic). Appendix E details the procedures we followed in the parcel valuations.

**BUILDING THE NATION'S FOUNDRY: THE EVOLUTION OF
THE ARMY ORDNANCE INDUSTRIAL BASE**

As the Army and others consider how to modify the ownership and organization of its ordnance industrial base, it is important to understand that any significant change will bring about a profound cultural shift. Furthermore, this cultural bias is not confined to the Army; it extends to the Congress as well. The current structure is rooted deep in the Army's history, and many of the attitudes that form the thinking about how weapons and munitions should be provided to the forces trace back to the very origins of the Army and, indeed, the nation itself. This is not to say that these attitudes are either wrongheaded or obstructive. However, as policymakers consider other ways to provide weapons and munitions, it is important to understand that such attitudes exist and why. This chapter briefly outlines the history of how the nation armed itself, beginning in days of the revolution, and charts how the United States arrived at a way of procuring weapons and munitions that differs substantially from most other nations.

Two patterns characterize how the Army supplies itself with weapons and munitions. Before World War II, the Army faced the dual requirements of equipping its modest peacetime force for active service while simultaneously preparing for mobilization in the event of a national emergency. In the rush to arms in any given conflict, prewar preparations were generally inadequate. Thus a buildup normally took place before the Army could begin active campaigning. Following World War II, arming a large standing Regular Army—deployed overseas even during peacetime—and National Guard and Reserve forces has been the norm. In contrast, constant readiness and large peacetime standing forces, with rapidly available reserve force augmentation, are perhaps the defining characteristics of the post-World War II Army. The remainder of this chapter examines how the Army and the nation have approached the issue of arming these very different forces.

THE FIRST ERA: ARMING THE SOLDIERS OF A NEW NATION

Colonial Antecedents

During the years before the American Revolution, the militia system provided for the defense of the individual colonies. In theory, all men between the ages of sixteen and sixty were required to arm themselves and be available for militia service. If individuals could not afford weapons, their local town provided them, pending payment (Huston, 1966, pp. 4–5).

The militia was a decentralized institution, centered on each colony, and members served under locally elected officers (Huston, 1966, pp. 4–5). As the colonies became more developed and the threats along the frontiers lessened, the zeal for militia service—and accountability for meeting its requirements—receded. Increasingly, volunteers, instead of militia drafts, were relied upon to supplement British regulars in the North American wars between England and France. Even when the militia was called up, the more well-to-do often paid for substitutes (Millet and Maslowski, 1984, pp. 41–42). In the case of the French and Indian War, colonial troops were raised and paid by the colonies, while the British government provided arms and ammunition (Huston, 1966, p. 4).

Arming the Revolution

When active conflict finally erupted between Massachusetts militia and British regulars at Lexington and Concord on April 18, 1775, it marked the onset of a revolution whose origins lay in some ten years of increasingly strained relations between the colonies and the mother country. As tensions grew, the colonial legislatures had already begun making preparations in the event war did break out. Militia training increased, and weapons and ammunition were collected (Risch, 1981, p. 335). The Revolution, however, was fought by two American armies that “created a ‘dual army’ tradition that combined a citizen-soldier reserve (militia) . . . with a small professional force that provided military expertise and staying power.” A Regular Army was thus at least a temporary necessity, and the Congress created the Continental Army (Millett and Maslowski, 1984, p. 53). Arming this mixed force would present significant challenges throughout the Revolution.

The Americans had three sources of supply for arms and ammunition: domestic manufacture, captured materiel, and foreign imports. On the domestic side, both states and the Continental Congress opened foundries that produced small arms, artillery, and ammunition. Captured weapons augmented American stores—most famously after the battle of Ticonderoga. Additionally, American privateers preyed on English shipping in search of munitions.

Nevertheless, during the course of the war, the American demand for arms outstripped what could be produced domestically or captured from the British. The key source of supply was foreign procurement. The decentralization of the government, however, created difficulties in procuring weapons and munitions abroad, because the states and the Continental Congress competed with each other in foreign markets. The leaders of the revolution also realized that to guarantee their new nation's sovereignty, they would have to develop a domestic source of arms, rather than rely on foreign powers (Huston, 1966, p. 92).

The Early American System

In the aftermath of the Revolution, a uniquely American approach to providing arms and munitions for its Army began to take root. This approach was described retrospectively in the official Army history of World War II.

Unlike England, France, and Germany, the United States has never sponsored private manufacturing establishments that specialized in the design and production of heavy munitions. Instead of relying upon a Vickers-Armstrong, a Schneider-Cruesot, or a Krupp, this country from its beginnings followed the policy of assigning responsibility for Army munitions supply to a special government agency, the Ordnance Department of the Army. . . . the Ordnance Department itself undertook development and manufacture of ordnance or directly supervised the work placed with private contractors (Green et al., 1990, p. 3).

But it would take time for this American system to emerge. To begin with, the new nation was concerned about the prospect of a standing army, for reasons of economy as well as fears that it would be "turned to the coercion of the states or become an instrument of despotism." Instead, Congress hoped that "a well-regulated and disciplined militia sufficiently armed and accoutered" could protect the United States (Huston, 1966, p. 86). Congress had ample reason to develop a coherent national military policy, because the early post-Revolutionary period was rife with domestic and international threats to the new nation. Shay's Rebellion, the Whiskey Rebellion, Fries' Rebellion, expeditions against Indians along the frontier, the possibility of another war with England, and the "Quasi-War" with France all spurred Congress to enact legislation that by 1800 resulted in a military policy grounded in universal military service in the militia (Uniform Militia Act of 1792) and a small Regular Army (Military Peace Establishment Act, 1802) (Millett and Maslowski, 1984, pp. 86-114).

The Congress also settled on a method for arming these forces. Secretary of War Henry Knox stressed the need for a domestic armaments capability and for stockpiling arms in a 1793 letter to the Senate. Knox "conceded that weapons manufactured in the United States might be more expensive than those imported from Europe, but he said this was of little significance 'compared with the solid advantages which would result from extending and perfecting the

means upon which our safety may ultimately depend” (Huston, 1966, p. 93). In 1794, Congress authorized the construction of national armories. The first of these was at an existing site at Springfield, Massachusetts, and the second was at Harper’s Ferry, Virginia. Capacity at these armories increased steadily. In 1811 and 1812, the Springfield Armory produced 20,200 muskets and the Harper’s Ferry Armory 22,140 (Huston, 1966, p. 106).

In addition to establishing armories, Congress in 1798 authorized the government to contract with private firms for the manufacture of arms (Huston, 1966, pp. 93–94). Government contracts stimulated a nascent domestic arms industry. Federal contracts also gave working capital to innovators like Eli Whitney, who in 1798 won a contract to manufacture 10,000 muskets. Whitney introduced the process of interchangeable parts as a way to make up for the shortage of skilled armorers. Thus, machines would replace artisans and facilitate mass production, leading to what became known as the “American system of manufactures” (Huston, 1966, pp. 94–96; Smith, 1985, p. 39). The domestic arms industry was, however, unreliable and fragile. In 1798, the government let contracts with 27 domestic enterprises for the delivery of 30,200 muskets. By the due date of September 30, 1800, only 1,000 weapons had been delivered (Huston, 1966, p. 96).

For artillery, the government relied on the private foundries located in almost every state to supply cannon—a situation the Congress in 1811 deemed adequate to meet emergencies.

Early Tests: The War of 1812 and the Mexican War

As war with Great Britain approached again, the Congress created an Ordnance Department on May 14, 1812 and charged it “with inspection, storage and issue, and supervision of the government ‘laboratories’ or workshops, where gun carriages, muskets and other arms were made” (Green et al., 1990, p. 16). Although the United States prevailed in the war, “the country had barely skirted disaster . . . good fortune rather than military might had ensured the nation’s survival. From the beginning faulty arms, insufficient supplies, and tactical errors had plagued the war effort” (Smith, 1985, p. 43). As an interesting aside, the War of 1812 also highlighted the emerging conservatism of the Regular Army with respect to adopting new technologies. As Tennessee volunteers for the war were informed by their governor, “Those having no rifles of their own will be furnished by the state to the extent of the supply on hand. . . . It is desired to avoid smoothbore muskets as much as possible. They may be good enough for Regular Soldiers but not the Citizen Volunteers of Tennessee” (Huston, 1966, p. 107). The conservatism of the Ordnance Department, particularly in the realm of rifles, would be a continuing theme through the coming years.

In the aftermath of the War of 1812, the Congress attempted to remedy the system it had put in place before the war by more fully explaining the role of the Ordnance Department. "An Act for the better regulation of the Ordnance Department" became law in 1815, expanding the department's responsibilities to include "contracting for arms and ammunition, for supervision of the government armories and storage depots, and for recruitment and training of 'artificers' to be attached to regiments, corps, and garrisons" (Smith, 1985, p. 43; Green et al., 1990, p. 16). The act also placed the Springfield and Harper's Ferry arsenals under the command of the Ordnance Department and "empowered the chief of ordnance 'to draw up a system of regulations . . . for the uniformity of manufactures of all arms ordnance, ordnance stores, implements, and apparatus, and for the repairing and better preservation of the same' . . . the proviso set the stage for important developments in military technology and the eventual transformation of the American industrial system" (Smith, 1985, p. 44).

By 1819, the government had established ten additional arsenals, and by 1840 the number had grown to twenty-two. The government arsenals "were engaged primarily in manufacturing accouterments and small arms and artillery ammunition in addition to repairing and maintaining arms and equipment" (Huston, 1966, pp. 114, 130).

The Army still relied on private foundries for artillery, although arsenals at Washington, Pittsburgh, and Watervliet produced carriages and accoutrements and assembled the guns. Regarding artillery developments, attention in the Army focused on the adoption of rockets, the ongoing debate about the relative virtues of bronze versus iron cannons, and the development of a "complete and precise definition of the whole artillery system"—work that was completed in the late 1840s (Huston, 1966, pp. 118–120).

The conservatism of the Army came again to light in the case of the Hall breech-loading rifle. John Hall had patented his rifle in 1811, and the Ordnance Department tested the weapon and found it superior to the standard musket. The Harper's Ferry Armory began manufacturing the rifle using—for the first time by a national armory—the interchangeable parts system. Still, the Army resisted wide fielding of the rifle—"senior officers continued to insist on the superiority of muzzle-loaders"—and the muzzle-loading musket was the standard weapon used in the Mexican War. An argument against the more rapid firing breechloader was that it would strain the logistical system. Furthermore, the national armories did not accept the interchangeable parts system for other weapons until 1841 (Huston, 1966, pp. 114–115, 130).¹

¹See also Smith, 1985, pp. 39–86, for a discussion of the importance of the federal government and the Ordnance Department in the introduction of the uniformity system in American industry. Smith notes: "Although private contractors expended time and money in developing new

In another example of conservatism, the Army resisted the fielding of percussion cap rifles to replace flintlocks, because of a “natural distrust of new ideas and fear on the part of some officers that soldiers would be more likely to lose percussion caps than flints.” Thus, although Joshua Shaw patented the percussion cap in 1822, the Army did not begin production of weapons using the technology until 1845.

During the 1840s and 1850s, an emerging private machine-tool industry collaborated with the arsenals to bring about significant improvements in production processes as well as the end items of small arms and ammunition themselves. In the 1840s, the Ordnance Department introduced the percussion musket and a revolver, invented by Samuel Colt. Both represented significant improvements over the flintlock muskets and cumbersome pistols that had preceded them. It was characteristic of innovations during this period to come from foreign nations, commercial firms, or inventors. Inventors were permitted to use the government arsenals to manufacture test models of their innovations.

In the 1850s, however, the Congress severely limited the development of a private munitions industry. Both the War Department and its Ordnance Department argued that government design, manufacturing, and oversight of any private manufacturing were required to ensure quality and innovation. This policy was in distinct contrast to the practices of many European nations, whose governments fostered and encouraged a flourishing private arms industry, a distinction that, somewhat mutedly, continues today (Green et al., 1990, pp. 17–19).

The Mexican War was the Army's first major test since the War of 1812. By and large, the Ordnance Department did a creditable job of supporting the Army during the war. There were sufficient weapons and ammunition for the campaigns, a testament to the maturation of a system that relied on the combined efforts of the national armories and private contractors. The foresight of the government in nurturing the private arms industry, beginning with the 1808 permanent appropriation that began the process of long-term contracts, was particularly important, as noted by an Ordnance Department contracting officer: “The steady support and patronage given by the Government since that time [1808] to the contractors whose skill, perseverance and capital saved them from early failure has resulted in the firm establishment of several manufactories of arms, and preserved to the country establishments of great importance to its security and defence” (Huston, 1966, p. 117).

techniques, only the federal government could have financed such a huge undertaking. . . . What the government provided, in addition to large infusions of money was an ongoing bureaucratic organization within which the new technology—itsself a bureaucratic phenomenon—could evolve. That the innovation transcended both individual limitations and the confines of isolated geographic environments was due largely to agency of the Army Ordnance Department.”

FROM THE CIVIL WAR TO THE GREAT WAR

The American Civil War resulted in mobilization on a scale unprecedented in U.S. history. The Union Army grew from its small core of 16,000 regulars in 1861 to over 1,000,000 in 1865. As volunteers thronged to the colors, however, there were shortages. An Indiana volunteer, commenting on the state of affairs at the beginning of the war, noted that all his "regiment lacked of being a good fighting machine was guns, ammunition, cartridge boxes, canteens, haversacks, knapsacks, blankets, etc., with a proper knowledge of how all these equipments should be used with effect" (Millett and Maslowski, 1984, p. 166). From the perspective of supplying the Union Army with arms and ammunition, the challenge was immense, but the processes employed were familiar, given the experience of the Mexican War. As one would expect, the rapidity and scale of the mobilization fostered conditions favorable for profiteers and unscrupulous contractors, particularly when coupled with an imperfect procurement system. Shoddy materials and weapons inevitably made their way into the Army. Nevertheless, the Union Army mobilized and sustained itself in the field (Huston, 1966, pp. 175, 186–187).

In the area of small arms, the Springfield Armory—doubly important because the Harper's Ferry Armory had fallen into Confederate hands—markedly increased its production to some 350,000 rifles per year (Huston, 1966, p. 178).² Given the scale of the mobilization, however, the Army had to turn to foreign and domestic firms to arm the swelling Union ranks.

In the first fifteen months of the war, before Secretary of War Edwin Stanton forbade foreign procurement, European sources provided 738,000 small arms for the Union Army. Ironically, many European countries used the American (Union and Confederate) demand as an opportunity to dump their obsolete weapons, because they were in the process of adopting needle guns or other modern designs. Stanton's edict also left European markets open to the Confederacy (Huston, 1966, pp. 178–179, 187).

The various sources of supply for small arms strained the ammunition logistical system, because of the proliferation of types and calibers. And the number of small arms procured for the Union Army was impressive:

The Springfield Armory turned out 802,000 rifled muskets (with the use of parts manufactured by private industry in a number of cases). Private arms makers

²See also Hagerman (1992, pp. 308–309): "The breakdown of weapons in American arsenals at the outbreak of the war was as follows: 500,000 flintlock muskets altered to percussion and the 1842 model percussion musket; 42,000 .54-caliber rifled muskets; 35,000 .58-caliber rifled muskets; 12,500 .58 caliber muzzleloading rifles, model 1855. . . . Of these rifles and muskets, 119,000 fell into the hands of the Confederacy."

produced 670,600 of these Springfield weapons. Other purchase from domestic industry and from abroad included nearly 1,225,000 muskets and rifles, over 400,000 carbines and 372,800 revolvers (Huston, 1966, p. 186).

Private industry did, however make a significant contribution to the war effort aside from its small-arms production. All artillery casting was done by private industry, with the government arsenals providing carriages, caissons, and accoutrements. Also, private industry provided all the gunpowder for the Union.

Several controversies involving weapons erupted during the Civil War. The most hotly debated of these centered on the failure of the Union Army to employ breechloaders, repeating rifles, and carbines to a larger degree than it did. Commercial designs for all of these weapons were available before the war, from Sharps rifles, Henry repeaters, and Spencer repeating rifles and carbines as well as a process to convert existing muzzle-loading Springfield rifles into breechloaders. But the Ordnance Department resisted their adoption, again citing concerns about soldiers wasting ammunition and creating supply problems (Huston, 1966, p. 190). Only after intervention by President Abraham Lincoln was Spencer able to make headway against the War Department bureaucracy. By the war's end, the Union had purchased from Spencer some 12,400 rifles, 94,200 carbines, and 58,238,000 cartridges. Direct sales to others brought the number of Spencers in service to nearly 200,000. Approximately 10,000 Henry repeaters, purchased by states and individuals, also made their way into the Union forces (Huston, 1966, pp. 191–192).

After the war, the War Department convened a board to adopt a breechloader. The choice for the majority of the Army was converted Springfields, while the cavalry received Spencer and Sharps carbines. The process was not completed until 1869 (Huston, 1966, pp. 192–193). While civilians were buying Winchester 1873 repeaters, the single-shot Springfield remained the principal infantry weapon. Not until the adoption of the bolt action Krag-Jorgenson in 1892 would all American soldiers finally have a repeating rifle (Huston, 1966, p. 255).

The other weapon that foundered on the shoals of Army indifference was the machinegun. As early as 1861, Ezra Ripley and Wilson Ager had offered machinegun designs to the Army, but they were not adopted. Another inventor, Dr. Richard J. Gatling, had a working machinegun available in 1862, but the Ordnance Department did not adopt it until 1866. Even then, the weapon was viewed as an auxiliary, not as an infantry weapon, and machineguns received little attention in the American Army for decades (Huston, 1966, p. 194). As one author has noted,

With machine guns as with other weapons, Americans would gain credit for the invention, but other nations would take advantage of their use. While Germany would gain a reputation for building tomorrow's weapons today, the United

States frequently would be content to build yesterday's weapons tomorrow (Huston, 1966, p. 194).

In the end, however, the Civil War demonstrated that the United States had a strong weapons industry that could be mobilized, based on the twin pillars of government armories and arsenals and private industry. Additionally, in 1862 "the War Department established Federal standards for arms, uniforms, and equipment and centralized their purchase." This simplified supply and eliminated the competition between the federal and state governments that had been the norm before the war and gave the federal government preeminence in military matters (Abrahamson, 1983, p. 70).

Following the war, the 25,000-man Regular Army, dispersed throughout the country in some 134 posts, was mainly engaged in constabulary and Indian-fighting duties (Huston, 1966, pp. 268–269). But as the West was settled, the proponents of Manifest Destiny began looking overseas. Key to this shift in policy was the building of a strong Navy and coastal defenses. In 1882 the Navy began its rebuilding program, which gained added impetus under Secretary of the Navy Benjamin F. Tracy. Tracy's views were unambiguous: "[The] sea will be the future seat of empire. And we shall rule it as certainly as the sun doth rise!" Tracy's sentiments were given intellectual underpinning by Alfred Thayer Mahan's writings that advocated an aggressive American Navy capable of winning "command of the sea." To many, a revitalized Navy could operate away from American shores, but only with a system of strong coastal defenses—an area under the purview of the Army.

The Endicott Board, a joint Army-Navy-civilian board commissioned by Congress, reported in 1886 and recommended a massive \$127 million coastal defense program. The construction of a new Navy and a massive Army coastal fortification program inextricably linked the government, the military, and industry in unprecedented ways and levels.

By the 1890s construction of the Navy and the coastal fortifications had intertwined private and public policy in a mutually beneficial relationship. Manufacturing armor and ordnance required expensive plants employing skilled workmen; to cease construction would idle the factories and create unemployment or disperse the workers into other endeavors. Thus economic depressions no longer meant decreased government expenditures, but increased expenditures to keep factories operating and workers employed. . . . In short, armed forces modernization bound together the public welfare, private interest, and national security (Millett and Maslowski, 1984, pp. 249–255).

The major test for the Army after the Civil War was the Spanish-American War of 1898. Significant shortcomings in the conduct of that war were laid out in the postwar Dodge Report. Among the most significant was the inadequacy of mobilization processes. In particular, stockpiles of materiel and equipment—

and industrial mobilization planning—were inadequate to support a major mobilization. The postwar introspection also gave a new Secretary of War, Elihu Root, traction to begin long-overdue reforms in the Army (Hewes, pp. 3–13; Huston, 1966, p. 306; Millett and Maslowski, 1984, pp. 286–287).

The Root reforms were important first steps in refocusing the Army away from what had been an existence largely dominated by frontier constabulary duties since the end of the Civil War. The Army was still performing this function to some degree, but it was now overseas in support of U.S. policy in places such as Cuba, Puerto Rico, the Philippines, China, and Mexico. Before the American entry into World War I, the Congress also passed legislation (the Dick Act of 1903 and the Militia Act of 1908) that gave the Regular Army more control over the Organized Militia (National Guard) but also placed greater demands on the federal government for equipping those forces (Millett and Maslowski, 1984, pp. 311–314; Huston, 1966, pp. 306–307). And this is where the greatest deficiency continued to exist—the United States did not have the stocks of equipment or industrial mobilization processes in place to support a large-scale mobilization, “and as long as it continued to be a common belief that military mobilization was a matter of raising men before arms, this unsatisfactory state of affairs would persist” (Huston, 1966, p. 307).

This is not to say that the weapons being developed in the United States for the Army were deficient only in quantity. Quality lagged also. The U.S. Army clearly lagged behind European developments in armaments. Artillery, in particular, had made significant strides in Europe. The French 75, one of the best field artillery weapons of World War I, was introduced in 1897. Additionally, many armies by the 1890s had breechloading rifled artillery, smokeless propellants much superior to black powder, highly effective explosive artillery shells, and improved sighting and recoil systems, all of which increased lethality and accuracy (Weigley, 1984, p. 291; Johnson, 1998, p. 21). Other nations were adopting machineguns, particularly in the aftermath of their effective use in the Russo-Japanese War (1904–1905). In the U.S. Army, the Gatling gun remained standard until 1909, replaced then by the “mediocre light Benet-Mercie machine gun.” This despite the fact that two of the most successful machinegun designs used in World War I—the Maxim and the Lewis—were invented by Americans who were forced to market their wares in Europe when the Army did not buy their inventions. Indeed, the Ordnance Department’s principal achievements in the period before World War I were the Springfield Model 1903 rifle and the opening of a plant (Picatinny Arsenal) to produce smokeless powder in 1905 (Huston, 1966, pp. 296–297).³

³See also Green et al. (1990, p. 19) for a discussion of the degree to which the Ordnance Department controlled Army weapons design and production: “After the standardization of the famous Spring-

Even when the Ordnance Department began modest efforts to begin anticipating the entry of the United States in the Great War, its attempts were thwarted.⁴ In 1915 and 1916, Brigadier General William B. Crozier, the Chief of Ordnance, argued for the expansion of private capacity to manufacture weapons and munitions. But the Congress resisted, holding strongly to the notion that the government should procure such materiel from government-owned arsenals "unless the private concerns could compete on price," a rare condition at the time (Green et al., 1990, pp. 20–21).⁵ Nevertheless, the "failure in organization" was complicated by "a deficiency in attitude":

Although efforts were made to encourage the development of improved weapons, the whole approach generally was one of testing and screening ideas that came to the attention of the Army, rather than one of pushing a vigorous pursuit of ideas. If an inventor brought in a new weapon, it still was up to him to prove his case, and the kind of hearing he got might depend as much on who he happened to be and what his attitude was as upon the ingenuity and practicability of his device (Huston, 1966, p. 296).

The inadequacies of the system for providing weapons for the Army became manifestly apparent with the American entry into World War I. After three years of war, the principal European combatants had made enormous strides in weapons design. Machineguns, airplanes, poison gas, tanks, and ever larger and more sophisticated artillery had taken their places as important implements of modern war. The United States did not have the capability to supply any of these modern weapons in the quantities it would need when it entered the war. Nor was private industry up to the task, largely because, as noted earlier, the Army's bureaus dominated the manufacture and procurement of weapons and equipment.

The Army's attempts to establish programs for building artillery, aircraft, and tanks based on allied designs were fiascoes. Manufacturing problems were manifold: tooling delays, slow decisionmaking, difficulty in adapting French designs, labor shortages, lack of manufacturing expertise, and uncoordinated

field rifle M1903, government manufacture of small arms as well as more artillery became the general rule, and up to 1915 the art of ordnance-making in America was chiefly contained within the government establishments."

⁴See also Green et al. (1990, p. 21) for a discussion of "educational orders": "The National Defense Act of 1916 had recognized the wisdom of placing educational orders by permitting public funds to be spent for procuring special tooling for private manufacturers willing to accept orders. But this provision and the lifting of the requirement of competitive bidding were so hedged about with other restrictions that the so-called mobilization of industry was theoretical only."

⁵This doctrine provided the intellectual foundation of the later Arsenal Act, a law whose interpretation serves as the basis for internal Army debate over the use of arsenals even today. This is codified as 10 USC 4532, the Arsenal Act, which states "(a) The Secretary of the Army shall have supplies needed for the Department of the Army made in factories or arsenals owned by the United States, so far as those factories or arsenals can make those supplies on an economical basis. (b) The Secretary may abolish any United States arsenal that he considers unnecessary."

buying all contributed to the inability of the U.S. production base to respond to the enormous demand. Facilities also presented serious problems. The Army had permitted the Navy to contract with existing commercial suppliers, and private firms were given permission to complete foreign orders before turning to U.S. needs. The manufacturing demands of other Army departments also contributed to ordnance shortages. Furthermore, production planning was primitive, resulting in shortages of some components and excesses of others (Green et al., 1990, pp. 21–28). In the end, the American Expeditionary Force (AEF) had to rely on the British and the French for virtually all of its ordnance needs, save small arms and ammunition (Johnson, 1998, pp. 21–22, 31–35, 43–45).⁶

Fortunately for the American Army, what its European allies required was men to fill their depleted lines. Their war industries were functioning at full capacity, and they were able to meet the AEF's materiel shortfalls (Johnson, 1998, p. 22).

FROM THE GREAT WAR TO WORLD WAR II

In the aftermath of World War I, the Army attempted to draft legislation that would correct the deficiencies that had been so glaringly apparent during the war. In two areas in particular—manpower and industrial mobilization—the Army attempted to make improvements.

The Army asked Congress for a Regular Army of 500,000 men, divided into nine corps areas, each with one active division. Having witnessed the “War to End All Wars” and with no threat to the United States, the Congress, in the National Defense Act of 1920, authorized a Regular Army of only 17,717 officers and 280,000 enlisted men. Budget cuts and reduced appropriations resulted in a Regular Army whose combined officer and enlisted strength remained below 150,000 men for most of the interwar period. To an Army that believed fundamentally that massive manpower mobilization was the key to waging modern war, these personnel cuts were alarming. And throughout the interwar period, the principal aim of the Army was to increase its manning (Johnson, 1998, pp. 54–59, 66–67).

The Army did, however, change its approach to the acquisition of munitions and industrial mobilization in the event of a future crisis. The National Defense Act of 1920 created an Assistant Secretary of War, who “under the supervision of

⁶See Green et al. (1990, p. 24). They did produce and ship 817 U.S.-made field guns to the AEF. See also Zimmerman (1992, p. 144), who notes: “Ordnance had a dismal record of accomplishment. It produced little finished artillery or ammunition; less than three percent of contracts made before December, 1917, had been delivered by the end of the war. The AEF had fought with foreign artillery and ammunition.”

the Secretary of War, shall be charged with the supervision of the procurement of all military supplies of the War Department pertaining thereto and the assurance of adequate provision for mobilization of materiel and industrial organizations essential to wartime needs" (Gropman, 1996, p. 9). Additionally, the Army and Navy Munitions Board was created in 1922 to coordinate planning between the two services and to develop legislative plans to facilitate mobilization. Finally, the Army established the Army Industrial College in 1924 to train officers "in the useful knowledge pertaining to the supervision of all military supplies in time of war and to the assurance of adequate provision for the mobilization of materiel and industrial organizations essential to war time needs" (Gropman, 1996, p. 15).

It was a start, although domestic sentiments, budgetary constraints, the Great Depression, and rivalries within and between the military services all conspired to limit effective planning and cooperation (Gropman, 1996, pp. 11–18).⁷ Furthermore, the four industrial mobilization plans (1931, 1933, 1936, and 1939) prepared by the Planning Branch of the Assistant Secretary's office during the interwar period, although better by far than the preparations before World War I, were deeply flawed. To begin with, they had been prepared by "military agencies with some knowledge of industry but no real depth." Furthermore, "[t]he Army and Navy Munitions Board . . . was unwilling to work with existing governmental departments." Finally, politicians were loath to put the military in charge of mobilization, as the plans recommended. Quite simply, "in addition to the political climate militating against implementation, superficial planning, and disharmony between operators and logisticians, the United States business world was not too keen on being mobilized until the president and Congress and the people were behind it. . . . the real change in perspective did not occur until the bombing of Pearl Harbor" (Gropman, 1996, pp. 22–23).

One other provision in the National Defense Act of 1920 had a fundamental effect on how the Army would approach designing and fielding new weapons, munitions, and equipment. The act created several new combatant arms (field artillery, infantry, cavalry, air service), which were now equal in the War Department hierarchy with the bureaus.⁸ These new branches were responsible

⁷Throughout the interwar period, American public opinion, often reflected in the Congress, was largely isolationist and in many cases antimilitary. Part of this was deeply seated disillusionment with World War I and a widely held belief that the United States had been dragged into the war by industrialists, the so-called Merchants of Death. Coupled with this disillusionment was the belief in some quarters that treaties and disarmament (the Kellogg-Briand Pact and naval disarmament conferences) were the routes to national security and world peace (Johnson, 1998, pp. 63–68).

⁸See Johnson (1998, p. 59). The new chiefs of arms were all major generals and reported directly to the Army Chief of Staff; "they had broad charters to supervise their branch service schools, formulate tactical doctrine for their arm, develop organizational plans, prepare instructional and training publications, cooperate with the supply branches in the development of arms and equipment,

for defining the requirements for new weapons under their purview; the Ordnance Department was responsible for designing prototypes to meet these user specifications. The effect of this new arrangement on munitions was that the "Chief of Ordnance ceased to be the Czar whose dictates on military characteristics and design of weapons the using arms accepted without demur. . . . The Ordnance Department became the skilled servant, not the master, of the using arms" (Green et al., 1990, p. 29).⁹

The fundamental problem facing the War Department during the interwar period was the budget and how this constraint influenced manning the Army. For an Army convinced that mass armies were the *sine qua non* of modern warfare, two goals—maintaining personnel strength and the skeleton of a structure in the Regular Army around which the nation could mobilize in an emergency—were sacrosanct. Thus, when it came to a choice between investing in technology or manpower, the choice was simple: "everything except personnel, training, and the civilian components could be sacrificed" (Johnson, 1998, p. 112). This situation only became direr as the nation sank into depression in the early 1930s. Finally, the conservative nature of most Army officers also conspired to focus limited resources on manpower as opposed to technology. Chief of Staff General Douglas MacArthur captured the essence of this perspective, when he noted the following in his 1934 annual report: "It is easy, of course, to overemphasize the influence of machinery in war. It is man that makes war, not machines, and the human element must always remain the dominant one" (Johnson, 1998, p. 113).¹⁰

During the interwar years, ordnance activity consisted primarily of design, testing, experimentation, and development conducted wholly in the arsenals and on the proving grounds. Given the War Department's priorities and tight budgets, it is not surprising that actual procurements were small. For example, the ordnance program published in May 1925 called for the total procurement—over ten years—of the following small numbers of selected items: 2,000 Cal.30 semiautomatic rifles, 24 75mm field guns, 24 155mm howitzers, and 64 tanks (Green et al., 1990, p. 47). Actual production fell short of even these

assign and classify personnel in their branch, and prepare the appropriate mobilization and war plans."

⁹The guidance from Major General Clarence Williams, Chief of Ordnance from 1918 to 1930, was clear: "If the fighting men want elephants, we get them elephants." Consequently, "Ordnance officers in Washington would no longer exercise their technician's prerogative to insist that mice or mules would suffice" (Green et al., 1990, p. 29).

¹⁰See Johnson (1998, pp. 81–94, 153–175). The one arm that was a clear exception to this focus on manpower was the Air Corps. This arm embraced technology and did not rely on the Army's technical arms for its airplane designs. Indeed, a close relationship between the Air Corps, Congress, and the U.S. aviation industry developed during the interwar period, resulting in the Air Corps, and its successor the Army Air Forces, having modern aircraft when the United States entered World War II.

planned figures. Private manufacturers concentrated on commercial products, but the Army to some degree maintained liaison with them, conveyed drawings, and prepared mobilization plans for the potential wartime expansion of commercial manufacturing facilities. This activity constituted the first real peacetime mobilization planning in American history.

The decision to invest in manpower instead of technology "resulted in a protracted period in which technological development slowed to a glacial pace in all areas except aviation." Manpower mobilization planning in the late 1930s, in the face of a deteriorating world situation, only worsened the situation. Chief of Staff General Malin Craig froze weapons designs to allow the Army to begin stockpiling weapons and munitions for the 1,000,000-man force embodied in the "Protective Mobilization Plan" (PMP) that would defend the nation in the event of an emergency. When war did arrive, the emphasis shifted to mass production of existing equipment models because of the huge demand to equip both rapidly expanding Army forces and allies (Johnson, 1998, p. 114).¹¹

And the scale of production was immense. During the war, the Ordnance Department procured and produced an enormous quantity of major items and ammunition, as Table 2.1 shows.

The mobilization effort in the United States during World War II was unique in American history. For the first time, "controls were imposed on wages and

Table 2.1
Weapons and Ammunition Produced and Procured
by the Ordnance Department During World War II

Item	Quantity
Small arms	18,370,000
Machine guns	2,700,000
Field guns and howitzers	61,500
Mortars	102,000
Tanks	96,000
Trucks	2,350,000
Small-arms ammunition	78,070,000,000 rounds
Artillery ammunition	1,000,000,000 rounds
Aircraft bombs	6,860,000 short tons

SOURCE: Director, Service, Supply, and Procurement Division (1993), pp. 25-26.

¹¹The scale of manpower mobilization dwarfed even PMP estimates. From a 1940 strength of 269,023 officers and men, the Army grew to 8,267,958 during the war (Johnson, 1998, p. 115).

prices; productive capacity and raw materials were allocated; and fiscal and monetary policies were directed toward controlling inflation and demand, and toward financing the war" (Vawter, 1989, p. 7-8). The war effort consumed about 40 percent of the gross national product. Additionally, the production of durable goods such as automobiles and refrigerators for civilian consumption was stopped. And other consumer goods, e.g., tires and gasoline, were rationed (Gropman, 1996, p. 107; Cardozier, 1995, p. 132).

As never before, the U.S. effort to produce the weapons of war became a partnership between government agencies and civilian industry. Existing government facilities produced to capacity, and many civilian plants converted to war production. Private industry was also offered inducements to convert to war manufacturing:

Subsidies or low-interest federal loans to enlarge plants and build new machinery, fast tax write-offs for expansion and retooling, generous contracts negotiated on the basis of cost plus fixed fee, the assurance that facilities for war production financed by government funds would be available at bargain-basement prices for postwar use. Those and other devices guaranteed large profits without risk. That was Stimson's [Secretary of War Henry Stimson] intention. "if you are going to . . . go to war in a capitalist country," he wrote, "you have to let business make money out of the process or business won't work" (Blum, 1977, p. 122).

Another aspect of the industrial mobilization that was different was the degree to which the nation's scientific and academic resources were integrated into the war effort. The Office of Scientific Research and Development was formed in June 1941 and "was of invaluable aid to the War Department . . . in encouraging and financing fundamental research by universities and industry, and in coordinating this work with what carried on in the War Department" (Director, Service, Supply, and Procurement Division, 1993, p. 6). Largely gone were the days of inventors peddling their products to the War Department. The future would be dominated by what President Dwight Eisenhower would later describe as "task forces of scientists in testing fields," giving rise to a situation in universities and private laboratories where "because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity" (Weigley, 1969, p. 156).¹²

One particular approach that had its origins in the mobilization for World War II was unprecedented: government-owned, contractor operated (GOCO) facilities.¹³ Even before Pearl Harbor, the Ordnance Department embarked on a

¹²See Baxter (1946) for a discussion of the role of scientists in World War II and a discussion of the technologies they helped develop.

¹³This discussion of GOCO efforts relies mainly on Kane and Gaither (1995).

Table 2.2
World War II GOCO Ordnance Industrial Facilities by Type

Number	Type
25	Load, assemble, and pack (LAP) plants
23	Propellant and explosives works
13	Small-arms ammunition plants
11	Chemical works
2	Gun tube plants
1	Case cup plant
1	Incendiary (magnesium powder) works
1	Tank plant
1	Artillery metal parts plant

NOTE: The number of facilities sum to 78 rather than 77. Scioto Ordnance Plant was built as a LAP plant but was later converted to small-arms production and is, therefore, counted in both categories. The designation "plant" typically referred to a facility that conducted fabrication or assembly; "works" manufactured powder, explosives, propellants, chemicals, or incendiaries.

plan to build 77 GOCO industrial facilities in 26 states (Kane and Gaither, 1995, p. 13). These plants, built between August 1940 and November 1942, were of nine types, as shown in Table 2.2. Forty of the facilities performed more than one of the nine functions; they are categorized here according to their principal function.

The land for these facilities was largely purchased from private owners, but some was condemned. The Army decided to own the land under its expanded ordnance base but have private firms operate the facilities for three reasons. First, it estimated that the six government-owned and -operated arsenals could expand to produce less than 5 percent of its anticipated wartime needs and that private firms could adapt more readily than could the government. Second, private industry then owned insufficient real property to meet the expanded demand. Hence, new plants would have to be built rather than existing plants expanded. Many of the required processes were simply not in operation before the war. Third, the Army assumed that private industry would not finance the necessary real and personal property because it was anticipated that after the war the nation would return to its customary small standing army, requiring little ordnance procurement. The first two of these assumptions were indeed valid, but the third proved not to be the case.

From World War to Cold War, Limited Wars, and Sole Superpower

After World War II, the nation began to demobilize. But for the first time in its history, the United States did not retreat from the world stage after a conflict. As a consequence, the United States maintained large standing military forces, including an unprecedented large Regular Army.

The nation also put in place measures designed to maintain mobilization readiness (Vawter, 1989, p. 8-82). Additionally, private industry—once the Cold War and the competition between the superpowers emerged—never completely reverted to its normal postwar state of producing civilian goods. There emerged what President Dwight D. Eisenhower termed the “military-industrial complex.”¹⁴ Ironically, the post-World War II era in many ways made providing ordnance items into a permanent “big business” affair, one too large for the Army’s own arsenals to address other than in a complementary role.

Despite occasional problems in accurately forecasting requirements—particularly ammunition during the Korean, Vietnam, and Gulf Wars—the post-World War II arrangement has generally satisfied the Army’s ordnance needs.¹⁵ Nevertheless, old problems occasionally came back in new forms. In an unfortunate demonstration of historical continuity, fielding a new rifle—the M-16—was the cause of a fair amount of controversy during the Vietnam War era (McNaugher, 1984).¹⁶

The GOCO and GOGO ordnance facilities became an integral part of the military-industrial complex that developed in the 1950s. When the Army Materiel Command was created in 1962, it inherited 34 of the 77 GOCO facilities (Kane and Gaither, 1995, p. 55). Today, only eleven GOCO ammunition plants remain as part of the Army’s required inventory (see Table 1.1).

Hence, the Army enters the new century with a history of several decades of increased reliance on private ordnance manufacturing. Today, most of it is conducted in commercial plants. This completely private manufacturing is augmented principally by commercial manufacturers operating in government-

¹⁴President Eisenhower’s exact phrasing, made during his 1961 Farewell Address, was: “In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for disastrous rise of misplaced power exists and will persist.” See also Noble (1984, p. 10), who expands on Eisenhower’s statement: “The emerging military-industrial complex was really a tripartite affair; wedding industry to the military, it also tied science closer to both.”

¹⁵On Korea, see Gough (1987, pp. 58–65); on Vietnam, see Heiser (1991, pp. 116–120) and Magruder (1991, pp. 39–48, 109–116); on the Gulf War, see Schubert and Kraus (1995, pp. 92–94, 159–160).

¹⁶See also Hallahan (1994) for the story of the Army’s long-standing difficulties in fielding shoulder-fired weapons.

owned plants but with a small fraction of the manufacturing being done by civil servants in government-owned facilities.

Today's mixture of private and public ordnance capacity differs dramatically from that of almost complete reliance on the arsenals in our nation's earlier peacetime years. Yet the continued reliance on a mix of GOCO and GOGO facilities differs markedly from the policies of our closest Western European allies, particularly Germany and the United Kingdom, who now rely completely on the private sector for their ordnance materiel. Postwar Germany, once manufacturing resumed, relied from the outset on private arms manufacturers, while privatization of government facilities in the United Kingdom was completed in the 1980s. While government support of private defense industries is common, it is an unusual modern Western army that either owns or operates its own factories.

This research represents only the latest in a succession of assessments both internal and external that apply to the Army's industrial base and the business practices that surround it. While addressing a much broader scope than the Army's industrial base, the recent Quadrennial Defense Review provides a mandate for change that includes the Army activities under review here.¹

THE CASE FOR CHANGE

The Defense Department has recognized the need to transform its business practices and support structure as well as its operational fighting forces. The 2001 QDR offered the following DoD self-diagnosis, arguing for an overarching strategy to improve business practices:

An infrastructure that needs to be streamlined to match the new reality, financial systems that limit the ability to see and manage the enterprise, and processes that discourage action and reasonable risk at the working level are hallmarks of a mature enterprise that must be transformed. While America's businesses have streamlined and adopted new business models to react to fast moving changes in markets and technologies, the Defense Department has lagged behind without an overarching strategy to improve business practices. (QDR, 2001, p. 49)

The report goes on to argue for a more exclusive definition of functions that should remain government-owned. It also recognizes the deeply cultural attachment to continued ownership of certain functions that was illustrated in the last chapter.

Only those functions that must be performed by DoD should be kept by DoD. Any function that can be provided by the private sector is not a "core" government function. Traditionally, "core" has been very loosely and imprecisely defined and too often used as a way of protecting existing arrangements.

¹U.S. Department of Defense, *Quadrennial Defense Review*, 2001, hereinafter cited as QDR.

Over the last several decades, most private sector corporations have moved aggressively away from providing most of their own services. Instead they have concentrated efforts on core functions and businesses, while building alliances with suppliers for a vast range of products and services not considered core to the value they can best add in the economy. . . . Aggressively pursuing this effort to improve productivity requires a major change in the culture of the Department. (QDR, 2001, p. 53)²

The QDR also issues guidance on working-capital-funded activities, the funding mechanism under which five of the sixteen installations under study here are financed. About such activities, the QDR offers the following assessment: “The notion of paying for outputs is right minded. However, the Fund mechanism subsumes a number of elements in its pricing mechanism (for example, the expected cost of mobilization), which masks the peacetime cost of outputs” (QDR, p. 54). As demonstrated later in this chapter, the five Army Working Capital Fund (AWCF) installations under study here suffer from invisibility of costs.

Finally, the QDR raises the crucial importance of mitigating institutional risk by restoring vitality to DoD processes. Today’s inefficient business practices, the report points out, increase the risk of losing public support for defense needs (QDR, 2001, p. 63). Since high cost and out-of-date manufacturing processes characterize much of the base under study, this QDR concern appears to relate directly to the base.

Pacific Northwest National Laboratories (PNNL), in a comprehensive 1997 report (Doherty and Rhoads, 1997) on the ammunition segment of the Army’s industrial base, diagnosed problems consistent with those the QDR cited. Recognizing the inherently commercial nature of ammunition manufacturing, the report urged the commercialization of Army-owned ammunition plants and greater reliance on competition and private incentives to transform the base. Specifically, the report recommended that the Army:

- Acquire ammunition from the commercial sector. Convert government-owned production assets to commercial activities while preserving the ability to conduct operations with major quantity/distance (Q/D) requirements.
- Apply acquisition reform initiatives already under way in DoD to the munitions acquisition process to stabilize the business environment and incentivize industry investment in the production base. Focus government

²We recognize that the QDR is unclear in some cases and contradictory in others (e.g., private sector should supply any function it can, but public and private sector should share functions “indirectly related” to warfighting). The overall thrust toward more efficient practices, however, is clear.

activities on accurately expressing the total needs for munitions. Let industry, operating in a competitive market place, determine how best to meet the needs. (Doherty and Rhoads, 1997, p. 1)

The PNNL study made two other principal recommendations: (1) manage munitions as a major program, using the DoD life-cycle acquisition process, and (2) consolidate management responsibility and financial resources for munitions in a Program Executive Office (PEO) for Ammunition. Responding to these recommendations in the fall of 2001, the Army announced the creation of a PEO for ammunition, but the details of the office's breadth of responsibilities, missions, and functions are still being worked out. The Army has not yet adopted the other PNNL recommendations.

OUR ASSESSMENT OF THE BASE

As this chapter lays out, the sixteen Army installations under study suffer, to varying degrees, from the symptoms corresponding to the QDR's general diagnosis. Our assessment acknowledges certain differences in and unique characteristics of the operations on these installations. We observe in the organic base several categories of problems and issues. Below we describe the following problems:

- Absence of a strategic vision
- Management distractions
- Reduced workload and high costs
- Invisibility of costs
- Lack of access to capital
- Low priority of ammunition
- Time required to dispose of excess
- Lack of replenishment policy
- Strategy by default

The Army has long been aware of some of these problems and has attempted to address them in a variety of ways. We conclude the chapter with a discussion of the Army's efforts at innovation and change.

Lack of a Strategic Vision or Plan

During the course of this research, we have heard a variety of contrasting and mutually exclusive proposals from various Army organizations about the future of the organic industrial base. The ideas include complete divestiture, consoli-

ation, nationalization of activities now in the commercial base, and retention of unneeded facilities simply to generate revenue from commercial tenants.

Despite this array of views, any one of which might serve as the basis for a strategic vision and plan, no such plan has emerged. Instead, we observe an apparently long-standing internal disagreement among Army agencies over the policies that govern industrial base decisions and, in the end, guide its future. Some in the Army Secretariat support greater reliance on private manufacturing and reduction of excess organic capacity to improve efficiency. Within the Army Materiel Command, we see disparate views but general skepticism about divestiture and a mistrust of greater reliance on private manufacturing of ordnance materiel. From the Army Staff, we also hear a range of views, from divestiture to consolidation to the status quo. Some senior leaders say that they are not concerned with Army ownership of facilities. However, they also believe that as long as the Army does own them, workload should be directed into them to enhance their efficiency and spread overhead.

If we were to infer a strategic vision from the Army's ad hoc industrial base decisions in recent years, it would read something like the following:

For the GOCO ammunition plants, declare unneeded facilities excess. Maintain roughly the current balance of commercial and organic work. Employ facility-use contractors and the Armament Retooling and Manufacturing Support (ARMS) program to bring revenue-generating tenants onto the plants. Change from cost-plus to firm-fixed-price ammunition contracts. Compete ammunition contracts rather than funnel workload into organic facilities.

For the arsenals and GOGO ammunition plants, maintain all as GOGO working-capital-funded activities. Reduce workforces to the extent possible. Divest excess equipment and capacity. Employ demonstration programs to enhance commercial use of excess capacity. Maximize the use of supplemental funding to bring labor rates down.

The lack of an agreed-upon vision for the industrial base is attributable to several factors:

- Management of the industrial base is a peripheral activity to the Army and hence its future is of low priority to the Army leadership.
- Turnover within the Army leadership, combined with the low priority noted above, precludes the sustained effort required to develop a plan and achieve consensus.³

³The entire political leadership of the Army has changed with the new administration. The uniformed leadership of every Army organization participating in this study has turned over since the study began. Without a stable, approved, long-term vision, turnover at the top leaves an organization unable to effect sustained change.

- The diverse views within the Army often include deeply held cultural beliefs and values that are very difficult to change.⁴

Regardless of the reasons for their absence, a strategic vision and plan are essential prerequisites either for change or for validating the status quo. The problems and issues cited in this chapter provide the basis for the strategic vision and plan set forth in subsequent chapters.

Management Distraction

The manufacture of ordnance materiel is an inherently commercial activity that is peripheral to the primary mission of the Army⁵ and so is a peripheral function that consumes management resources and requires Army leaders to make decisions outside their primary area of expertise. Management of much of the Army's organic industrial base is a primary responsibility of the Operations Support Command (OSC) of AMC. OSC operates 15 of the 16 installations under review here as well as the ammunition depots. But the commodity commands of AMC operate the repair depots. Within OSC, the time and effort of a major general, a large number of colonels, lieutenant colonels, and senior civil servants, in addition to the support of many lower-ranking staff, are devoted to managing ordnance manufacture. Additionally, because the Army's senior logistics leadership rarely rise from the manufacturing ranks, decisions that occur above the level of the individual facility commanders tend to be made by leaders who have no manufacturing management experience.⁶

Reduced Workload and High Costs

The two arsenals dramatically exhibit the problems caused by a declining demand for their products. In 1976, Watervliet Arsenal made roughly 5,000 cannon gun tubes, recoilless rifles, and mortars (Figure 3.1). The arsenal now

⁴While the arsenals' long history of service to the Army drives much of the cultural attachment (Watervliet Arsenal dates to 1813; Rock Island to 1863), ownership of ammunition manufacturing facilities is perhaps even more connected to the Army psyche. As one general officer put it to us, "Ammunition is the soldier's fundamental commodity."

⁵The manufacture of ordnance items is specifically cited as a commercial activity by OMB Circular A-76.

⁶Chiefs of staff and vice chiefs of staff traditionally come from the combat rather than the support side of the Army. Within the Army logistics community, the deputy chiefs of staff for logistics as well as the commanding generals of the Army Materiel Command and its subordinate Operations Support Command typically have neither served in nor commanded an arsenal or ammunition plant. Normally, even the commanders of the arsenals and plants themselves lack direct experience before assuming command, because the only authorized military position in each plant is that of the commander. There have been exceptions. MG (ret.) Paul Greenberg, for example, former commander of the predecessor of the Operations Support Command, commanded both an arsenal (Rock Island) and an ammunition plant (Longhorn).

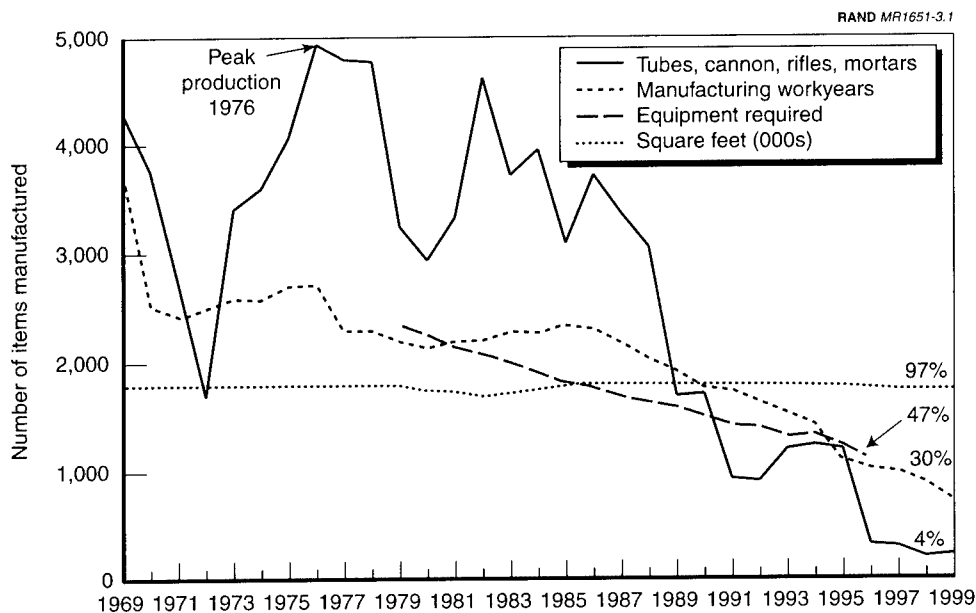


Figure 3.1—Inputs and Output at Watervliet Arsenal

produces about 4 percent of that number each year. While not shown, the figures for gun mounts and related major items at Rock Island Arsenal echo a similar drop in production.

Despite declining demand, manufacturing space has remained essentially constant, though as mentioned in Chapter One, closing manufacturing space saves little. Equipment levels have declined, but not as quickly as production of major items.⁷ Equipment divestiture is becoming increasingly difficult, however, and absent major process redesign it will not produce significant savings anyway. As it now stands, many pieces of underused equipment are necessary for making even the small number of items required by current demand and replenishment plans. To illustrate, Figure 3.2 plots the annual utilization rate of machines that Watervliet arsenal requires to manufacture the M256 cannon⁸ at planned replenishment levels.⁹ The arsenal requires 71 machines to manufacture these cannon. Thirteen of these machines are laid away in peacetime but

⁷Rock Island Arsenal has partially compensated by increasing the production of miscellaneous items, such as tool kits and OPFOR (opposing force) turrets. As a result, however, gun mounts now account for less than 10 percent of that arsenal's revenue. In contrast, Watervliet Arsenal's workload remains heavily concentrated on its historically important products. Hix et al. (2003), pp. 8–10.

⁸The 120mm cannon for the M1A1 and M1A2 Abrams tank.

⁹Data are for FY99, the latest year for which we have data.

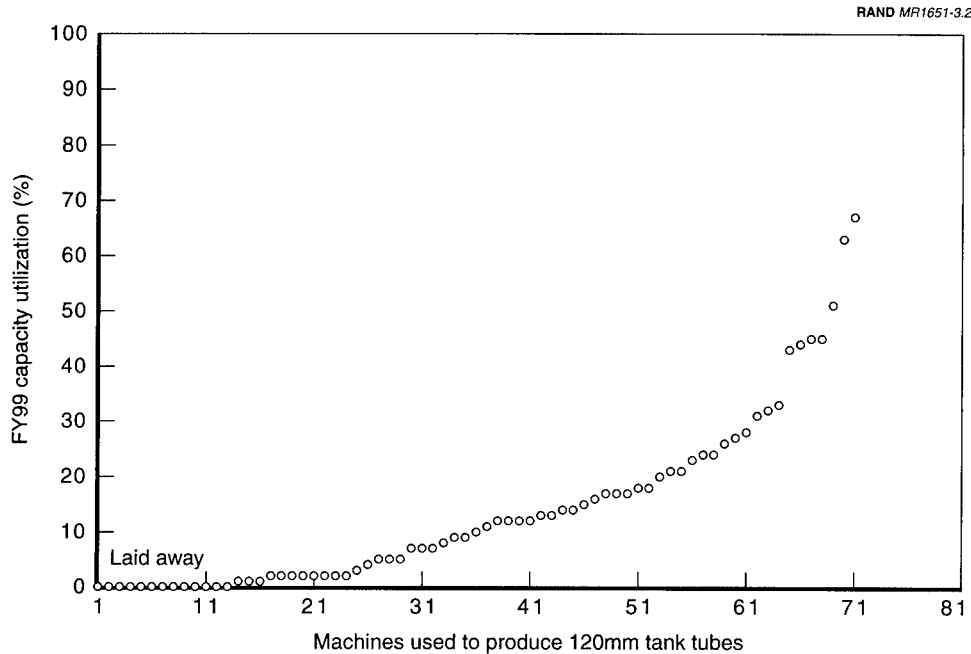


Figure 3.2—Utilization Rates of Machines Required to Manufacture M256 Gun Tubes at Watervliet Arsenal

would be used during replenishment; of the remaining 58, 55 are used at less than 50 percent of their one-shift capacity. These machines are highly capable and are designed to meet the high historical rates of production shown above. For example, Watervliet Arsenal can meet its needs by using only 18 percent of the capability of a particular 26-foot Wohlenberg lathe, but it cannot divest the other 82 percent. This raises the question of how the arsenal might use this highly capable equipment more fully.

Despite the very low utilization of space and equipment, these factors play only a small part in driving up arsenal prices (Hix et al., 2003, p. 3). Manpower inefficiencies play the biggest role. Referring back to Figure 3.1, we note that in 1976 at Watervliet Arsenal, manufacture of each major item (tube, cannon, recoilless rifle, or mortar) required about half a workyear. A quarter of a century later, it takes nearly three and a half workyears per major item, despite the productivity gains that mark the last part of the 20th century. As a result, the price of these items has risen concurrently. For example, in 1987 customers paid \$30,500 for each M256 gun tube. By 1997, that had about doubled to \$60,000. By 2000 the M256 cost had nearly doubled again to \$114,000. Importantly,

during this period the direct labor required to manufacture one of these tubes has not changed appreciably.¹⁰

The rapidly declining productivity and the accompanying large product cost growth seen at the arsenals mainly results from an increasing ratio of indirect to direct labor. These issues are discussed in greater detail and compared more fully with commercial enterprises in Chapter Six but are illustrated here by Figure 3.3. Recent figures from the two arsenals reflect moderate year-to-year variation in the ratio of nondirect to total labor. At Rock Island, no trend is apparent, although the FY01 ratio was the worst of the four years. At Watervliet, the ratio has improved modestly over each of the last three years. Nevertheless, the ratios at both arsenals are chronically worse than similar commercial manufacturing firms.

Regardless of the reason, as working-capital-funded activities, the arsenals must recover their full costs from customer charges (U.S. DoD, 2000). The high costs then discourage customers from using the arsenals, and the resulting decline in business drives unit costs even higher. In turn, higher unit costs further reduce demand, leading to what AMC and OSC officials term a “death spiral” at the arsenals.

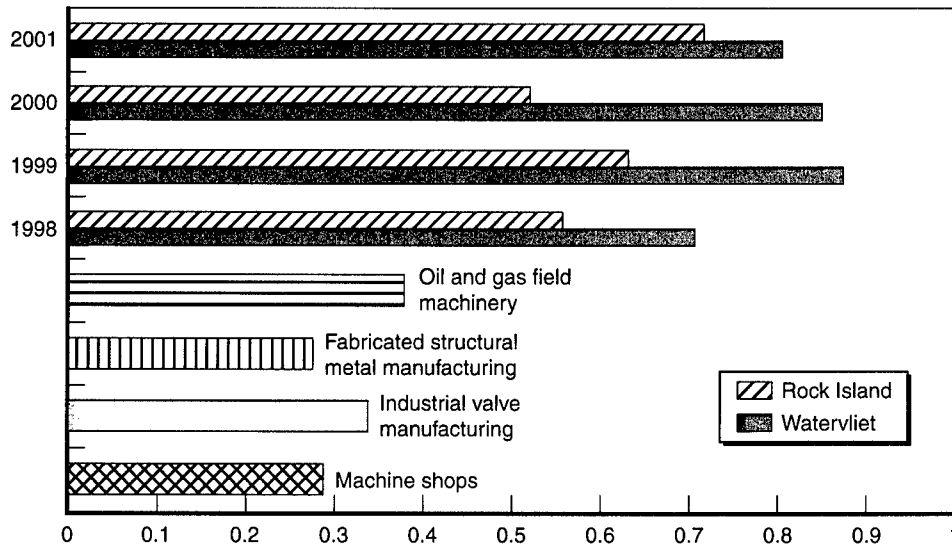
The GOCO facilities have less of a problem with reduced workload and excessive costs, for several reasons. First, because the facilities are managed and operated by private firms, which are unconstrained by government civil service rules, it is easier to size the workforce to the current workload. Second, these facilities have been somewhat easier to declare excess and close. Finally, in recent years some level of competition has been introduced, both to run some of the GOCO facilities and to produce the items historically made at them.

Invisibility of Costs

The two missions of the Army's organic industrial facilities—current production and maintenance of replenishment capacity—impose costs. Unfortunately, many of these costs serve both missions, making it impossible to align costs unambiguously to each. As will be explained, for working-capital-funded activities, this results in unstable product prices, creates an incentive structure that discourages process improvement, and inhibits rational resource decisionmaking. This unhappy circumstance occurs because of rules that require (1) costs

¹⁰Cost data is quoted in constant FY02 dollars and was provided by the Office for the Project Manager for Tank and Medium-Caliber Armament Systems (PM TMAS). The “customer” cost of the M256 declined in 2001 to approximately \$44,000, but that was due to a \$20 million infusion of money directly to the arsenal. The actual cost of manufacture had not declined, and by 2002 the arsenal was again charging customers more than \$100,000 for each M256.

RAND MR1651-3.3



NOTE: Ratio of Overhead to Total Labor here is defined as total nondirect labor (including all indirect labor charged to mission, paid leave, and G&A labor) divided by total labor.

SOURCES:

U.S. Department of the Army, Army Working Capital Fund (1998, 1999, 2000, and 2001).
 U.S. Department of Commerce, 1999d, 1999g, 1999j, and 1999m.

Figure 3.3—Ratio of Overhead to Total Labor at Arsenal and Comparable Commercial Firms

for mobilization to be provided through separate funds and hence excluded from customer rates, and (2) working-capital-funded activities to recover the full cost of running peacetime operations from their customers (10 USC 4541 and U.S. DoD, 2000). While these two requirements sound innocuous enough, the opacity of costs and the procedures for implementing the laws make them contradictory in practice.

10 USC 4541 requires the Army to submit, as part of its budget justification, an “estimate of the funds to be required in that fiscal year to cover unutilized and underutilized plant-capacity costs at Army arsenals.” Such costs are defined to include

the costs associated with operating and maintaining the facilities and equipment of an Army arsenal that the Secretary of the Army determines are required to be kept for mobilization needs, in those months in which the facilities and equipment are not used or are used only 20 percent or less of available work days.

The statute goes further in stating that these “mobilization” costs¹¹ will not be considered in arsenal bids for government work. The intent, as amplified in U.S. DoD (2000), is to protect the arsenals’ peacetime customers from the cost of maintaining capacity needed only for contingency requirements. Funding is specifically appropriated to AWCF organizations for maintaining equipment needed for mobilization in compliance with the requirements of 10 USC 4541 and is termed Industrial Mobilization Capacity (IMC).¹²

In practice, it is impossible to separate mobilization costs from those associated with peacetime production. Most equipment costs are fixed, whether the equipment is used at 20 or 100 percent and regardless of the size of the replenishment requirement. Are these fixed costs incurred because of the peacetime production or because of the replenishment requirement? The question cannot be answered satisfactorily because the costs are incurred for both missions. The intent of the law, however, appears to be to identify the costs incurred *solely* for replenishment. And since, as mentioned, most costs serve both missions, the incremental costs incurred solely for replenishment are small. To illustrate, at one GOGO ammunition plant, the plant commander told us of an ammunition line used at less than 20 percent for current production. That same line will be used during replenishment (though not at 100 percent), and hence he receives IMC funding for it. When asked how his peacetime costs would change if the replenishment requirement went away, he responded that they would not change at all because he would need to continue to maintain the line for his peacetime mission regardless of the replenishment requirement. Thus, the true cost of peacetime production on that line is understated by the IMC funding provided for that line. This has the effect of substituting funding for other purposes. Similarly, as shown in Figure 3.2, 58 of 71 machines at Watervliet Arsenal are used for peacetime production of the M256 cannon, and two-thirds of these are used at less than 20 percent of single-shift capacity.¹³ However, the Watervliet Arsenal only needs to increase production by roughly 30 percent (on a one-shift basis) to meet current replenishment requirements (Hix et al., 2003, p. 96). Increasing utilization rates by 30 percent and bringing the 13 idle machines on line (assuming their usage is greater than 20 percent) would still leave more than 40 percent of the equipment at Watervliet Arsenal

¹¹DoD sizes its capacity to support replenishment after conflict. It does not size it to support national mobilization of capacity during conflict. Thus, the term “mobilization” here refers to replenishment production.

¹²IMC funding is provided in the Operations and Maintenance Army budget. In addition, the procurement accounts separately fund the cost of laying away and maintaining equipment needed for replenishment but not for peacetime production.

¹³As of May 2000, Watervliet estimated that 467 of 764 total pieces of equipment had been used at 20 percent or less of their capacities during the past year and therefore met the requirement for IMC funding. Another 68 machines were laid away, meeting the requirement for Layaway of Industrial Facilities (LIF) or Maintenance of Inactive Industrial Facilities (MIIF) supplemental funding.

operating at less than 20 percent capacity. As should be clear from these two examples, trying to separate mobilization costs from peacetime production is thus bound to be a somewhat arbitrary exercise.¹⁴

Perhaps more important, the method of implementing IMC funding creates a disincentive for making manufacturing process improvements. Managers of facilities eligible for IMC funding, in fact, have an incentive to justify the retention of underutilized equipment and the personnel required to maintain it because they receive additional funding for each piece of equipment in such a status. Since the costs of replenishment and peacetime production are blurred, justifying the need for underutilized equipment is made relatively easy. Processes and production flows are already in place and provide both peacetime and replenishment needs. If these have excess capacity, even for replenishment, the cost of investing in smaller, more efficient capacity is difficult to justify in a budgeting process that ignores the long-term benefits of near-term investments. For example, at both Watervliet and Rock Island Arsenals, the unused capacity in 2001 was documented at 75 and 76 percent respectively,¹⁵ meaning that total capacity is four times that required for peacetime production and at least twice that required for replenishment.¹⁶ Already noted is the fact that even for replenishment production, much of the industrial capacity used remains under 20 percent. At Watervliet Arsenal and to a lesser extent at Rock Island Arsenal, this appears to occur because machine tools are not well organized or laid out for multifunction operations, but are instead located along an established production flow path and used for single-process operations. This is entirely consistent with a manufacturing organization rewarded for maintaining underutilized equipment but not for efficiency.¹⁷

The invisibility of costs, the resultant inability to separate replenishment and peacetime production costs for budgeting purposes, the skewed incentive structures, and the requirements to recover unfunded costs from customers all lead to unstable price structures. The data presented earlier in this chapter concerning the price of the M256 tank cannon make this obvious. Over the course of production, the price of the cannon quadrupled in real terms, and in one two-year period (1999 to 2001) the price of the cannon fell 60 percent and

¹⁴Even if IMC requirements did reflect costs incurred uniquely for replenishment, the way they are computed overstates such cost. Overhead is allocated to machines on an average rather than a marginal-cost basis.

¹⁵U.S. Department of the Army, *Fiscal Year 2003, Budget Estimates: Operation and Maintenance Army, Justification Book*, February 2002, pp. 213-18 and 213-19.

¹⁶Since unutilized capacity is based on single-shift capacity, these figures significantly understate the true capacity of continuous or multishift production.

¹⁷An industrial consortium, which proposed to operate Watervliet Arsenal for the Army, suggested a much shorter production path for cannon manufacture that could have eliminated many single-process tools.

then rose 130 percent the next year. In another example, the projected price of the cannon assembly for the new lightweight 155mm towed howitzer rose 40 percent with a six-month schedule slip. Price fluctuations like these make a program manager's job very difficult.¹⁸

In the end, the blurred costs of peacetime and replenishment production make it difficult for the Army leadership to make decisions about the allocation of resources. On the one hand, IMC funding masks the true cost of manufacturing during peacetime. On the other hand, to the extent that IMC funding does not cover the true costs associated with reserve industrial capability, peacetime production costs end up making the difference. In either case, when these costs are intertwined in ways that make their separation indistinct, ammunition resource decisionmakers will find it difficult to determine what is really necessary. Later in this chapter we discuss the dangers associated with a default ammunition-provisioning strategy that occurs because of underfunding of war reserve stocks or imprecise contingency planning. Obscuring the costs of peacetime and replenishment production makes both more likely.

At the AWCF facilities, costs are invisible in another way as well. Each installation prepares a budget, which is submitted through its major subordinate command (MSC) to AMC headquarters. Both the MSC and AMC make adjustments to the installation's budget, then AMC consolidates the budgets of all the installations and activities of each of the AWCF activity groups (ordnance, depot maintenance, information systems, and supply management) and submits the aggregate budgets to Headquarters, Department of the Army (HQDA). HQDA in turn makes adjustments to the aggregate budgets of the four groups without insight into the details of the individual installation budgets. These revised budgets are then sent to the Office of the Secretary of Defense (OSD), where further budget decisions are made in the program budget decision (PBD) process each year. OSD conveys its aggregate activity group decisions to the Army and the Army conveys them to AMC, where deletions and additions are distributed among the installations that make up each activity group. AMC then communicates these installation-level decisions to the MSC, and in turn to the installation.

While one might prefer that HQDA have routine visibility into installation-level budgets, financial rollups are common in hierarchical organizations. The problem occurs in that AMC is not able to provide a record of decisions and adjustments to the budgets for each installation, preventing accurate analysis of budget trends. Perhaps even more important than the budgeting issue is that

¹⁸In fact, since the Program Office for the Lightweight Howitzer compared and rejected the alternatives to Watervliet Arsenal production of the cannon in FY00, the projected cost of production at Watervliet has risen 60 percent in response to schedule and quantity adjustments.

these installations lack cost-accounting systems that allocate costs to individual activities for purposes of execution review against budgets.

Lack of Access to Capital

Government-owned enterprises, such as the installations under study here, must initiate a long and problematic process of competing for capital investment funding within a federal resource allocation process that culminates in congressionally appropriated funds. Since this process may take several years, if it succeeds at all, valuable time and money can be lost. In addition, funding requests for capital improvements in government facilities are handicapped by vying in a budgetary system that has modulated incentives for making long-term financial investments whose benefits accrue in later years. The results appear in the outdated, inefficient manufacturing technology at the organic facilities under study here. These results are difficult to document due to the inadequacy of data and the skewed incentive structures described in this report but are fairly clear by inspection.¹⁹

By contrast, when a private firm sees an opportunity to improve productivity, it may raise capital to invest in that improvement. This occurs when the capital improvements will lead to more efficient processes that save enough money to both repay the capital costs and enhance the profitability of the product line above some threshold. In a competitive environment, such improvements are also necessary to reduce product price and improve product quality in order to keep customers from moving to otherwise more efficient rivals. Traditional defense contractors, operating in an oligopolistic and monopsonistic market, have fewer incentives for raising capital for efficiency improvement than industries in highly competitive markets. Regardless, they still retain greater capability and stronger incentives to do so than their government-owned counterparts.

¹⁹These kinds of problems affect not only the Army's organic industrial base. In another example, the Army's family housing units have long been plagued by a lack of capital, resulting in run-down, substandard facilities for soldiers and their families. Recognizing this, the Department of Defense has begun programs that are privatizing the Army's family housing facilities. Since private owners can raise capital more easily than the Army, those housing units that have been privatized are being renovated at a faster rate and are now maintained in a more effective manner.

This example is not perfectly analogous to the government-owned industrial facilities. Military family housing has not been managed in a working capital fund. As a result, the capital accounting systems for family housing cannot allocate, and recover through revenue, the costs of capital investments over the life of those investments. Working-capital-funded facilities, such as the GOGO facilities under discussion here, have structures in place that make such capital accounting possible. However, the GOGO's problem with access to capital remains somewhat similar to that afflicting military family housing. The monopolistic nature of their markets, the federal budget process, and the invisibility of their cost structures (discussed further in this chapter) prevent the GOGO facilities from operating as a competitive player in a more idealized market.

Low Priority of Ammunition

The Army spends only about 1 percent of its budget on conventional ammunition. By itself, the relatively small budget for ammunition says little about the priority the Army places on ammunition. However, internal Army studies also show that the recent historical and planned levels of funding leave the Army far short of its war reserve needs (McManus briefing, 2001, Slide 2).²⁰ That ammunition budgets remain small in light of the declared shortfalls indicates that the Army places a low priority on the acquisition of ammunition.²¹

To a certain extent, it is likely that government ownership of a large part of the ammunition industrial base contributes to the low priority accorded ammunition procurement. This occurs when ownership of the means of ammunition production provides a *perceived* hedge against war reserve shortfalls. When such a perception exists, underprocurement of war reserve ammunition will occur when there is an assumption that production can be restarted on an "as-needed" basis. As noted elsewhere in this report, though, such a hedge does not always exist in the short term. Ammunition production lines that have been idle for a considerable period require significant time and resources to restart.

The low priority accorded to ammunition procurement is also partly explained by the divided authority that managed ammunition procurement until the very recent past. For the last several years, management of ammunition procurement was handled by three organizations.²² The Operations Support Command (OSC) was generally responsible for procuring mature ammunition products. The Deputy for Systems Acquisition of the Tank-Automotive and Armaments Command (TACOM) managed other ammunition items, including both developmental and more mature designs.²³ Finally, several program managers within the Army's Program Executive Offices managed the remainder of the ammunition items. As a result, no single advocate for ammunition was available to fight for resources or manage overall procurement and production; thus, ammunition procurement tended to be somewhat unstable. A fairly stable aggregate level of buys masks this problem; however, the actual mix of ammunition tends to vary substantially from year to year. Furthermore, future-year estimates of quantities of particular end items vary as the execution year

²⁰Training ammunition requirements, on the other hand, tend to be fully funded.

²¹As shown in Chapter One, the level of funding for Army ammunition procurement has been relatively flat since FY96. Despite an increase of more than 10 percent in the Army's overall FY03 budget (from \$81.075 billion in FY02 to \$90.978 in FY03), ammunition procurement actually declines slightly, from \$1.192 billion in FY02 to \$1.159 billion in FY03.

²²This situation changed in FY02 with the establishment of the Program Executive Office for Ammunition. At the time of this writing, the Army has not completed the task of defining the limits of the PEO Ammunition's authority and responsibility.

²³TACOM is itself a major subordinate command of the Army Materiel Command.

approaches. Figure 3.4 illustrates this kind of problem. It shows the budgeted production levels for the M795 artillery projectile as published in successive Army procurement budget documents, FY99 through FY02. Also plotted are estimates of the actual production levels for FY98 to FY00. During these three years, actual production achieved an average of only half the earlier budgeted figures for those years.²⁴ These year-to-year variations result in part from program and budget decisions made in the press of time to find savings, but they have unanticipated effects on the efficiency of the production base, resulting in idle capacity and higher ammunition costs. Higher ammunition costs then lead to underinvestment in munitions and distort the Army's overall allocation of resources.

Figure 3.4 also illustrates another issue with production stability: planned and actual production that varies significantly from year to year. For example, the production plan laid out in the FY99 budget envisioned a production rate of 80,000 M795 rounds in FY98 and 130,000 in FY99. Such an increase is to be expected, since FY98 was the first planned year of production. However, the

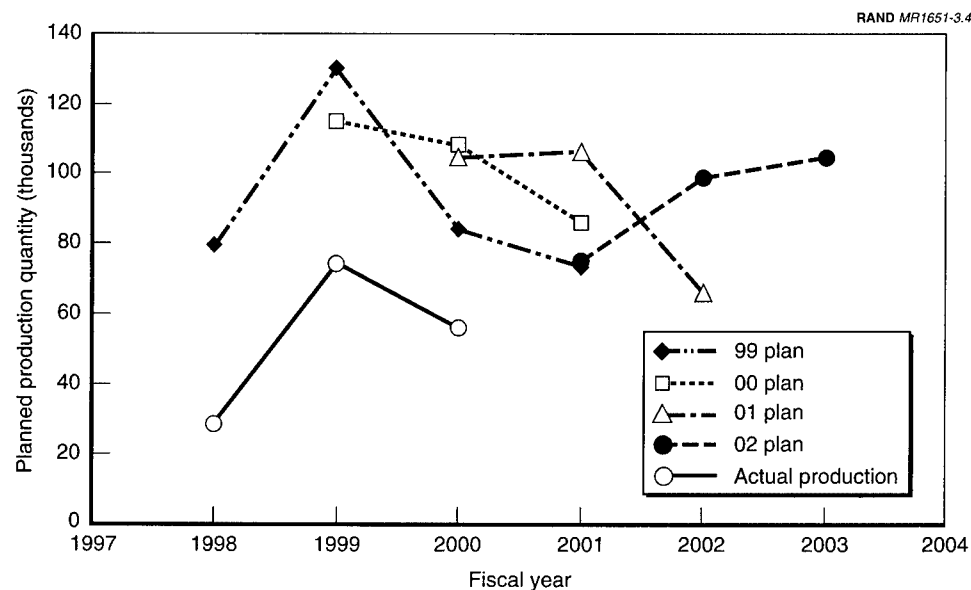


Figure 3.4—Planned and Actual Production for the M795 155mm Artillery Projectile

²⁴For example, the FY01 Budget Estimate was published in February 2000. In that estimate, planned production for the M795 during FY00 was 104,000 rounds. The FY02 Budget Estimate, published a year later in February 2001, shows actual production for FY00 at 56,000 rounds, roughly half the amount planned a year earlier.

same production plan envisions production dropping back to 82,000 rounds in FY00 and even further in FY01. Such production instability makes it difficult to operate production lines efficiently, since the most efficient production processes for 130,000 rounds may be different from those for 80,000 rounds. Clearly, the result may affect the overall cost of the ammunition.²⁵

Ownership and governance solutions will neither solve this problem nor make it worse. Virtually all the private manufacturers as well as Army and DoD officials we interviewed argue that multiyear contracting and more consistent ammunition buys would stabilize production facilities and reduce ammunition costs. Establishment of the PEO Ammunition should facilitate both of these remedies.

Time Required to Dispose of Excess Facilities

Chapter Four, Table 4.1, demonstrates that it takes on average about nine years to dispose of the last acreage of an ammunition plant declared excess to need.

Lack of a Replenishment Policy

Since the end of the Cold War, the Defense Department has had a policy of not surging its manufacturing capabilities during potential hostilities, which are anticipated to be limited in duration. Instead, the plan is to maintain a stockpile of materiel (equipment, spare parts, and ammunition) large enough to ensure the successful resolution of these conflicts and to replenish those stocks after hostilities have ceased. While DoD directs a three-year replenishment policy for parts and equipment, the Army has the latitude to define its own policy for what ammunition to replenish, how much to replenish, and over what period. Today the Army lacks an explicit policy for replenishment of ammunition. It also lacks a single proponent for policy pertaining to replenishment of ammunition, spare parts, and equipment.

Despite this lack of established policy, the Army Materiel Command plans to replenish ammunition over a 36-month period, a span established by *former* DoD policy. It will do so in two ways: (1) increasing production on currently producing lines,²⁶ and (2) activating laid-away capabilities.

²⁵One commercial vendor complained about this kind of production schedule for another ammunition family. He stated that these kinds of production requirements made it difficult for private producers to respond to solicitations with competitive bids.

²⁶This can be done by increasing single-shift production on partially utilized equipment or by going to multiple shifts.

A replenishment capability is not cost free. Keeping and using underutilized production equipment incurs opportunity costs and may entail production processes that are inefficient for smaller peacetime production rates. More explicitly, the GOGO facilities receive IMC funding intended to pay overhead and personnel costs associated with replenishment—required equipment that is active but used at 20 percent or less. In FY02, IMC funding for the five GOGO facilities under study will amount to about \$43.5 million, which funds only part of the IMC requirement. Beginning in FY03, the DoD plans to fund its IMC requirement fully. This decision increases the IMC line item to \$126 million (U.S. Department of the Army, *FY2003 Budget Estimates: Army Working Capital Fund*, p. 54). Equipment deemed necessary for production at replenishment rates but idled and laid away during peacetime also incurs costs. These include the one-time costs to prepare and lay away the equipment as well as recurring maintenance costs. In FY02 the Army will spend about \$11 million for these activities at the facilities under study, funded through the procurement appropriations (U.S. Department of the Army, Procurement Programs, 2001a and 2001b). Hence, as of FY03 the total direct funding for replenishment, both for laid-away and unutilized capacity, will amount to more than \$137 million a year.

Whether the 36-month replenishment policy is correct or not, the capacity holding costs of \$137 million lack the foundation of an overall replenishment policy upon which to justify the resources. The policy needs to be thought through carefully so that the dollars spent on replenishment capacity buy the capability the Army truly needs.

Strategy by Default

It is critical that the Army has access to a reliable source of ammunition, whether through stockpile and replenishment or immediate and effective production surge during hostilities. An armed force without materiel, whether spare parts, equipment, or ammunition, cannot serve as an effective instrument of national policy. Since current national security strategy excludes any requirement to surge or to support a national mobilization, hostilities are to be fought with on-hand materiel supplemented by budgeted production levels during the hostilities.

Despite the national security strategy, however, repetitive and possibly extended campaigns of the character of Kosovo and more recently in Afghanistan and Iraq may reveal the need for some surge capacity. If DoD could predict the number, duration, and intensity of future hostilities, adequate funding of war reserve stocks would obviate the need for surge capacity, and replenishment after hostilities could serve DoD's needs. But either unplanned campaigns or

underfunded war reserve stocks can leave DoD in the problematic position of requiring an unforeseen surge during hostilities. In other words, underfunding of war reserve stocks can place the nation in the position of resorting to a default national strategy of surging during operations.

Hence, the validity of a policy of fighting with existing stocks and replenishing later depends on well-hedged contingency planning and adequate funding of war reserve stocks. Failure in either risks an unplanned default to a surge strategy. If that strategy has not been planned for and resourced, an unplanned default to it can subject the nation to real-time operational risks. Such risks, however, occur independently of whether the Army or some other entity owns the manufacturing assets.

Army Efforts at Innovation and Change

The Army has recognized the various problems with the ordnance industrial base and has attempted to address them in different ways. Below we discuss some of these efforts.

The ARMS Act of 1992. In the past decade, the business operations in the organic base have benefited from a legislative initiative known as the ARMS Act of 1992 (10 USC 434). First authorized as part of the National Defense Authorization Act for Fiscal Year 1993, ARMS provided the impetus for improving the business practices at the eleven GOCO ammunition plants. Before the ARMS initiative, contractors who used the organic facilities typically signed five-year cost-plus contracts, in the form of basic ordering agreements, to produce ammunition. Contractors were granted authority to use facilities and equipment within the government-owned plants to carry out the terms of their contracts. Agreements also included maintenance of laid-away capacity, modernization, and other services. Modifications were negotiated each year after the Army decided upon specific quantities of ammunition and the details of other services the contractors were to provide. The cost-plus nature of the contracts required the Army contracting officer representatives to negotiate all the details of cost elements in these sole-source transactions. Negotiated details included direct labor and all its indirect burdens.

The ARMS Act laid the groundwork for a different way of doing business at the GOCO plants. Before ARMS, neither operating contractors nor the government commanders at the local plants had much incentive to expand the business base at the plants. Contractors concentrated on executing their cost-plus supply contracts. Plant commanders and their staffs fulfilled the government's responsibilities in seeing that ammunition was produced on time at a reasonable cost and that the government's equities were protected in the management of the plant. Absent ARMS, plant commanders and their contractors lacked

both the authority and the incentive to bring other business onto a facility, despite the availability of unused physical assets and the opportunity to bring additional revenue to the plant.

The ARMS initiative changed the nature of the contractor relationships with the Army and provided authority for contractors to collect revenue from the lease of physical assets on the GOCO plants to commercial tenants. First, under the ARMS program, the Army began to negotiate facility-use contracts for periods up to 25 years. Under such contracts, the facility-use contractor is encouraged to bring commercial firms onto the plant to reduce the Army's cost of ownership and to serve a number of other objectives. ARMS tenants pay rent to the facility-use contractor, not to the government. The government benefits indirectly, as the facility-use contractor agrees to use part of the rental payments to improve, maintain, protect, repair, or restore the facility or property on it, or to reduce overhead or product costs (10 USC 4554). In some cases, the contractor negotiates to keep a fixed share of tenant revenues as profit. Hence, under ARMS both the local commander and the contractor now have an incentive to develop plants for commercial purposes. (A detailed assessment of the ARMS program may be found in Hix et al., 2003, Appendix A.)

Leasing authority. Also in the early 1990s, the Congress enacted legislation (10 USC 2667) that permits half of any lease revenues the government receives from ordinary leases with the government to be returned to the installation for "(i) Maintenance, protection, alteration, repair, improvement, or restoration (including environmental restoration) of property or facilities. (ii) Construction or acquisition of new facilities. (iii) Lease of facilities. (iv) Facilities operation support." These purposes are similar to those intended for ARMS revenues. This legislation applies not just to the GOCO plants, as does the ARMS program, but extends also to the GOGO facilities under study here. In the FY01 National Defense Authorization Act, 10 USC 2667 was amended to mirror the ARMS program provisions in that it authorized ARMS Act-like in-kind considerations in lieu of lease payments. Hence, there are now in place for both GOGO and GOCO facilities the legal authorities necessary to permit commercial sharing of their capabilities and capacities to reduce cost of ownership.²⁷

Pilot program to sell manufactured articles and services. In the FY98 National Defense Authorization Act (PL 105-85, Section 141), the Congress authorized a

²⁷It should be noted, though, that 10 USC 2667 has restrictions that have limited its use. As stated above, only half of the lease revenue is returned to the installation involved; the rest goes to the U.S. Treasury. Additionally, even those lease proceeds allowed to the installation must be included in an appropriations bill before they can be spent. 10 USC 2667 also requires environmental impact statements, significant congressional notification, five-year limitations, and other provisions that deter the use of the statute's leasing authority.

two-year²⁸ pilot program intended to permit three AWCF activities to sell manufactured articles and services to commercial contractors making weapon systems for DoD. The pilot program was intended as a means of increasing the workload at underutilized Army facilities. The legislation granted a temporary waiver of the provisions of 10 USC 4543(a)(5), which requires the Secretary of the Army first to determine that such articles are unavailable from a commercial source before permitting such a sale to DoD weapons contractors. The program was intended to enhance “the opportunity for United States manufacturers, assemblers, developers, and other concerns to enter into or participate in contracts and teaming arrangements with Army industrial facilities under weapon system programs of the Department of Defense” (PL 105-85, Section 141(c)). The Army selected Watervliet and Rock Island Arsenal and McAlester AAP as the three participants in the pilot program.

The pilot program has so far produced insignificant results, in part because of the noncompetitive cost structure of the facilities. The three facilities participating in the pilot program have combined annual revenues of roughly \$300 million. The program generated only 12 contracts worth \$6 million. Only one of the 12, a five-year \$5.2 million contract to demilitarize ammunition awarded to McAlester AAP in August 2000, was for more than a million dollars (U.S. Department of Defense, *Pilot Program . . .*, 2001, p. 15).²⁹ The pilot program failed to enhance the aggregate revenue at plants by more than one-third of 1 percent in any year.

At issue during the pilot program was the basis for determining the prices the facilities could charge to pilot-program customers. Working-capital-funded activities are required by law (10 USC 2208(o)) to recover their full costs. But 10 USC 4543(b)(3)(a), which pertains to sale of manufactured articles or services outside DoD, permits a facility to charge the buyer “at a minimum, the variable costs that are associated with the commercial articles or commercial services sold.” DoD (U.S. DoD, *Pilot Program on Sales . . .*, March 2001, p. 29) ruled against the Army in its request to waive the full-cost requirements of 10 USC 2208 in favor of the permissive marginal cost provision of 10 USC 4543. The Army argued that pilot-program customers should not pay the costs of unutilized capacity retained for mobilization or replenishment. Announcing the DoD decision on the Army’s request, the Assistant Deputy Comptroller (Program/Budget) (U.S. DoD, *Pilot Program on Sales . . .*, March 2001, p. 26) pointed out that such costs were already separately funded, so that rates

²⁸Section 115 of the FY00 National Defense Authorization Act extended the test program through FY01 and Section 112 of the FY02 act extended the program through FY02.

²⁹The combined total of the other eleven contracts is less than \$1,000,000.

charged to all working-capital-fund customers excluded such costs.³⁰ DoD offered the further observation that to charge commercial customers a lower, marginal rate while continuing to charge its regular customers the full cost recovery rate would be "counterproductive to sound financial management." It would be difficult to assess the extent to which the pilot program would have generated more revenue had potential buyers been quoted prices based on variable rather than full costs.

Arsenal Support Program Initiative. The Arsenal Support Program Initiative (ASPI), enacted as a part of the FY01 National Defense Authorization Act (PL 1060-398, Section 343), represents another demonstration program intended to boost utilization of arsenals. In FY02, ASPI is in the second year of a two-year demonstration phase. It is intended, among other purposes, to encourage commercial firms to use the Army's manufacturing arsenals for commercial purposes. ASPI differs from the pilot program described above in two ways. First, ASPI envisions commercial firms actually using arsenal facilities for manufacturing rather than having arsenal employees manufacture and sell commercial items to firms not employed at the arsenals. Second, ASPI permits completely commercial work to be done at the arsenals; the other pilot program restricted sales to defense-related programs.

ASPI permits the Army to contract with commercial firms to use all or part of an arsenal, as well as arsenal employees, to enter into subcontracts for the manufacture of commercial items. As with the ARMS program, ASPI permits the Army to enter into long-term facility-use contracts. The program also allows the Army to enter into property management contracts, leases, and other arrangements that support recapitalization, environmental remediation, and the promotion of commercial business ventures. Unlike the ARMS program, Congress provided no funding for ASPI in FY01, but it earmarked \$7.5 million of Operations and Maintenance funds for the program in its FY02 Defense Appropriations Act (U.S.H.R. Report 107-350, 2001, p. 171).

It is still too early to assess the outcome of the ASPI program. One promising initiative at Watervliet Arsenal envisions the use of its chrome-plating activity by a commercial plating firm for its own commercial products, as well as for gun tubes and other defense-related arsenal products as well. The firm would also have access to government employees at the arsenal who might actually be assigned to the commercial plating firm under the Intergovernmental Personnel Act Mobility Program. This initiative and others under the ASPI program are managed through a private site manager who was hired to market unused

³⁰These issues should be familiar to the reader, as they mirror those discussed in the section above on invisibility of costs.

capacity and manage the real estate (to include collecting rent and conducting maintenance).³¹

Rock Island Arsenal envisions a different use of ASPI authority, leasing excess administrative space to commercial firms who will perform in-kind services in lieu of rent (Mapley personal communication, 2001). As with the ARMS program, local commanders prefer these leasing arrangements to those authorized under 10 USC 2667, because they streamline bureaucratic activities and permit all revenue to remain at the installation rather than be shared.

The ASPI legislation requires the Army each year to (1) report the amounts of loans guaranteed under the program, (2) conduct a comprehensive review of contracting at the arsenals, and (3) recommend changes to the program. In its first report to the Congress (U.S. Department of the Army, "Oscar Letter," 2001) for FY01, the Army reported "limited success." Specifically, no loans had been guaranteed and contracting at the arsenals had been "limited." The Army asked that no funds be appropriated to the program, because it believed that the program could be made to work without government investment and because it had higher priorities for any funds that might be available. Importantly, the letter pointed out that the Army believed leasing under 10 USC 2667 to be preferable to loan guarantees under the ASPI program, in that long-term leases give businesses interests and responsibilities that permit them to negotiate investor support directly, avoiding Army liabilities.

Both the pilot and the ASPI programs recognize the potential benefit to the government from applying arsenal assets to commercial purposes. A central issue of this report is how best to realize the benefit from such commercial use.

³¹The Watervliet Arsenal Business and Technology Partnership, a private, not-for-profit organization created by the state of New York in 1988, is today engaged in marketing Watervliet's unused arsenal capacity (Murnane, 2001).

A STRATEGIC VISION AND OPTIONS FOR ACHIEVING IT

The previous chapter chronicled the problems our analysis identified in the ordnance base. A major deficiency noted was the absence of a strategic vision. This chapter serves four purposes. First, it offers a strategic vision for the ordnance industrial base. Second, it describes four options that to varying degrees move from the status quo toward achieving that vision. Third, it translates the features of the vision into a set of criteria against which we shall assess the options in later chapters. Finally, it sets aside options that are considered infeasible for parts of the base at this time.

A PROPOSED VISION

Both statute and executive branch policies support, indeed require, reliance on the private sector. Specifically with regard to the technology and industrial base, 10 USC 2501 sets forth the following three objectives:

Relying to the maximum extent practicable upon the commercial national technology and industrial base that is required to meet the national security needs of the United States.

Reducing the reliance of the Department of Defense on technology and industrial base sectors that are economically dependent on Department of Defense business.

Reducing federal government barriers to the use of commercial products, processes, and standards.

10 USC 2535, which deals with the narrower issue of maintaining a reserve capacity (capacity not needed during peacetime), reinforces these goals. It states that "to the maximum extent practicable, reliance will be placed upon private industry for support of defense production," but it allows for an "essential nucleus" of government-owned industrial reserve capabilities, warning that, "such Government-owned plants and such reserve shall not exceed in number or kind the minimum requirements for immediate use in time of national emergency."

A third piece of legislation, the Arsenal Act (10 USC 4532), is often cited as conflicting with the above two pieces of legislation, but it is not clear that any such conflict exists. The statute consists of only two sentences:

The Secretary of the Army shall have supplies needed for the Department of the Army made in factories or arsenals owned by the United States, so far as those factories can make those supplies on an economical basis.

The Secretary of the Army may abolish any United States arsenal that he considers unnecessary.

In other words, if the Army owns an arsenal and it can make goods cheaper than commercial sources, the Army must use the arsenal. But if the arsenal is not needed, it may be closed. There is some ambiguity as to what conditions must exist before an arsenal might be considered "unnecessary." And there is a question as to whether the spirit of 10 USC 2501 and 2535 permits cost as a consideration in relying on the private sector "to the maximum extent practicable."

DoD Directive 5000.60 reinforces the statutory basis for primary reliance on the private sector, precluding any action "to preserve an industrial capability unless it is the most cost- and time-effective alternative to meeting national security requirements."

While Army Regulation 700-90, "Army Industrial Base Policy," is currently under revision, Army Industrial Base Policy Letter 98-1 explicitly lays out Army policy. It says "Rely on the private sector to create and sustain ammunition production assets in response to production and replenishment contracts," and "To the maximum extent feasible, transition government-owned ammunition production assets to the private sector while preserving the ability to conduct explosives handling operations safely."

Against the backdrop of our national policies, which are clear and consistent, the problems and issues associated with the current base provide a motivation for a strategic vision for the ordnance industrial base. In that context, the following vision is offered:

A Strategic Vision for the Ordnance Industrial Base

Convert the organic ordnance base to a responsive, innovative, efficient manufacturing base, capable of meeting national security requirements while relying to the maximum practical extent on the inherent advantages of competition and private ownership of capital

Key words and phrases in the proposed vision merit some elaboration.

A “responsive” base stays abreast of innovations in manufacturing technology and rapidly introduces those innovations into its processes. It also responds to the changing and sometimes unpredicted needs of its customer during normal periods, hostilities, and replenishment. A responsive base stays close to its customer so that it may better anticipate demands.

An “innovative” base not only takes advantage of new ideas generated by others but also initiates its own innovations, becoming a leader rather than a follower in both its business and manufacturing practices.

Economic efficiency may be loosely but usefully defined as the absence of waste (Baumol and Blinder, 1982, p. 46). Perfect efficiency will always remain an elusive but nevertheless worthy objective. The competing demands of multiple missions of the industrial base may require configurations of lines and equipment that appear inefficient to the uninitiated but are necessary to meet all requirements. Equipment used at low rates in peacetime may represent the most efficient allocation of resources when the replenishment mission is also considered. Nevertheless, competitive pressures foster an innovative base that constantly seeks new ways to improve efficiency. The government, as typically the sole customer of the base, bears the responsibility to ensure that the base can meet all its requirements, not just the day-to-day production. This means adequate funding, guidance, and oversight of the base, regardless of whether it is organic or commercial.

A base that, for whatever reason, cannot meet national security requirements cannot be sustained. That said, resources by definition are scarce, and shortages must always be balanced across functions. It is rare, if not unheard of, for any defense function to receive all the resources its proponents deem apt. Hence, any inability of the base to meet its national security demands, either programmed or replenishment, must be assessed in the context of the capabilities of the other inputs to the equation that defines overall military capability. The Army’s ordnance industrial base serves all the U.S. military services as well as certain weapon systems that the United States no longer uses but its allies do. Hence, the national security requirements are much broader than just the U.S. Army. A completely robust ammunition capability purchased at the expense of the weapons required to fire the ammunition would make no sense. The adequacy of a capability to meet requirements must be taken in the context of a balance in resources, not against an isolated requirement. Hence, a statement that the Army is able to meet only 60 percent of its replenishment requirement for a certain item means little without understanding how that capacity relates to all the other required ammunition and nonammunition inputs to military capability.

A base that relies “to the maximum practical extent on the inherent advantages of competition and private ownership of capital” is one that is consistent with national industrial base policy. In competitive markets, public-sector ownership is likely to be less efficient than private-sector ownership because of a lack of clear objectives, soft budget constraints, and easier government intervention in firm operations (Megginson and Netter, 2001). However, in the ordnance market, economic theory is less clear, because the government is the dominant or the only buyer, and there are only a small number of private-sector performers, so the market may not be fully competitive. We must therefore examine the evidence to determine whether public- or private-sector ownership is more efficient in the ordnance market.

There are valid reasons for the government to perform functions. At issue is the extent to which the manufacturing assets under study here fit these reasons. First, functions such as contracting, interpretation and execution of laws, and acquiring or disposing of government property are termed “inherently governmental” activities and may not be performed by commercial entities (U.S. Executive Office of the President, 1983). The manufacturing functions under study here do not fall into that category.

Second, if the private sector cannot be induced to manufacture the required ordnance materiel, it may be appropriate for the government to be in the business. For the products at hand, such is not generally the case. Although markets are thin for some products and order quantities are sometimes uneconomic, markets—however imperfect—generally exist for these products. (Hix et al., 2003, Appendix B).

Third and related to market conditions is the condition under which the government can manufacture the products at lower cost. In A-76 competitions, the government often competes successfully for the performance of functions. The organic facilities under study here win competitive contracts.¹ Decisions are, however, governed by an interpretation (Comptroller General, 1995) of the Arsenal Act, which allows sourcing decisions to be made by comparing the incremental (out-of-pocket) costs in the organic facilities with the full costs of private competitors, conveying a heavy advantage to the organic facility.

Finally and most subjective is the condition of risk in meeting national security requirements. In the case of ordnance materiel, the base must provide a reasonable certainty that it can meet programmed and replenishment requirements, respond to crises, and maintain its technological edge. Since September 11, 2001, security of defense-related facilities within the United States, both commercial and organic, has come to the fore as a concern. The Army has

¹The exceptions are Crane and McAlester, which are restricted by PL 99-661.

tightened security around the ammunition plants and arsenals. To the extent that the risk associated with private-sector reliance exceeds what the Army considers prudent, then continued ownership is indicated.

These considerations are all explored in depth in Chapters Five through Seven.

POLICY OPTIONS FOR MOVING TOWARD THE VISION

From the above vision, we propose four broad policy options that offer the possibility of moving the base toward the vision: privatization, creation of a federal government corporation, consolidation, and recapitalization and unification. The vision also provides the basis for the criteria against which the options are measured. The options and criteria are briefly described below.

Privatization

The term “privatization” is defined here as divestiture of government-owned plant and equipment. Privatization results in private rather than government ownership of capital, which includes real estate, buildings, property, and equipment. It implies the substitution of private for government employees, except for inherently governmental functions such as contract management, auditing, and other essential oversight.

Divestiture of plants through privatization as going concerns differs dramatically from the Army’s recent practice of divesting by terminating manufacturing at a plant or moving production to other facilities and declaring the plant excess, typically leaving an unproductive plant with a large underfunded environmental liability, continuing costs of upkeep, and little prospect of revenue from sale.

Currently excess plants. As a result of the Army’s declaring plants excess to need, it still retains title to 13 ammunition plants, 12 of which were declared excess outside of the Base Realignment and Closure process (BRAC), and one, Alabama AAP, which was closed in the 1988 round of BRAC. These facilities lie outside the scope of this study. However, they are relevant to this study as an example, described in more detail later, of the drawbacks of simply declaring facilities excess to need, then trying to dispose of them. Table 4.1 shows when the plants were declared excess, when the disposal process began, their current status, and the annual operating costs and estimated environmental liability.

On average, it is expected to take just over nine years from the date a plant is declared excess until the final acreage is transferred. Several factors contribute to the lengthy lags, but most prominent is the requirement to complete environmental remediation before the property is conveyed. While anticipated

Table 4.1
Excess Army Ammunition Plants in Disposal Process

	Excess Year	Disposal Year	Lag (yrs)	Current Status	Ann O&M (\$m)	Env Liab (\$m)
Alabama	1988	2002	15	Awaiting approval	0.1	4
Badger	1998	2011	13	Remediation	0.9	111
Cornhusker	1998	2015	17	Transferred to USACE	0.1	42
Indiana	1998	2011	13	Master lease	0.0	65
Joliet	1996	2011	15	3 remaining parcels	0.2	88
Kansas(part)	1998	2005	7	Re-evaluating	0.0	27
Longhorn	2001	2003	2	Awaiting USFWS MOA	0.4	44
Ravenna	2000	2006	6	Negot. w/ NGB	0.1	45
Sunflower	1998	2003	5	Negot. w/ developer	2.1	62
St. Louis	1994	2003	9	Remediation	0.0	10
Tarheel	1995	2003	8	Remediation	0.0	3
Twin Cities	1999	2004	5	Negot. w/ USAR/NGB	0.0	62
Volunteer	1998	2002	4	Remediation	1.8	28
TOTALS					5.6	592

SOURCE: U.S. Department of the Army, *Industrial Base Program Review* briefing, 2002.

dates of transfer approach, as of the writing of this report, none of the 13 plants had yet undergone a full environmental characterization in a manner acceptable to potential owners, state governments, and the Environmental Protection Agency (EPA), a necessary step in disposing of a property. The properties collectively carry a remaining estimated environmental liability of \$592 million. This figure is likely to climb as complete characterizations provide more thorough descriptions of actual liabilities.

As the following subsection explains, the Army has available a means of divesting the GOCO plants under study here while avoiding the lengthy disposal process illustrated above.

A better model: excess-to-ownership but not excess-to-need. Under the privatization option envisioned here, Army facilities would be sold as “going concerns” to ordnance producers who agree to maintain required capabilities for specified periods. Under an “excess-to-ownership but not excess-to-need” determination, the General Services Administration (GSA) would sell the facilities either to the current operators of GOCO ammunition plants through negotiated sales or conduct limited competitive sales of facilities to qualified ordnance producers.² No plants would be added to the Army’s stock of excess plants, and

²Excess-to-ownership but not excess-to-need transfers have recently been accomplished at two Navy activities, a facility in St. Louis sold to Boeing and another in Minnesota sold to United

no plants would be taken out of service. The ownership of plants actively producing ammunition would simply change from the Army to a private firm.

This excess-to-ownership but not excess-to-need authority offers another distinct advantage over the past practice of simply declaring a plant excess to need. When a plant is declared excess to need, as has been the case with the plants enumerated above, the law (40 USC 484) requires the property to be offered first to other DoD agencies, then to other federal agencies, and finally to state and local agencies before it may be offered to the public. In certain circumstances, the provisions of these screenings permit the conveyance of the property without compensation to the Army. By contrast, a sale under the condition of excess-to-ownership but not excess-to-need offers two advantages over an excess-to-need sale. First, because the continuing need fixes the future use of the property, it can be transferred only to firms that have the capability to meet the continuing manufacturing need; thus, the federal and state screenings are not applicable. Second, the buyer must pay fair market value for the property, improving the probability that the Army will receive revenue from the sale. We also envision that the Army would simultaneously award initial production and replenishment contracts (for a five-year period, for example) to the new owners of the facilities.

Another advantage to this approach is by using either the early-transfer authority from the FY97 National Defense Authorization Act or a sale to a potentially responsible party (42 USC 9620), the property can be transferred to the new owner before environmental remediation is completed.³ In addition, the Army can partially or completely fund its environmental remediation costs through conditions of sale under which the buyer agrees to conduct remediation in lieu of cash payment for purchase. Further, in some cases it may be possible to negotiate reductions in purchase price in return for reductions in future product prices or to offset other one-time transfer costs, such as contract termination costs or liabilities for retiree benefits. After the initial production contract period, independent production and replenishment contracts would be awarded based on full and open competition in the ordnance industrial base.

Divestitures under the excess-to-ownership provision offer a second environmental-related rationale. Under normal excess-to-need transfers, the

Defense. The Air Force used the authority to transfer its PJKS facility in Colorado to Lockheed. To date the Army has not tried to use this authority.

³GSA has successfully used the early-transfer authority in the conveyance of 13 DoD properties, both BRAC and non-BRAC. They are: Bristol Naval Weapons Center, Tennessee; FISC (Fleet and Industrial Supply Center) Oakland, California; Griffiss AFB, New York; Grissom, AFB, Indiana; Lowry AFB, Colorado; Mather AFB, California; Monticello MTS, Utah; NAS Guam; NAS Memphis, Tennessee; NTS (Naval Training Center) San Diego, California; Tooele Army Depot, Utah; Volunteer AAP, Tennessee; and Wurtsmith AFB, Michigan.

National Environmental Policy Act (NEPA) (42 USC 4332) requires detailed environmental impact statements. Preparation and approval of these statements can take years to complete. Under an excess-to-ownership sale, because the property is transferred for a like use, NEPA compliance requires only the preparation of a “categorical exclusion” document, a minimal administrative task that GSA undertakes.⁴

In the GOCO plants, the government now owns both the land and most of the equipment, but only a handful of government employees work at the sites. Hence, the difficult issues associated with converting a government workforce to a private one are not a serious consideration at the GOCO plants.

The five working-capital-funded activities differ from the GOCO plants in that the conversion of a substantial government workforce is daunting. In fact, privatization of the GOGO facilities is not feasible outside of BRAC authority. Conversion of certain functions at GOGO facilities to contract performance, however, would be possible through A-76 competition. For these and other reasons described later, the practical extent of privatization is circumscribed by legal and regulatory authorities.

Privatization, however, represents the only option of the four that fully embraces and takes as its objective the fulfillment of the portion of the vision that suggests “relying to the maximum practical extent on the inherent advantages of competition and private ownership of capital.” Further details on legal authorities, implementation issues, and designing a divestiture plan are discussed below and in Chapter Eight.

Creation of a Federal Government Corporation

Federal government corporations (FGCs), as explained in detail in Chapter Six, operate at the boundary between the public and private sectors and possess some of the characteristics of each. FGCs are established by act of Congress to serve public purposes while operating free of many of the legal and regulatory constraints of executive branch agencies. They operate as self-sustaining commercial organizations to provide goods and services of national importance that are not provided adequately by the private sector. Unlike government agencies, FGCs may borrow money in capital markets. Their profits and losses are not reflected in the federal budget deficit or surplus. Their employees are not necessarily subject to civil service rules. They are not bound by federal procurement regulations. Conceived as a compromise between options that leave the base under Army ownership and privatization, an FGC avoids any national

⁴John Kelly, GSA, personal communication, March 18, 2002.

security risk by maintaining government control of assets while introducing many of the positive aspects of private ownership.

An FGC would retain government ownership of manufacturing assets but relieve the Army and the DoD from managing a peripheral function. The assets would be placed in the hands of an organization whose core missions would be manufacturing and the management of real estate it owns principally to support necessary defense-related manufacturing. An FGC partially achieves private-sector reliance. It would introduce many private-sector incentives to improve efficiency, innovation, and responsiveness, while mitigating any risks of supply disruption associated with private ownership of assets.

We assume that legislation creating the FGC would convey property to the FGC without compensation to the Army as a means of capitalizing the new entity. Legislation could, however, provide appropriated compensation to the Army without encumbering the FGC with debt.

Consolidation

Consolidation, one of two options that leave the organic base entirely under Army ownership, embodies Army policy over the last decade. Consolidation rationalizes facility utilization by moving production into a smaller number of plants, declares others excess, and either terminates employees or moves them to the new location.

Since the end of the Cold War, the Army has closed the GOCO ammunition plants shown as excess in Table 4.1 above, terminating production at some and consolidating production from others. While the Army lacks a strategic plan for its industrial base, recent draft plans envision further consolidation over the long term. Consolidation can create efficiencies by reducing overhead costs and therefore may be worthwhile. However, it leaves the Army with its management distraction, no better access to capital, and contractors with few incentives to modernize. Further, it can impose upfront budget costs to complete environmental remediation before transfer. Finally, it can culminate in the transfer of land to other government agencies without compensation to the Army. Fundamentally, consolidation ignores the imperative to rely on the private sector. Chapter Seven provides a more detailed assessment of consolidation relative to other options.

Recapitalization and Unification

The fourth broad option envisions a long-term strategy of relocating the organic base entirely on multifunctional installations of the Army or the other services.

It would ideally be considered as part of a larger Army or DoD base realignment strategy to eliminate the many single-function installations that today house such activities as headquarters, training, and industrial operations.

DoD owns 24 million acres of land, much of it underutilized; the organic ordnance base sits on less than 1 percent of it. While this option would not move toward greater private-sector reliance, it would confer the overhead advantages associated with consolidation. More importantly, though, the option would offer a one-time opportunity to recapitalize the aging manufacturing technology now found on much of the current base. The drawbacks are obvious: high one-time budget cost (but potentially offsetting long-term savings) and the significant political issues associated with local job loss (but workable under a BRAC umbrella).

This option would comprise only a small piece of a much larger and more comprehensive consolidation effort by the Army implemented to achieve broader goals as part of a comprehensive BRAC initiative.

ASSESSMENT CRITERIA

The strategic vision suggests a set of criteria by which to assess the absolute, as well as relative, goodness of options under consideration. The criteria fall into five categories: ability to meet mission requirements, long-run cost, consistency with national and DoD policy, managerial ease, and external issues. Below we define and explain each. The vision suggests a relationship among the criteria through the following policy decision logic: "What mix of options permits the Army to meet its mission requirements, at minimum long-run cost, in a manner consistent with national and DoD policy, considering the ease of management and external issues?"

Mission Accomplishment

Any candidate option must offer reasonable assurance of its ability to meet current and anticipated production and replenishment requirements. Further, the flexibility to respond to unexpected crises should be optimized. Implicit in these statements of mission accomplishment is the concept of risk. No option, including the status quo, eliminates risk completely.

The imperative to meet the demands of current policy is not in question. Less clear is whether it is appropriate to divert scarce resources to provide a hedge against scenarios not now relevant to current policy. For example, national mobilization is not a part of national security policy, but it may become relevant in the future. Should the Army invest some of its limited resources to re-

tain capacity as a hedge against such possible future contingencies at the expense of satisfying current policy?

All other factors being equal, an option that provides greater assurance of the continuing availability and serviceability of a given capability or capacity is to be preferred over one that carries greater risk. Army ownership of capability is often cited as preferable to private ownership for this reason; that issue is more fully explored in Chapter Five.

Options that provide incentives for innovation not only increase efficiency and reduce cost, they can also improve the quality and effectiveness of ordnance materiel itself and hence enhance mission accomplishment. One of the criticisms of the current base is that it lacks incentives for investment in productivity-enhancing and product-improving capital.

Together, the above aspects of mission accomplishment provide a rich but complex and interrelated set of considerations in assessing options. Mission accomplishment is the *sine qua non* of an industrial base.

Long-Run Cost

From a purely economic standpoint, options should be compared according to the net present value of their economic costs. But practical policy decisions must also take into account the extent and timing of their budget costs; like all government agencies, the Army operates under budget and program constraints that limit budgetary flexibility. Hence, an option that makes good economic sense in the long run but has high short-term costs might not compete well for fixed budget dollars. Army analyses of BRAC options provide ample evidence of economically sound options discarded because of their near-term budget costs (Hix, 2001, pp. 65–71). Nevertheless, the principal cost criterion is the net present value to the federal government.

Consistency with National and DoD Policy

Options that move the base in a direction consistent with the mandates of 10 USC 2501 and 10 USC 2523 and implement DoD policies are to be preferred over options that do not. Maximum reliance on the private sector, all other things being equal, is to be desired.

Administrative Ease

Government ownership of manufacturing assets carries with it a wide array of statutes and regulations that inhibit management actions. By contrast, private

manufacturers operate under less stringent personnel and contracting rules, making them more agile and adaptable. Further, a decision to retain Army ownership of manufacturing assets has the effect of keeping that peripheral function in an organization whose core competencies relate more directly to warfighting. But the management of contracts that arise from privatized enterprises require management attention as well.

External Issues

Before it recommends any solutions outside of its ability to implement independently, the Army will obviously take into account external political realities. While these considerations are key, a careful, detailed analysis of them should be undertaken by the Army rather than RAND. In Chapter Seven, this report simply enumerates such considerations but makes no assessment or recommendations concerning them.

LIMITING THE OPTIONS TO A FEASIBLE SET

The feasibility of the four options varies by option and by class of facility, as shown in Table 4.2. In certain cases broad BRAC authority is required, in other cases specific legislation is required, and in other cases no legislation is needed other than normal appropriations. Each case is described below.

Privatization

GOCO plants. The GOCO plants may be privatized without special legislation or legal authority. A-76 competitions for production and base support are not required, because these functions have already been privatized. Typically, no more than two dozen DoD civilians work at the GOCO plants. Hence, these installations are not subject to the substantial restrictions of 10 USC 2687,

Table 4.2
Constraints on Options by Type of Facility

Option	GOCO Plants	GOGO Plants	Arsenals
Privatization	No legislation required	A-76—Pine Bluff	A-76 or special legislation required
FGC	Specific legislation required	Specific legislation required; protective legislation in place for Crane and McAlester	Specific legislation required
Consolidation	No legislation required	BRAC required	BRAC required
Recap/Unification	BRAC required	BRAC required	BRAC required

which precludes the Secretary of Defense from closing an installation that employs 300 or more DoD civilian employees without undertaking rigorous analysis and reporting requirements to the Congress, as explained below. In privatizing the GOCO plants, 10 USC 2662 requires the Army to notify the Congress of its intent, but the substantial requirements of the BRAC law do not apply. Hence, privatization of the GOCO plants is considered feasible. Because NASA rather than the Army owns the real property at the laid-away Mississippi AAP, we set that plant aside in our privatization option.

GOGO plants and arsenals. Privatization of either the GOGO plants or the arsenals is not feasible for a complicated set of reasons. First, because each of these five installations employs more than 300 DoD civilians, 10 USC 2687, mentioned above, precludes any action to close such an installation until

(1) the Secretary of Defense or the Secretary of the military department concerned notifies the Committee on Armed Services of the Senate and the Committee on Armed Services of the House of Representatives, as part of an annual request for authorization of appropriations to such Committees, of the proposed closing or realignment and submits with the notification an evaluation of the fiscal, local economic, budgetary, environmental, strategic, and operational consequences of such closure or realignment; and (2) a period of 30 legislative days or 60 calendar days, whichever is longer, expires following the day on which the notice and evaluation referred to in clause (1) have been submitted to such committees, during which period no irrevocable action may be taken to effect or implement the decision.

Even though the legislation provides a means by which DoD can request authority to close a large installation, in practice the procedure permits any member of Congress to block such requests. Since its codification 25 years ago, the DoD has not been able to close a single qualifying facility outside of the specific BRAC legislation that authorized the four BRAC rounds in 1988, 1991, 1993, and 1995.

Privatization results in the closure of the installation as a DoD facility. Hence, privatization of any of the five GOGO installations is legally feasible, but it is not a practically viable option without BRAC authority. But even when the Congress grants BRAC authority, BRAC commissions have not ruled on whether functions should be converted from government to private performance. Instead, BRAC commissions limit their consideration to what facilities are required to perform functions assumed to continue as government functions. Privatization is therefore a special kind of closure that has been outside the scope of BRAC deliberations.⁵

⁵In fact, after the 1995 round of BRAC, the Clinton Administration attempted to privatize in place jobs that the BRAC Commission had recommended be realigned away from Kelly AFB in San Anto-

One possible way for the Army to privatize the arsenals would be to propose specific authorizing legislation. While we could find no precedent for such an action, the action is at least conceptually feasible. To the extent that willing buyers are known to be interested and the privatization could protect employment at the arsenals, the option could be appealing to all concerned. Privatization is very different from the closure of facilities and transfer of jobs to other areas, which occur with consolidations and closures.

Barring such legislation leaves A-76 competitions as a feasible partial privatization solution. A-76 competitions could leave the capital assets under Army ownership but privatize the workforce of the functions competed, or could leave the government workforce in place. One cannot predict the outcome of any A-76 competitions for any of the functions at Pine Bluff or the arsenals before the actual A-76 analysis is performed.

But even A-76 competitions are infeasible for Crane AAA and McAlester AAP. PL 99-661, Section 317, prohibits conversions to contract performance of functions at both plants. (A-76 competitions would, however, be feasible at Pine Bluff.) Moreover, all three GOGO ammunition facilities serve other major purposes that lie outside the scope of this study. Crane and McAlester serve as Tier 1 ammunition depots. Pine Bluff not only serves as a large storage facility, but it also engages in substantial demilitarization of ammunition. Even if the above restrictions were eliminated, divestiture of Crane would be a Navy, not an Army, action because the Navy owns the facility. For these various reasons, we excluded these three facilities from further privatization consideration. But the retention of these three facilities plus Mississippi AAP offers a benefit by retaining a government-owned hedge of more than 126,000 acres, about 55 percent of the land the 16 installations under study now occupy.

Federal Government Corporation

Creating an FGC is a proven path. Because specific enabling legislation is required to create an FGC (31 USC 9102), such legislation could provide exceptions to 10 USC 2687 for the arsenals. We set aside the GOGO ammunition plants from consideration as part of any FGC options because of the extensive functions these facilities perform that fall outside the scope of this research and because of the legislation governing the workforces at Crane and McAlester. Hence, the feasible FGC options are limited to the GOCO ammunition plants and the arsenals.

nio and McClellan AFB in Sacramento. It was later decided to conduct an A-76 competition, and the Air Force won; the jobs were ultimately realigned.

Consolidation

Consolidation of the GOCO plants remains a feasible option without special legislation. As discussed above, 10 USC 2687 effectively prevents consolidation of the arsenals or GOGO ammunition plants outside of BRAC authority. But with BRAC authority, consolidation of GOGO plants and arsenals is feasible. The GOGO ammunition plants are set aside from consolidation consideration for the same reasons they were set aside in the paragraph above as FGC candidates.

Recapitalization and Unification

The recapitalization and unification option is conceived as part of an overall BRAC strategy that would take as one of its themes the elimination of single-function, special-purpose installations of all kinds (training, headquarters, industrial facilities) in favor of enduring, multipurpose installations. Because its execution depends first on the adoption of such a concept by DoD and the Army and then on BRAC legislation, it is considered as a potential long-term option for any of the base that might remain.

SUMMARY

In this chapter, we have assessed the feasibility of the various options, eliminating those indicated in Table 4.3. The fourth option, recapitalization and unification, is set aside from further assessment for all classes of facilities. Further, the GOGO ammunition plants are removed from consideration for all options except possible A-76 conversions at Pine Bluff. Finally, due to the complicated legal issues surrounding the closure of bases employing more than 300 DoD civilians, privatization options at the arsenals are limited to A-76 conversions or special legislation authorizing privatization.

Having limited the feasible set to the options shown below, in subsequent chapters we assess the relative desirability of the remaining feasible options.

Table 4.3
Feasible Options for Further Assessment

Option	GOCO Plants	GOGO Plants	Arsenals
Privatization	√	A-76—Pine Bluff	A-76 or special legislation
FGC	√		√
Consolidation	√		√
Recap/Unification			

THE PRIVATIZATION OPTION

The previous chapter proposed a strategic vision of the Army's industrial ordnance base and described four ways the Army might move toward achieving that vision. This chapter discusses one of those options—privatization—in more detail. It describes how privatization would be accomplished. It then lays out and discusses the arguments against privatizing: market conditions, cost, and risk of mission accomplishment.

Since the GOCO ammunition plants employ relatively few government civilian workers, a sale of these facilities would be relatively straightforward. For the reasons laid out in Chapter Four, direct privatization of the GOGO ammunition plants and arsenals is infeasible, but eventual privatization of the arsenals could be possible after a transition stage as a federal government corporation. This chapter therefore concentrates on the privatization of the GOCO ammunition plants, but it also includes examples from the arsenals.

As discussed in the Phase 2 report (Hix et al., 2003) and in Chapters Three and Four, our assessment takes as an underlying principle the imperative to rely on the private sector for the provision of ordnance materiel unless overriding considerations dictate to the contrary. In principle, privatization could resolve many of the problems described in Chapter Three.¹ Its benefits include:

- Removal of management distractions by divesting the Army of the organic industrial base, freeing military and civilian personnel to focus on issues more central to the Army's mission.
- Ability of private-sector owners to bring in additional workload or to redeploy assets not currently used for ordnance production.
- Increased visibility of the full costs of ordnance production by removing restrictions on competition associated with the Arsenal Act, under which the

¹As one reviewer pointed out, privatization offers only the *potential* for achieving the benefits listed below. Outcomes depend on the actual relationship between the government and the contractor.

out-of-pocket costs of GOCOs and GOGOs can be compared with the full costs of COCOs (contractor-owned and -operated), and subsidies to GOCO and GOGO ordnance prices such as Military Construction funds and government-provided insurance.

- The potential to disentangle production and replenishment costs using contracting mechanisms and thereby make more informed decisions about the costs and benefits of holding idle replenishment capacity.
- Private-sector access to capital markets, which creates the potential to modernize facilities and make cost-saving investments.

However, some issues would remain for the Army to resolve internally. These include:

- Developing a strategic vision for the industrial base, by recognizing that procurement decisions affect the structure and financial health of private-sector ordnance producers.
- Employing contracting policies that promote competition and innovation, such as best-value source selection, system-level contracting, performance incentives, and relaxing military specifications or using commercial equivalents where feasible.
- Providing more stable funding for ammunition procurement.
- Creating a coherent and cost-effective replenishment policy.

In addition, as described in earlier chapters, there are circumstances under which government-run production or government ownership of the means of production may be preferable to reliance on the private sector. These exceptions include the following:

- Unresponsive markets, i.e., private-sector firms are unwilling to produce needed ordnance materiel in a timely fashion.
- Government-owned facilities can produce ordnance materiel at a lower cost than the private sector.
- Mitigation of the risk that private-sector producers will not have the capability or the capacity to produce ordnance materiel in sufficient quantities, particularly in time of crisis.
- Activities defined as inherently governmental.²

²Inherently governmental activities are those that involve the discretionary application of governmental authority (such as criminal investigations, judicial functions, and management and direc-

The fourth exception, inherently governmental activities, is relatively easily dismissed in the case of ordnance materiel. OMB Circular A-76 specifically cites the manufacture of ordnance equipment as a commercial rather than an inherently governmental activity (U.S. Executive Office of the President, 1983, p. 2 and Attachment A).

In the remainder of this chapter, we discuss the applicability of the remaining three exceptions to private-sector production of ordnance materiel, supporting our arguments with empirical examples and analytical models. In the first section, we discuss the characteristics of the market for ordnance materiel and whether commercial firms are unresponsive. In the second section, we discuss whether private-sector production of ordnance materiel is likely to be more or less expensive than GOGO or GOCO production. The third section addresses whether private-sector production is likely to lead to an unacceptable risk that ordnance materiel will not be available in sufficient quantities in times of crisis. In the final section, we discuss the Economic Regeneration Model, an AMC-proposed alternative to immediate privatization.

ARE COMMERCIAL PRODUCERS UNRESPONSIVE?

This section first describes the characteristics of the market for ordnance materiel that differ from typical competitive markets for goods and services and that may result in the unwillingness of commercial producers to respond to Army demands for ordnance materiel. It then discusses whether these characteristics are sufficient to drive private-sector firms out of the market, thus requiring government ownership of facilities and equipment or government control of production processes.

Characteristics of the Market for Ordnance Materiel

A number of factors that differ from typical competitive markets characterize the market for ordnance materiel in the United States. Among these are uneven demand histories for components and end items; a requirement for a significant production increase during or after periods of military conflict; geographical semi-isolation of some ammunition production for safety reasons; a single buyer for the vast majority of products; a concentrated supplier market; and Army ownership of a substantial fraction of ordnance production facilities and equipment. Understanding these characteristics is essential before evaluating arguments that unresponsive markets require continued government ownership of the Army's organic industrial base.

tion of Armed Services), or the conduct of monetary transactions involving public funds (such as tax collection, revenue disbursements, and contract administration).

The uneven demand for ammunition is particularly noteworthy for those types and components associated with warfighting ammunition, as opposed to those items used exclusively or partially for training. Ammunition used principally for warfighting is produced and stored against the day it is needed. As mentioned earlier, in balancing the demands on its limited resources, the Army never funds its full requirement. Production also tends to be compressed to achieve adequate stockage levels rapidly. As a result, the production demand history is very uneven for warfighting rounds.³ Production of the types of ammunition used in training tends to be more prolonged and regular, as existing stocks are constantly used up in training.⁴

The demand for other ordnance items, such as cannon, recoilless rifles, and mortars produced at Watervliet Arsenal and gun mounts produced at Rock Island Arsenal, has also been volatile, though the change in quantity has been primarily negative. In the last fifteen years, production of cannons, recoilless rifles, and mortars at Watervliet Arsenal has fallen from approximately 3,500 per year to 300 to 400 per year (see Figure 3.1). Likewise, production of gun mounts at Rock Island Arsenal has decreased more than 90 percent in the last decade.⁵

The market for ordnance materiel is also noteworthy in that most products have only one buyer: the U.S. government, primarily the Department of Defense.⁶ As in any monopsonistic (i.e., one-buyer) market, the buyer has substantial flexibility to set the rules that govern the relationship between the seller and buyer. In the ordnance market, the role of the monopsonistic buyer is further

³For example, Olin Corporation produced approximately half a million M903, Saboted, Light Armor Piercing (SLAP) .50 caliber rounds between 1996 and 1998. After this production, the SLAP lines at Winchester's East Alton, Illinois, facility shut down for three years. In late FY01, a new contract was awarded for the production of SLAP rounds, and the line is being restarted at this writing. (Contract number DAAE30-01-C-1114, posted in CBDNet on September 27, 2001.)

⁴For example, the M865 Target Practice Cone-Stabilized Discarding Sabot with Tracer (TPCSDS-T) is a tank training round. It has been produced every year since the introduction of the 120mm tank cannon in the U.S. Army in the mid-1980s. Between 1995 and 2001, production averaged 175,000 per year, though annual quantities varied substantially. (See U.S. Department of the Army, Procurement Programs, 1998, 1999, 2000, 2001.) Ammunition used in both training and combat, such as the M107, 155mm high-explosive round, also has more stable production.

⁵Production of various gun mounts and towed howitzers fell from 991 in 1990 to 70 in 1999. Future production is based primarily on residual demand for legacy systems. Of planned new systems, neither the Mobile Gun System nor the Lightweight Towed Howitzer will have its gun mounts produced at Rock Island. Rock Island did win a competitive subcontract to produce a component of the Lightweight Towed Howitzer, but that decision was contingent on reducing its overhead rate. There was some hope that the Crusader self-propelled artillery system gun mount would be produced at Rock Island, but that system has been cancelled. Thus, the prospects for gun mount and towed artillery production at Rock Island Arsenal are bleak.

⁶The U.S. government does not always act as one, and in fact, a number of distinct organizations within the Department of Defense are responsible for purchasing ammunition and ordnance items. Nevertheless, the government retains most characteristics of a monopsonistic buyer. There are some foreign military sales (FMS), but the quantities are typically small compared to the U.S. market. Most FMS sales must also be approved by the U.S. government.

distorted from classic market mechanisms in that the buyer owns a substantial portion of the production capital in the form of facilities and equipment, particularly as associated with final assembly of ammunition. As one might expect in such a market, competition is considerably constrained. To spread the overhead cost of owning and maintaining large production facilities, the government tends to favor the producers that run or use the government's facilities when it awards production contracts.⁷ In some cases, competitions are constructed in a manner that virtually guarantees the continued use of government facilities.⁸

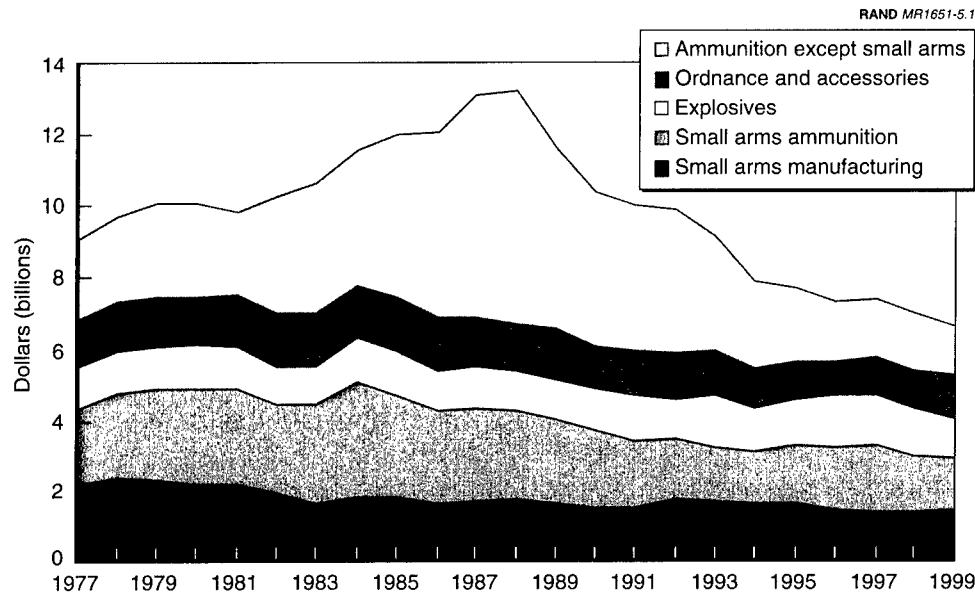
In addition to the existence of a monopsonistic buyer, the supply side of the ordnance market is highly concentrated. First, we consider the market for ammunition. Three firms, Alliant Techsystems, General Dynamics, and Day & Zimmerman, account for 55 percent of the ammunition end items identified by the 1999 Production Base Plan (PBP).⁹ The Army's GOGO facilities account for another 30 percent of the end items in the PBP. The concentrated supplier market is partly the result of the general decline in ammunition procurement since the end of the Cold War. DoD ammunition procurement budgets have been halved in real terms (2001 dollars), from \$4.2 billion in 1991 to \$2.1 billion in 1996 (U.S. Government, 1992, and U.S. House of Representatives, 1995). Total ammunition and ordnance sales (including commercial sales) declined by about 50 percent in real terms from a peak of \$13.2 billion in 1988 to \$6.7 billion in 1999. As Figure 5.1 indicates, much of the decline in sales since 1988 is in large-caliber (greater than 30mm) ammunition, which is primarily a military market. However, as shown in Chapter One, recent DoD budgets show a real increase in ammunition procurement, one that has not yet appeared in the Department of Commerce annual sales, shown in Figure 5.1.

⁷The Arsenal Act of 1920 (10 USC 4532) requires the Secretary of the Army to use factories or arsenals owned by the United States when they are less expensive than the private sector. This requirement has been interpreted to mean that the out-of-pocket, or marginal, cost of production in Army-owned facilities must be less than the full cost proposed by privately owned firms. Thus, workload could be awarded to government facilities even if their full costs are higher than the private sector. The government also provides other subsidies for GOCO ammunition producers by covering insurance costs and exempting them from property taxes, for example.

More recently, a briefing from the U.S. Army Materiel Command Deputy Chief of Staff for Ammunition (DCS-AMMO) recommends that the organic industrial base be taken into account when making weapon system procurement decisions. See U.S. Army Materiel Command Deputy Chief of Staff for Ammunition (2002), slide 2.

⁸For example, the competition to produce the majority of the Army's small-arms ammunition was conducted in a way that tied the running of Lake City AAP, the Army's small-arms ammunition production facility, to the production of small-arms ammunition.

⁹The Production Base Plan is a biannual report that assesses the capability of the U.S. munitions industrial base to replenish ammunition that would be expended in the event of war. See Appendix B for a more detailed description.



SOURCES: U.S. Department of Commerce (1995a), (1995b), (1996), (1998), (1999a), (1999c), (1999o), (1999p), (1999q), and (2001).

Figure 5.1—Value of Ammunition and Ordnance Shipments, 2001 Dollars

The decline in the ammunition budget since the end of the Cold War, as in so many other defense procurement areas, has forced substantial consolidation in the ammunition industrial base. Some of the consolidation is also a result of government ownership of much of the base. The largest survivors in the ammunition market consolidation are those involved in running the government's facilities. As mentioned earlier, these firms enjoy some competitive advantages in winning production contracts, and this has helped them weather the downturn in the ammunition budget. Finally, the high level of market concentration is exacerbated by the fact that the major market players have entered into partnerships or joint ventures with each other to manage the government's facilities.¹⁰ In addition to the corporate-level relationships, these firms often work together in prime contractor-subcontractor relationships.¹¹

¹⁰For example, General Dynamics and Day & Zimmerman have partnered to form American Ordnance, which manages both the Iowa and Milan AAPs. General Dynamics and Alliant Techsystems formed American Powder as a joint entity to run Radford AAP, but this enterprise was abandoned in the face of antitrust scrutiny.

¹¹Examples include tank ammunition, where Alliant Techsystems and General Dynamics are the prime contractors, but American Ordnance (joint venture between General Dynamics and Day & Zimmerman) holds the subcontract to load, assemble, and pack rounds at the Iowa AAP. Alliant

For other ordnance materiel (e.g., large-caliber cannon, mortars, and gun mounts), the U.S. supplier base is even more concentrated than in the ammunition market. Other than the Army-owned Watervliet Arsenal, only United Defense has a current capability to produce large-caliber cannon.¹² As for gun mounts, other than the capability at Rock Island Arsenal, only General Dynamics and United Defense produce gun mounts, for the Abrams tank and naval applications, respectively.

The ordnance market is also notable for its need to be able to increase production substantially during or after conflicts.¹³ This requirement has probably shaped the current market more than almost any other factor, by providing a rationale for continued Army ownership. The need to maintain replenishment/surge capability appears to require the retention of large amounts of production capital in either an idle or underutilized capacity. The prevailing argument for government retention of this capital is that absent explicit contractual agreements, the private sector will not allow such large amounts of capital to remain so underutilized. By retaining this capital in the government, it is argued, the Army can better manage its upkeep and can remain assured of its availability during times of replenishment or surge. However, this argument requires careful examination, because much of DoD's ammunition production, as well as other weapon system and component production and repair, which would also need surge or replenishment strategies, is currently conducted in the private sector. Issues involved with replenishment are discussed in more detail below in the section on risk and in Appendix B.

Responsiveness of Markets

Uneven demand for ordnance materiel, the need to maintain a replenishment or surge capability, and the presumed unprofitability of the ordnance business cause concern that a complete absence of market responsiveness is prevented only by continued government ownership of much of the production capital and extensive, detailed management of the market. These concerns are high-

provides nitrocellulose from its facilities at the Radford AAP to General Dynamics for ball powder production in its role as a subcontractor to Alliant for the production of small-arms ammunition at Lake City AAP.

¹²United Defense produces cannon for the Navy at its Louisville, Kentucky, facility. This was a Navy owned and operated facility until it was privatized in the mid-1990s.

¹³For example, the M864, 155mm Dual Purpose, Improved Conventional Munition (DP-ICM) is not currently in production. This is a major warfighting round that has a replenishment requirement to produce over 700,000 rounds during the replenishment period. The bill of materials for this round includes items such as submunitions grenades, shell body, fuze, explosive, and propellant. Each of these components must also be produced at an accelerated rate to meet replenishment requirements. While some of the components are in production for other end items, many are not and require the restart of lines that either have been laid away or are producing other types of components.

lighted by recent trends, such as an exodus of companies from the ammunition market,¹⁴ consolidation of existing companies,¹⁵ and a lack of entry by new firms.

But some of the presumptions that underpin the fear of an unresponsive ordnance market need closer examination. A couple of points are particularly relevant. The first is that over half the current ammunition budget is spent outside of the organic base. Much of this production is for items that have commercial analogues,¹⁶ but much is also for militarily unique ammunition items and components.¹⁷ Second, newer munitions, such as guided missiles, are not produced in Army-owned facilities. Nor does replenishment or surge production planning for these items include Army-owned facilities.¹⁸ Significantly, even for very advanced conventional munitions the trend is to plan for replenishment or surge more and more in the private sector.¹⁹

It is difficult to make direct comparisons between GOCO and COCO ammunition facilities, because most are operated as subunits of larger, defense-oriented conglomerates such as General Dynamics, Alliant Techsystems Inc. (ATK), Olin, and BAE Systems, or by privately held corporations such as Day & Zimmerman, Chamberlain, and Norris Industries. Some broad comparisons between various sectors of the ordnance industry and other comparable defense and non-defense industries are possible using data collected by the U.S. Department of Commerce in the Economic Census and the Annual Survey of Manufactures. These data are collected at the "establishment" level, so each operating location

¹⁴Between 1992 and 1997, the number of firms in the market for large-caliber (greater than 30mm) ammunition fell from 56 to 45, while the number of establishments (separate plants) fell from 70 to 53 (U.S. Department of Commerce, 1995b and 1999a). In the 1980s, up to eight companies were involved in the production of submunition grenade bodies. Today, only one company, Amron, continues production, and the replenishment capacity is retained through laid-away production lines on Army-owned facilities.

¹⁵The ammunition base continues to consolidate. Recent examples include General Dynamics' acquisition of HiTech and Primex and Alliant's acquisition of Thiokol.

¹⁶For example, General Dynamics produces most of the propellant used in small- and medium-caliber ammunition in a private facility at St. Marks, Florida. This production is mingled with production of propellant for commercial small-arms ammunition. Intercontinental Manufacturing, Wyman Gordon, and National Forge all produce bomb bodies. Bomb bodies are large, cylindrical, hollow bodies that are forged in a manner similar to some commercial products.

¹⁷Fuzes are a good example. These are critical for bombs; artillery, tank, and mortar projectiles; rockets; and missiles, yet all are produced in privately owned facilities. As another example, General Dynamics' (formerly HiTech's) facility in Camden, Arkansas, is included in surge/replenishment planning for a number of warheads.

¹⁸A few components for guided missiles, e.g., Patriot warheads, are included in replenishment planning for Army facilities, but not the assembly of end items.

¹⁹Load, assemble, and pack of the SADARM was planned for Aerojet's Azusa, California, facility. Load, assemble, and pack of the M829A3 is planned for an Alliant Techsystems facility in West Virginia.

within a company is represented separately and can more easily be classified into a specific industry.

Table 5.1 shows some descriptive statistics from the 1997 Economic Census²⁰ for the ammunition and ordnance industries, plus selected defense and commercial industries for purposes of comparison. Although comparisons of profitability between industries are problematic because of differences in capital structures and in industry risk, the ordnance industries do not appear to be noticeably less profitable than other comparable industries. Gross margins (sales minus the cost of materials and labor as a percentage of sales) in the ammunition and ordnance industries tend to be higher than in other comparable defense and commercial industries. Alliant Techsystems Inc., a large diversified ordnance materiel producer (and the installation manager for the Radford and Lake City AAPs), earned common shareholders a return of approximately 100 percent in calendar year 2001, most of which occurred before the terrorist attacks on September 11.²¹ Its gross profits for 2001 were 25 percent, and net profits were 4.4 percent. General Dynamics' gross and net profits were 21.4 percent and 8.1 percent for the same period.²² Another indication of the sector's profitability is that solicitations for ammunition products usually draw a number of proposals from different companies.²³

Finally, uneven demand for ordnance products is another potential reason for unresponsive markets. The fear is that few companies would be willing to make the capital investments required to produce ordnance materiel when the likely production run is short, uneven, or unpredictable. In the ammunition market, however, these fears appear to have less to do with actual ammunition requirements than with the method by which, or the perception of how, the government funds and buys ammunition. As Table 1.3 in Chapter One indicates, production of military ammunition in the United States has been funded at \$2–2.5 billion per year in real terms in recent years, and it is growing substantially in FY02 and FY03. Although emphasis may, in the long term, shift away from

²⁰This is the latest available census. The U.S. Census Bureau conducts an economic census for years ending in 2 and 7. Statistics for interim years are estimated based on a representative sample of manufacturing establishments canvassed in the Annual Survey of Manufactures (U.S. Department of Commerce, 2001).

²¹See ATK Investor Information and Annual Reports at <http://www.atk.com>.

²²For comparison, the gross and net profits of some commercially oriented companies over the same period were: Dupont (chemical manufacture) 32.6 percent and 3.5 percent; Varco (oil drilling equipment) 34.9 percent and 6.0 percent; Olin (commercial ammunition, copper-based metals, and chemicals) 18.4 percent and 1.6 percent. See Hoover's On-Line, <http://hoovers.com/>.

²³PM Mortars is the best example. Several years ago it successfully moved some of its products out of a workloaded government facility and instituted "best-value" competitions for mortar ammunition. These competitions draw a number of proposals, and according to PM personnel, have lowered price, increased quality, and improved the production base.

Table 5.1
Descriptive Statistics for Ordnance and Selected Defense and Commercial Industries

Industry	Number of Companies	Number of Employees	Production Workers as % of Employees	Sales ^a (Thousands of 2001 Dollars)	Gross Margin ^b	Capital-Sales Ratio ^c	Replacement Ratio ^d	Annual Sales Growth (1992-1997)
Small-arms ammunition manufacturing	108	6,863	76%	\$ 1,032,700	36%	0.56	0.77	-4%
Ammunition (except small arms) manufacturing	45	9,427	53	1,646,750	33	0.44	0.72	-13
Explosives manufacturing	65	7,770	71	1,450,244	38	0.35	0.85	2
Small arms manufacturing	191	9,907	76	1,376,971	46	0.39	1.03	-4
Other ordnance and accessories manufacturing	67	12,285	39	1,925,534	48	0.17	1.08	5
Military armored vehicle, tank, and tank component manufacturing	39	5,982	49	1,204,964	33	0.31	0.84	-13
Guided missile and space vehicle manufacturing	15	52,158	36	16,270,613	41	0.36	1.69	-5
Guided missile and space vehicle propulsion unit and propulsion unit parts	19	18,540	45	3,562,936	32	0.41	0.87	-12
Other guided missile and space vehicle parts and equipment	47	6,110	68	988,634	28	0.22	1.87	-10
Machine shops	23,438	290,849	78	29,844,695	33	0.49	1.46	8
Iron and steel forging	392	26,243	76	5,370,258	27	0.54	1.44	5

Table 5.1—continued

Industry	Number of Companies	Number of Employees	Production Workers as % of Employees	Sales ^a (Thousands of 2001 Dollars)	Gross Margin ^b	Capital-Sales Ratio ^c	Capital Replacement Ratio ^d	Annual Sales Growth (1992-1997)
Fabricated structural metal manufacturing	2,867	92,512	72%	\$17,737,117	26%	0.21	1.53	N/A ^e
Oil and gas field machinery & equipment	497	29,452	66	6,864,039	36	0.37	1.97	10%
Iron and steel pipes and tubes manufacturing	169	27,723	78	8,321,915	25	0.33	1.68	6
Industrial valve manufacturing	427	53,264	65	9,539,641	37	0.41	1.21	2
Automobile manufacturing	174	114,060	86	104,924,119	24	0.25	2.24	N/A ^e
Motor vehicle body manufacturing	749	42,674	76	9,828,326	19	0.14	2.97	N/A ^e

SOURCE: U.S. Department of Commerce (1999a-q).

^aValue of shipments.^b(Value of shipments - cost of materials - payroll)/value of shipments.^cGross book value of total assets at end of year/value of shipments.^dTotal capital expenditures/total depreciation during year.^eComparable 1992 sales figures are not available for some industries because the industrial classification system used by the U.S. Census Bureau switched from the Standard Industrial Classification (SIC) system in 1992 to the North American Industry Classification System (NAICS) in 1997.

legacy conventional munitions to smarter conventional munitions and missiles, the shift should be gradual, leaving a large demand for conventional ammunition for the foreseeable future. This volume should be sufficient to attract significant competition if the government acts as a good customer. Strategies that stretch out or smooth production schedules, combine similar types of ammunition production onto single contracts, make greater use of multiyear and options contracting, and tie replenishment/surge requirements to peacetime production can all help make ammunition production more attractive.²⁴

These types of recommendations are neither new nor unique to ordnance production. For example, Gansler (1980) recommended that DoD recognize, in industrial sectors where it is the primary or the only buyer, that its procurement decisions will influence the structure and financial health of the industry and the costs of production. More predictable and stable procurement allows firms to make long-range plans and investment decisions and ultimately lowers the prices paid by DoD. Gansler also recommended that DoD do less micro-management of industry through regulations, profit policy, and military specifications, and pay more attention to “macro”-level issues, such as maintaining competition and a robust industrial base, in its planning, programming, and budgeting processes.

Recent events also indicate that low-volume buys of other ordnance materiel have not deterred competition in that market. The U.S. Marine Corps and Army are in the process of buying a new towed howitzer system. As a part of that program, the government decided to procure the cannon for the system separately from the rest of the system and provide it as government-furnished equipment. United Defense emerged as a viable competitor to Watervliet Arsenal for production of the cannon. Likewise, BAE Systems, the prime contractor for the new towed howitzer, competed production of the other system components. Significantly, a large number of companies and government facilities, including Rock Island Arsenal, bid on the opportunity to manufacture various components of the new howitzer.

Examples of “Unresponsiveness”

If private-sector firms are unable or unwilling to produce particular ordnance items, Army ownership of arsenals and ammunition plants may provide the

²⁴As described in Chapter Three, a 1997 study of the Army's ammunition industrial base by the Pacific Northwest National Laboratory (Doherty and Rhoads, 1997) recommended commercializing the organic base but also, as a necessary corollary, creating a Program Executive Office for Ammunition to consolidate management responsibility and financial resources. The influence this newly created office should possess could create the more stable and predictable funding and procurement policies necessary to enhance the viability of the commercial base.

Army a capability to manufacture those items. To justify retention of this capability requires an examination of the frequency and criticality of private-sector unresponsiveness and the reasons why it occurs. To address this question, project team members investigated the three anecdotes most frequently cited to us as examples of private-sector inability to produce some goods economically and in response to military requirements: small-arms headspace and timing gages, links for automatic-fire ammunition, and bridge wires. In all three cases, we found that production problems were not due to an inherent inability or unwillingness by private-sector producers to meet demands, but had other causes.

Production of small-arms headspace and timing gages was brought into Rock Island Arsenal after several contractors failed to deliver gages that conformed to required specifications. Winning bidders underestimated the difficulty of meeting the extremely tight tolerances that make sure the gages can verify critical weapon parameters. These bidders, however, were selected primarily on the basis of bid price. Rather than indicating an inability of private-sector producers to make headspace and timing gages, this anecdote suggests that source selection based primarily on price is flawed. A "best-value" approach to source selection would be much more likely to identify contractors capable of meeting specifications.²⁵

The case of links for automatic-fire ammunition is somewhat more complex,²⁶ but again offered us no compelling reason to conclude that private ownership of production facilities and equipment led to the production problems. Instead, the problem appears to be related to a change in the way links were accepted by the Army. Our discussions with Army personnel indicate that, for a variety of legal and economic reasons, the production base for links entered a period of turmoil during the FY00 and FY01 timeframe. This turmoil eventually led to relocating links production to Lake City Army Ammunition Plant (LCAAP) in FY01. That move, as well as the production base turmoil, resulted in heightened technical scrutiny of links production.²⁷ In addition to having their functionality tested, links were physically measured to test compliance with their

²⁵Alternatively, a source selection based on performance specifications could have produced a better product at a lower price in the case of .50 caliber machinegun gages. Use of newer materials that were not available when the original specifications were written (in 1943 and last updated in 1966) would greatly simplify production and significantly lower the price of these gages. A performance specification approach could also be used for other small-arms gages.

²⁶The complexity of the story is related to a number of factors, including: a complete turnover in the contractor base, the move of production facilities onto a GOCO facility, a mix of government-owned and contractor-owned equipment, and somewhat confused government-to-contractor relationships.

²⁷For example, the move to a new links production facility required first article testing (FAT) of the links once production was restarted.

technical specifications. The failure to meet these technical requirements has caused most of the production problems. Army personnel implied that the technical conformance inspection of links before the move of production to LCAAP was rare, and no data were presented to indicate that compliance with the technical specifications actually declined in recent years. Since the same equipment was used before and after the move,²⁸ it is probable that the quality of links produced before and after the move to LCAAP are similar.²⁹ Whether moving the 50-year old links manufacturing equipment onto LCAAP was the best way to solve the production problems is an open question. We conclude more clearly, though, that the perceived problems with links production were not fundamentally related to private-sector capabilities. Ammunition links are not technically difficult to produce. The processes include metal cutting, rolling, bending, plating, spot welding, and riveting. All these processes are well within the capability of commercial industry. Also, these items have been successfully produced for decades in the private sector, indicating that recent problems are not due to an inherent unresponsiveness on the part of private producers. Finally, some government personnel note that private producers will be unwilling to produce links at the price the government is willing to pay. Such comments must be taken in light of the millions of dollars and the substantial time taken to move links production onto LCAAP.

A third example frequently cited as a failure to perform by the private sector is the production of bridge wires.³⁰ Bridge wires and associated detonators are common in the commercial sector, although Army detonators are typically smaller and more rugged. As with the links example above, the industrial base for bridge wires has recently turned over.³¹ During the transition to new bridge wire producers, the prime contractors for fuze production experienced difficulty in obtaining quality components containing bridge wires. These difficulties resulted in delayed fuze production. As a result, the Army, along with some of its contractors, devoted considerable resources to improving the bridge wire industrial base. This effort has been successful, and several commercial companies are now producing these critical items. As stated at the beginning of this section, these three examples (headspace and timing gages, ammunition

²⁸This equipment is both government and contractor owned, is of 1950s vintage, and relied on worn-out dies that are now being replaced.

²⁹It is unclear whether the rate at which links fail in functional testing has changed over the last few years.

³⁰A bridge wire is a thin wire that explodes in a controlled fashion when a high-energy electrical pulse is passed through it. It is typically the first link in a detonator's explosive chain. Detonators are used in bomb, artillery, and explosive charge fuzes. Bridge wires have been in use since the 1880s for both military and commercial applications.

³¹In the mid-1990s the two principal producers of military bridge wires, ICI Americas and Dyno-Nobel, decided to exit the market.

links, and bridge wires) have been cited most frequently as cases that demonstrate the unwillingness or unresponsiveness of commercial industry to respond rapidly to the military's needs. In each instance, we found this not to be the case. The example of the headspace and timing gages merely demonstrated that awarding contracts solely on the basis of price is flawed contracting policy. The use of links and bridge wires as examples demonstrates Army discomfort with the natural dynamism of the private sector more than it illustrates production failings in that sector. This point is made especially clear because the proposed solution, establishing production capability for these items on government facilities, has its own examples of production failure.³²

WOULD IT COST MORE TO PRODUCE ORDNANCE MATERIEL IN PRIVATIZED PLANTS?

Given the unusual characteristics of the market for ordnance materiel—high initial demands when a weapon system is built and fielded or when war reserves are stockpiled, followed by little or no demand while production capacity is held in reserve for surge or replenishment—the capital investment required is likely to be higher than if demands were more consistent and stable. As a result, there are a number of reasons why GOGO or GOCO production might be less expensive than private-sector production. First, if the government makes efficient investment and production decisions (i.e., chooses the cost-minimizing combination of capital, labor, and materials to produce a given amount of ammunition and maintain the required replenishment capacity), the government's lower cost of capital could give it a cost advantage over the private sector.³³ Second, except for annual capital investment costs, government-owned land and facilities are a sunk cost, whereas contractors would have to buy privatized arsenals or ammunition plants, and charge higher prices for ordnance materiel to recover the costs of buying the assets. Third, since contractors can compete to operate GOCO facilities, it is not necessary for them to duplicate investment in their own facilities to compete for ordnance production contracts. The existence of government facilities thus could lower entry barriers and increase competition. We examine each of these arguments in the remainder of this section.

³²For example, in the late 1990s, load, assemble, and pack of mortar ammunition was moved from Milan Army Ammunition Plant to the private sector because Milan had been unable to produce mortar ammunition to specification for several years.

³³Although the government can borrow at a lower interest rate than most firms, any individual investment project in an arsenal or ammunition plant would have similar risks whether it was carried out in the public or private sector. Thus, it can be argued that the government does not truly have a lower cost of capital than the private sector. Taxpayers simply are not compensated for this additional risk as they would be if they were lending to a private-sector firm.

Government Investment and Production Decisions

Although the government's cost of borrowing is nominally lower than the private-sector cost of capital because of lower default risk, there is evidence to indicate that the Army does not make efficient investment decisions for its arsenals and ammunition plants nor efficient production decisions for its GOGO facilities.

Government capital investment is tied to the annual budgeting process, because investment funds must be budgeted in the year they are obligated. As a result, investment decisions may depend more on the availability of funds than on net present value or cost/benefit analysis. Based on visits by project team members to Army-owned and COCO ammunition plants, much of the equipment at GOCO plants appears to be antiquated, indicating a tendency toward underinvestment. The Army also raids the budget for ammunition plant investments when funding falls short in other areas. In July 2002, for example, the Army proposed to defer \$9.9 million in electrical and equipment upgrades (out of a total investment budget of \$57.3 million) to cover military pay, contingency operations, and a surge in training requirements (Winograd, 2002).³⁴

Overinvestment could also occur if excess funds are available. For example, the decision to invest in the "Tank Line of the Future" at Iowa Army Ammunition Plant appears to have been based on congressional mandate rather than net present value analysis. Based on the 1997 Economic Census data in Table 5.1, capital intensity³⁵ (as measured by the capital/sales ratio) of the ordnance industry varies from .56 in small-arms ammunition manufacturing to .17 in other ordnance and accessories, a range that is similar to other industries reported in the table. However, the capital replacement ratios (capital expenditures divided by depreciation) for the ordnance industries tend to be lower than other industries in the table, including other defense industries that saw similar declines in sales between 1992 and 1997.

In contrast, private-sector owners have access to capital markets and can borrow or raise equity to finance investments that have a positive net present value at the firm's cost of capital. Provided that there is competition to produce ord-

³⁴In addition, the AMC Office of General Counsel has indicated that the Army uses the investment budget to pay for plant and equipment losses due to fires and explosions, since the Army self-insures the plants. Since these losses are not specifically budgeted, other investment projects must be deferred.

³⁵An industry is said to be more capital intensive if it employs relatively more capital than labor or other inputs. Capital-intensive industries tend to require higher investment and have higher fixed costs than other industries.

nance materiel, and contracting approaches create appropriate incentives,³⁶ private-sector owners also are likely to make investment decisions that result in a more efficient mix of capital, labor, and material inputs. Thus, privatization can help overcome the shortcomings associated with government capital budgeting, and it smooths capital investment spikes in government budgets by paying for capital investment as part of the cost of ammunition.

The government also appears to make inefficient production decisions in its GOGO ordnance facilities. In the Army's arsenals, factors of production have fallen at a much slower rate than output, leading to higher prices, further loss of business, and working capital fund losses.³⁷ For example, as described in Chapter Three, production of core products at Watervliet Arsenal has fallen to 4 percent of its 1976 peak, whereas workyears have fallen to about a third, equipment has fallen by half, and building space occupied has remained essentially the same. (See Figure 3.1.) Recall also from Chapter Three that the ratios of indirect to total labor are high. Indirect employees comprise 69 percent of the total staff at Watervliet and 77 percent at Rock Island Arsenal, compared with 28 percent in the commercial structural steel industry and 22 percent in the machine shop industry.³⁸

Estimated FY01 revenues per direct labor hour were \$331 at Watervliet and \$201 at Rock Island.³⁹ In contrast, fully burdened labor rates averaged approximately \$130 per direct labor hour in the commercial structural steel industry and \$70 per direct labor hour in the commercial machine shop industry. However, in spite of higher direct labor rates, revenues per employee (including both direct and indirect personnel) were \$163,000 per employee at Watervliet and \$129,000 per employee at Rock Island,⁴⁰ in comparison to \$193,000 per employee in the structural steel industry and \$104,000 per employee in the machine shop

³⁶For example, firm-fixed-price contracts create stronger incentives for efficient input decisions than cost-based contracts.

³⁷The Army's arsenals are financed by the Army Working Capital Fund (AWCF), a transfer-pricing system under which customer organizations buy goods and services from support organizations. Support organizations are required to set their prices to cover their full costs and to break even over the two-year budget cycle. Costs per unit at the arsenals have risen as workload has declined faster than total costs. The arsenals have also received cash infusions, not recovered in customer rates, to stabilize the prices charged to customers.

³⁸Based on U.S. Department of the Army, Army Working Capital Fund (2001) and U.S. Department of Commerce (1999d) and (1999j).

³⁹These estimates are derived by dividing total FY01 budgeted revenues by the number of direct employees times 2,080 labor hours per year. For example, the figures for Rock Island are \$152 million / (364 × 2,080) = \$201. They differ from the stabilized hourly rates charged to customers under AWCF rules (\$197.11 at Watervliet and \$267.45 at Rock Island) due to carry-in and nonstabilized orders at different hourly rates, cash subsidies, and adjustments for prior-year gains and losses.

⁴⁰These figures are derived by dividing total FY01 budgeted revenues by the total number of employees. For example, the figure for Rock Island is calculated as \$152 million / 1,179 = \$129,000.

industry. In practice, the arsenals have converted direct employees into indirect employees rather than lay them off as workload has fallen. Based on this evidence, private-sector firms in comparable competitive industries appear to be more likely to redeploy excess labor, but the actual practices in defense industries are likely to depend heavily on the relationship between the government and its suppliers.

Based on the available evidence about the employment of capital and labor at GOCO and GOGO ordnance producers, it seems unlikely that any government advantage in the cost of borrowing could overcome the offsetting inefficiencies in government investment and production decisions. Private-sector ammunition firms also seem to be able to manage their environmental liabilities at a lower cost than the Army's facilities. Six currently operating AAPs (Iowa, Lake City, Lone Star, Louisiana, Milan, and Riverbank) and a number of facilities previously declared excess are on the National Priorities List (NPL) for environmental cleanup.⁴¹ In contrast, COCO facilities recently acquired by General Dynamics (St. Marks Powder, producing ball propellant, and the former HiTech in Camden, Arkansas, producing warheads and rocket motors) have negligible environmental liabilities. Likewise, Olin Corporation's Winchester small-arms ammunition manufacturing facility in East Alton, Illinois, appears to have manageable environmental liabilities and is not on the NPL.

In the economics literature, there is little cost-based theoretical justification for government ownership of firms in competitive markets or in markets that could readily become competitive. Even in the case of "market failure," such as monopolies or externalities (e.g., pollution), government ownership has important weaknesses, such as difficulties defining the goals of the firm and monitoring managerial behavior, easier intervention in the firm's production decisions, and "soft budget constraints," which protect government-owned firms from the threat of bankruptcy and the financial discipline imposed by private-sector capital markets (Megginson and Netter, 2001, pp. 7–10).

Megginson and Netter (2001) survey recent empirical comparisons of the relative performance of government-owned and privately owned firms. Virtually all of the studies cited find that private ownership is associated with better measures of performance, including higher productivity, lower costs, higher profits, lower debt, and fewer labor-intensive production processes. Some studies also find that these performance improvements are not affected by the degree of market competition or regulation.

Although the market analysis in this report and in Hix et al. (2003) indicates that most markets for ordnance items have either current or potential competitors,

⁴¹See <http://www.epa.gov/superfund/sites/npl/npl.htm>.

there may be some end items or components where GOCO or GOGO producers have a monopoly. The Army's contracting approach, including the size and stability of buys, technical specifications, and source-selection criteria, can help to ensure that multiple contractors are willing to bid on ordnance contracts. Even in sole-source situations, contracting approaches can induce incentives for more efficient, lower-cost production after divestiture. The economic literature on privatization of monopolies (primarily utilities such as telecommunications, electricity, natural gas, and water),⁴² suggests that price-cap or "RPI-X" regulation, under which the prices of the firm's products are held constant between regulatory reviews or allowed to adjust at a fixed rate relative to inflation, is effective in creating incentives for cost reduction, if regulatory reviews are held relatively infrequently, e.g., every five years. (See, for example, Armstrong et al., 1994; Jenkinson and Mayer, 1996; or Pint, 1992.) In the context of defense procurement, firm fixed price or fixed price with economic adjustment contracts that capped prices over a five-year period would provide similar incentives. However, it should be noted that under these contracting/regulatory schemes, some of the benefits of cost reduction will accrue to the firm rather than the Army. If all the benefits of cost reduction accrue to the Army, the firm would have no incentive to reduce costs.⁴³

Recovery of Capital Costs

If the Army's arsenals and ammunition plants were privatized, private-sector ordnance producers would have to recover the costs of buying the privatized assets through the prices they charge for ordnance items and ammunition. Some might argue that this will cause the Army's cost of ordnance materiel to rise relative to the status quo. However, this will not necessarily be the case, for two reasons.

First, all of the Army's costs of ordnance, including capital investments and the opportunity cost of holding excess capacity, should be compared with the

⁴²It has also been possible to introduce competition in some of these industries as technology has changed (in telecommunications) or as production has been separated from distribution (in natural gas and electricity).

⁴³Armstrong et al. (1994, pp. 39–44) describe pricing policies as a continuum from firm fixed prices, under which the firm has strong incentives to minimize costs, but the government may pay more than actual costs (i.e., the firm earns above-normal profits), to cost reimbursement, under which price equals actual cost and the firm earns no abnormal profits, but the firm has no incentive to reduce costs. Intermediate schemes, under which the firm may be paid more than the target price if costs are unusually high, or the government gets a share of the savings if costs are unusually low, have incentive and efficiency effects that lie between these two extremes. The optimal amount of cost passthrough depends on tradeoffs between allocative efficiency (price equals cost, no abnormal profits) and productive efficiency (optimal cost-reducing effort), which are affected by the responsiveness of demand to changes in price and the relative risk aversion of the government and the firm, among other factors.

private-sector cost of ordnance. For example, at the 10 GOCO ammunition plants considered for privatization,⁴⁴ the Army spent a total of approximately \$617 million in FY01 for the production of ammunition.⁴⁵ It also spent \$7 million on layaway and maintenance of inactive facilities and \$11 million on offices of the Contracting Officer's Representative at each plant (including 160 government employees located at the plants). Capital investment costs for production facilities and environmental compliance totaled \$37 million. Approximately \$14 million was spent under the ARMS program to refurbish unused building space and attract tenants. In return, the facility-use contractors at the plants received approximately \$33 million in ARMS revenues, some of which was used to offset the government costs of overhead, maintenance of inactive facilities, and capital improvements. The Army also received \$4 million from agriculture and forestry leases. Thus, the Army spent approximately \$649 million (net of rental income) on the plants in FY01, not counting the time spent by military and civilian personnel at higher headquarters managing operations at the plants or the opportunity costs of holding idle facilities. The fraction of these additional costs that would no longer be incurred by the Army after divestiture could be more than enough to offset any capital cost recovery by the owner of the privatized facilities.

Second, the existence of competitors who could produce the same ordnance materiel in their own facilities or potential competitors who have the technological expertise and the resources to build their own facilities limits the maximum price that the owners of a privatized arsenal or ammunition plant could charge. To examine this argument, we construct a simple example in which the operator of a government-owned facility competes with two actual or potential competitors using contractor-owned, contractor-operated facilities. We then compare the GOCO example with the case where one of the competitors has bought the privatized facility.⁴⁶

Suppose the operator of Iowa AAP can load, assemble, and pack (LAP) 100,000 artillery shells per year at a cost of \$100 per shell,⁴⁷ but it would cost \$120 per shell for either of the other two contractors to perform the same work, because they would need to invest in their own facilities. If all three competitors know each others' costs, and the government awards a competitive contract to LAP

⁴⁴Mississippi AAP is excluded, since the Army is a tenant on a NASA facility.

⁴⁵This \$617 million includes both directly observable prime contract costs for ammunition production and estimated costs for ammunition subcontracts held by the GOCO contractors.

⁴⁶This example is intended to illustrate the effects of privatization on the competition for production contracts and the resulting price of ammunition, not to be a model of the entire privatization process.

⁴⁷This example is loosely based on the prices and quantities of M795 155mm artillery shells in U.S. Department of the Army, Procurement Programs (2000).

artillery shells, the operator of Iowa AAP only has to bid a price that undercuts its competitors' costs by a small amount to win the contract.⁴⁸ At a price of \$119 per shell, the operator of Iowa AAP would win the competition and earn an annual profit of $(\$119 - 100) * 100,000$, or \$1.9 million per year.

The government also holds periodic competitions to operate Iowa AAP that are open to all three firms. If a facility-use contract lasts five years, any of the three contractors should be willing to bid up to the net present value of \$1.9 million per year for 5 years, or \$7.1 million at an interest rate of 10.69 percent.⁴⁹ If a facility-use contract lasts 25 years, the maximum bid would be the net present value of \$1.9 million per year for 25 years, or \$16.4 million at the same interest rate. Whether the Army could obtain this maximum valuation through a competition for the facility use contract would depend on the design of the competition process and the potential for collusion, since firms could earn above-normal profits by paying less than the net present value of future profits.⁵⁰ However, assuming that the winning bidder does not pay more than the net present value of future profits, it will be able to recover the capital costs of its bid through the price it charges for ammunition.⁵¹

Now, if we consider the privatization of Iowa AAP, the winning bidder obtains the right to operate Iowa AAP in perpetuity (or as long as the Army continues to buy the same type of ammunition). If the number and costs of the competitors stay the same, the winning bidder will still charge a price of \$119 per shell and earn profits of \$1.9 million per year. Therefore, the maximum that the new owner of Iowa AAP should be willing to pay is the net present value of a perpe-

⁴⁸In practice, GOCO contractors have additional advantages in ammunition production competitions that may enable them to win even if their full costs per shell are higher than COCO competitors. Under the Arsenal Act, "out-of-pocket," or marginal, costs at the GOCO can be compared with full costs at the COCO. Under "best-value" contracting, the Army may weight the use of organic facilities favorably in its source-selection decision.

⁴⁹This is the weighted average cost of capital for the explosives and volatile chemicals industry (Ibbotson Associates, 2001, pp. 2-45 to 2-46).

⁵⁰According to Klemperer (2002), the important factors in designing auctions and similar forms of competition are discouraging collusive, entry-detering, and predatory behavior, and attracting potential bidders. The best auction design depends on the assets being sold and the number of incumbent producers and potential new bidders. Open-bid, ascending auctions reveal information about bidders' valuations and are more likely to allocate assets to the bidders who value them most, but they are prone to collusion and may discourage potential entrants. Sealed-bid auctions make collusion more difficult and are more attractive to entrants, but they may not allocate assets to the bidders who value them most, because bidders have an incentive to bid less than their full valuation of the asset in order to earn above-normal profits. In some cases, a hybrid auction, which begins with an ascending auction until two bidders are left, who then each make final sealed-bid offers, can yield the best results.

⁵¹In practice, GOCO contractors do not pay rent to the Army for use of the ammunition plants. However, when production contracts are competed at the same time as facility use contracts, bidders may offer concessions on ammunition prices, overhead rates, or payments for inactive facilities in exchange for the right to operate the facility.

tuity of \$1.9 million per year, or \$17.8 million at an interest rate of 10.69 percent, to buy the plant. Assuming that the owner of a privatized Iowa AAP does not pay more than this maximum value, it will be able to recover its cost of capital through the price of ammunition, but the price of ammunition depends on its competitors' costs, not whether Iowa AAP is GOCO or privatized.

More complex versions of this simple model that take more "real-world" conditions into account are possible but do not change the basic result that privatization does not increase the price of ammunition. For example, suppose the operator of Iowa AAP knows that it can LAP 100,000 artillery shells for \$100 each, but is unsure of its competitors' costs. It thinks its competitors' costs are uniformly distributed between \$110 and \$130 per shell, i.e., any value between \$110 and \$130 is equally likely. When the operator of Iowa AAP makes its bid to LAP shells, it must trade off higher potential profits against an increased probability that it could lose the contract as its bid increases above \$110. If there is only one competitor, the operator of Iowa AAP maximizes expected profits at a bid of \$115, but if there are two or more competitors, it should reduce its bid to \$110.⁵² The net present value of expected annual profits determines the maximum that contractors are willing to bid to operate Iowa AAP as a GOCO or a privatized facility, but it is the number of potential competitors and what is known about their costs that drives the price of ammunition, which remains the same whether Iowa AAP is GOCO or COCO.

Competition for Ordnance Production

Another possible cost-based argument in favor of government ownership of arsenals and ammunition plants is that it lowers entry barriers by providing facilities to contractors, who then do not have to incur the costs of investing in their own facilities. However, as the theoretical example above illustrates, the price of ordnance materiel is not determined by the availability of low-cost government facilities, but rather by the existence of actual and potential competitors who could make the same products in their own facilities.

Under the current rules for ordnance competition, as defined by the Arsenal Act of 1920 (10 USC 4532), government ownership appears to tilt the competitive playing field for ammunition and ordnance items. The Arsenal Act requires the Secretary of the Army to "have supplies needed for the Department of the Army made in factories or arsenals owned by the United States, so far as those factories or arsenals can make those supplies on an economical basis."⁵³

⁵²Mathematical calculations are given in Appendix C.

⁵³However, the statute also gives the Secretary of the Army the power to "abolish any United States arsenal that he considers unnecessary."

“Economical basis” has been interpreted to mean that the out-of-pocket, or marginal, cost of the government-owned producer can be compared with the full cost proposed by privately owned firms. However, the full costs of production, including overhead, are charged to the Army or DoD agency that is the customer for the ordnance materiel.⁵⁴

Although this type of cost comparison may be appropriate for short-term decisionmaking, when the existence of Army-owned facilities is taken as given and overhead costs would be incurred whether government-owned facilities win contracts or not, it is not appropriate for long-term decisionmaking, when the Army considers whether it is cost-effective to continue to own these facilities. One can cite a number of cases where the full cost of production in COCO facilities is less than the full cost of production in GOCO or GOGO facilities.

For example, in 1995, the Talon Manufacturing Company protested the award of a contract to produce .50 caliber blank ammunition to the Olin Corporation, the operator of Lake City Army Ammunition Plant at the time. Talon’s bid was lower than the historical GOCO full cost per round of \$0.95, but the contract was awarded to Olin because its out-of-pocket costs were 40 percent lower than the historic fully funded cost. The protest was denied by the Comptroller General of the United States on the basis of the Arsenal Act (Comptroller General, 1995).⁵⁵

The other armed services are not bound by the restrictions of the Arsenal Act and have increasingly turned to commercial competitors to produce ordnance items. For example, the 155mm Lightweight Howitzer, a joint Army–Marine Corps development program that is currently being managed by the Marine Corps, will use cannon barrels produced by Watervliet Arsenal, but Rock Island Arsenal had to compete with COCO facilities for a share of the production subcontracts. The prime contractor, BAE Systems, is obligated to stay within ceiling option prices for the first 190 howitzers, so any subcontracted work must

⁵⁴Although the Army is shifting toward more competitive production contracting approaches, such as system-level contracting for ammunition rounds instead of separate contracts for multiple components, other aspects of the procurement process and ownership structure still favor GOCOs. These include technical specifications tailored to current GOCO processes, large and variable quantities, requirements to hold excess capacity for replenishment, short notice of competitions, Army indemnification of insurance costs, and exemption from local property taxes.

⁵⁵The Comptroller General’s 1995 decision cites the following precedents: “‘Economical basis’ means a cost to the government which is equal to or less than the cost of such supplies to the government if produced in privately-owned facilities, and government plant production costs are to be computed on the basis of actual out-of-pocket cost to the government. *Olin Corp.*, 57 *Comp. Gen.* 209 (1978), 78-1 CPD P 45; *Action Mfg. Co.*, B-220013, Nov. 12, 1985, 85-2 CPD P 537. ‘Out-of-pocket’ costs for a GOCO include all costs incurred by the government directly as a result of producing an article at a GOCO plant and excludes those costs which would be incurred by the GOCO regardless of whether a particular contract were awarded to the GOCO firm. *Id.*”

meet cost targets to keep the full cost of the howitzers within the ceiling.⁵⁶ Rock Island was able to win a subcontract for the breach operating load tray system, contingent on reducing its overhead rate to bring its bid within the competitive price range, but subcontracts for stabilizers, spades, and trails, for body assembly, and for final assembly, test, and delivery were awarded to private-sector competitors. (See U.S. Marine Corps and U.S. Army, 1999, and U.S. GAO, 2000, 2001, and 2002.)

If the Army divested its arsenals and ammunition plants, it could treat all ordnance materiel producers on an equal footing and have greater assurance of awarding contracts that are cost-effective from a long-term as well as a short-term perspective.

DOES PRIVATE-SECTOR PRODUCTION INVOLVE UNACCEPTABLE RISK?

Another potential reason for government ownership of arsenals and ammunition plants is that private ownership could involve unacceptable risks that ordnance materiel will not be available in sufficient quantities in times of crisis or that the Army will lose critical production assets. These risks could take a number of forms, including the risks that private-sector owners will

- not retain sufficient replenishment capacity,
- be subject to greater physical security risks,
- exit the market and allow irreplaceable land, facilities, and environmental permits to be lost,
- go bankrupt, or
- not be responsive to emergency demands in times of crisis.

In the remainder of this section, we examine each of these potential risks.

Replenishment

A common justification for maintaining government ownership of ammunition production facilities is tied to a requirement to maintain a replenishment production capability for ammunition and ordnance items.⁵⁷ We provide a de-

⁵⁶This ceiling does not apply to the cost of the cannon barrels, which are being provided to the contractor as government-furnished material.

⁵⁷Missiles, which are analogous to conventional ammunition in many ways, provide an interesting counterpoint. They are primarily produced in the private sector, and no formal replenishment production planning is required for them. The Army leadership appears to accept that the next missile is always on the way and hence there is no need to be prepared to increase or restart production of current models. Missile production is discussed in greater detail in Appendix B.

tailed assessment of replenishment issues in Appendix B (Replenishment), but note the three major issues here.

The first issue is whether private firms can be relied upon to maintain sufficient underutilized and laid-away equipment to ensure an adequate ammunition replenishment capability. This is not so much a concern about the actual ability of private firms to hold reserve capacity. Rather, the concern is whether adequate incentives, primarily monetary ones, are available to induce them to do so. These concerns are quite manageable. Importantly, the Army already relies to a large degree on the private sector for replenishment capability. In addition, resources used to maintain government-owned replenishment capability would be freed up with privatization. Most important, though, reliance on the private sector for replenishment capability would demand explicit decisions about required replenishment capability as each contract was written or renewed. This decision process would further call for a well-thought-out ammunition replenishment policy that prioritized ammunition requirements on an ongoing basis. Enhancing the visibility of such decisions and making them more explicit is likely to improve the Army's overall ammunition readiness.

A second issue relates to the near-term budget effect of privatizing government-owned, replenishment-required facilities and the *perception* that government ownership of the organic industrial base has only a small cost associated with it.⁵⁸ This particular issue has little to do with the merit of privatizing the replenishment of ammunition. Instead the concern is focused on finding the funding to effect privatization. The near-term budget impacts of privatizing the organic industrial base can be made acceptable with a sound divestiture strategy, as provided in Chapter Eight. As for the costs associated with current and continued government ownership of an organic industrial base, these are substantial and are detailed elsewhere in this report.

The last of the three issues is not specifically one of "replenishment," but is related strongly to it. Here the question is whether private facilities are as able as government-owned ones to support "surge production" or other emergency requirements. As with the first of these three issues, this one has little to do with suspicions concerning the actual ability of the private sector to hold reserve capability and exercise that capability responsively, at least in comparison to the government's organic base. Again, the concern is that there are no incentives for the private sector to maintain a reserve industrial capability. This concern may be overstated, however, since there is no official requirement or policy to surge production. To the extent that production-surge remains an

⁵⁸Much of this perspective is the result of the Army's experience in divesting itself of excess facilities, industrial and others.

“informal” policy, resource allocation decisions are still required, especially since surge requires an enhanced industrial readiness to an even greater extent than replenishment capability requirements. Like replenishment capability, privatization enhances the explicit nature of the decisions, thus improving the probability that such decisions will support overall Army requirements.

To the extent that the Army retains the three GOGO plants as a hedge, these plants may be assigned replenishment or emergency production missions that the private sector is unable to accomplish. By assigning the GOGO the replenishment missions that are large compared with peacetime production, the Army permits commercial contractors to concentrate in peacetime on the more profitable workload.

Homeland Security

Since September 11, 2001, there is reason to be concerned about the physical security of domestic defense-related industrial facilities, both commercial and government-owned. At issue is whether privatization of government-owned facilities would increase or decrease the risk of terrorist attack.

Regardless of whether the government or private firms own defense-related industrial facilities, threats to their physical security (sabotage and terrorism) require the government to address the following options:

- Many distributed capabilities.
- Few consolidated production facilities.
- Government ownership.

One policy decision is whether to maintain the current set of widely distributed industrial facilities, both commercial and organic. Such dispersion limits the damage of a single attack but complicates and multiplies security requirements. The alternative, to consolidate onto fewer production facilities, risks greater damage from any single attack but simplifies and eases the security problem. From the standpoint of a terrorist attacker, the rural locations of the facilities under study here, regardless of the concentration of activities on them, limit their attractiveness as targets. Terrorists seek to create fear in as much of the population as they can reasonably affect.

The Army can maintain adequate physical security regardless of whether these plants are government- or contractor-owned. Co-locating industrial facilities on multifunctional installations with troops would provide an extra measure of protection. On the other hand, the services have a good record of protecting sensitive and dangerous manufacturing facilities in the private sector. Both private firms and government agencies have industrial security requirements and

means of meeting them. The extent of physical and personnel security measures may need to be upgraded regardless of ownership, but it is not clear that government ownership is necessary to ensure security. More than two-thirds of ammunition dollars already go into about 70 completely commercial facilities; the Army needs to validate its security measures as well. Neither the commercial nor the organic base can meet the Army's ammunition requirements if the other is destroyed.

While in many cases some comparable commercial capability could substitute for any destroyed organic capacity, the extent of this backup capacity varies considerably across products. If the Army were to become very concerned about the physical security of these places, it could split capabilities into two or more installations. For example, metal parts contracts now executed entirely at Scranton could be split between Scranton and Riverbank or even Iowa—or, more broadly, between Scranton and White Sands or Yuma, which do not now produce ammunition. While the Army would lose the benefit of any economies of scale it now enjoys, the split might generate other benefits through increased competition. To justify the large front-loaded cost of making such substantial changes, however, one would want a plausible threat.⁵⁹

Finally, while terrorist attacks on current production facilities would hinder the Army's long-term sustainability, they would not provide the dramatic fear effects that terrorists seek. So far, the terrorists have not tried to physically destroy U.S. warfighting capabilities; instead, terrorists exploit the fear created by their acts. They did not hit the Pentagon to disable the military; they hit it and the World Trade Center to kill some but, more importantly, to scare the rest of us. The Army's industrial facilities are likely to be low-priority terrorist targets because they tend to be in rural areas that lack the potential to produce mass casualties. Further, they are not symbolic targets that would have widespread psychological effects on the population at large. That said, the Army ought to make sure the plants are secure. In particular, the Army should take care to secure any facilities that may store weapons, such as chemical or nuclear devices, whose destruction or loss would cause substantial fear in the population apart from any loss in military capability.

If the nation begins to face the more traditional military threats—sabotage, subversion, espionage—intended to destroy our military capability rather than create mass fear, then the industrial base could be expected to be a higher-priority target. But such threats tend to come from more traditional foes, not terrorist organizations.

⁵⁹The recently announced creation of U.S. Northern Command may signal an elevated concern for U.S. security. Such concern could lead to consideration of such broad changes and on a joint, rather than a service-specific, basis.

That said, no one now feels comfortable predicting what may happen tomorrow, next month, or next year. Few would be astounded to learn tomorrow that an organic Army ammunition plant or a commercial Raytheon plant had been attacked. But such an attack would probably not create the enormous fear that terrorists have gained in attacking the more important symbolic targets.

If the Army perceives that the threat to these installations has intensified, security measures should be (and in some ways already have been) intensified, regardless of any divestiture options the Army may elect to implement. Security most likely can be achieved under either government or private ownership.

Loss of Irreplaceable Assets

A third type of risk that might be associated with divestiture of the Army's arsenals and ammunition plants is that the new owners may exit the market and allow irreplaceable land, facilities, workforces, and environmental permits to be lost. To the extent that excess capacity still exists in the organic production base, it would be neither unexpected nor undesirable for some of the divested facilities to exit the market. However, there may be some minimum level of capacity currently in the organic industrial base that the Army would like to retain in the event of divestiture.

To examine this question, the Army must first consider how "unique" or "irreplaceable" these assets are. If COCO producers of ammunition and ordnance items can set up similar facilities and get the required environmental permits quickly and easily enough to meet the Army's needs for peacetime production and replenishment, then the exit of particular facilities from the current organic industrial base should not be of great concern. If the Army's ordnance facilities truly are unique and difficult to replace, the Army must take a proactive approach to ensure that private-sector owners have an incentive to maintain these assets. Appendix B offers a detailed assessment of these issues.

This suggests a two-step approach to preserving critical assets in the private sector. First, the Army should identify critical assets that cannot easily be reconstituted if needed. For those assets deemed critical, the Army must provide a steady peacetime demand for ordnance materiel and be willing to pay the cost of maintaining its desired level of replenishment capacity. Under this approach, if one particular producer decides to exit the market, the most likely buyer of these critical facilities would be another ordnance producer, rather than a buyer who would put the facilities to some alternative use. Hence, applying this approach would eliminate this concern about privatization. Note that current Army replenishment planning is based on startup times of one year or more for organic, laid-away facilities. Plausibly, such facilities could be built from scratch in comparable lengths of time.

Environmental Issues

As mentioned above, it could be claimed that GOCO ammunition plants have unique, preexisting environmental permits for ammunition production that would be difficult for COCO producers to obtain. However, private-sector producers indicate that the permitting process for ammunition is similar to that for industrial chemical production. In other cases, such as TNT production at Radford AAP (which may need to be restarted in the near future unless substitutes are found), the permit for disposal of red water, a toxic by-product of TNT, is held by an independent disposal facility, which could presumably also be used by a COCO producer of TNT. Our review of environmental laws and regulations did not find any clear advantages for GOCO facilities relative to COCOs in obtaining necessary permits. In the remainder of this subsection, we briefly discuss the permitting processes for hazardous wastes, air pollution, and water pollution.

Industrial facilities that generate hazardous wastes are not required to obtain Resource Conservation and Recovery Act (RCRA) environmental permits unless they are considered to be Treatment, Storage, and Disposal Facilities (TSDFs). Arsenal or ammunition plants will be classified as TSDFs if they store hazardous wastes for more than 90 days or if they perform extensive treatment, incineration, or open burning of hazardous waste.⁶⁰ Changes in the ownership or operational control of a facility may be made as a Class 1 (routine) modification of a RCRA permit with the prior written approval of the director of the permitting agency.⁶¹ (The U.S. EPA has authorized all states except Iowa and Alaska to run their own hazardous waste programs.⁶²) Owners and operators of new TSDFs must submit a permit application at least 180 days before the date on which physical construction is expected to begin. RCRA permits are effective for a fixed term of a maximum of 10 years, or 5 years for land disposal of hazardous waste, at which time the operator must submit an application for reissuance (U.S. EPA, 1998a). Facilities that generate hazardous waste but are not classified as TSDFs are required to obtain an EPA identification number;

⁶⁰Totally enclosed treatment units that are directly connected to industrial production processes, elementary neutralization units used to handle corrosive wastes, and wastewater treatment units that treat and discharge hazardous wastewater pursuant to the Clean Water Act are exempt from TSDF standards. See U.S. EPA (1998a), pp. III-61 to III-63.

⁶¹The new owner or operator must submit a revised permit application no later than 90 days prior to the scheduled change. A written agreement containing a specific date for transfer of permit responsibility between the current and new permittees must also be submitted to the director. The old owner or operator must continue to provide financial assurance that it can cover the costs of closure and postclosure care of the facility until the new owner or operator can demonstrate financial assurance, which must occur within six months of the date of the change of ownership or operational control. See 40 CFR, Chapter I, Part 270.40-42 and Part 264.142-146.

⁶²Information obtained from RCRA Call Center, 1-800-424-9346, February 28, 2002.

identify, label, and measure the amount of waste generated; comply with accumulation and storage requirements; prepare the waste for transportation; track the shipment and receipt of waste; and meet record-keeping and reporting requirements.

Operating permits are required for all major stationary sources of certain air pollutants, such as carbon monoxide, particulates, volatile organics, sulfur dioxide, and nitrogen oxides.⁶³ Construction permits, also known as New Source Review permits, are required for all new stationary sources and all existing stationary sources that are adding new emissions units (i.e., pieces of equipment that generate pollutants) or modifying existing emissions units. EPA has established operating permit programs in every state as well as 60 local programs to manage the permitting process. The permits are legally binding documents that establish limits on the types and amounts of air pollution allowed, operating requirements for pollution-control devices or pollution-prevention activities, and monitoring and record-keeping requirements. Operating permits must be renewed every five years, and if laws change or additional requirements under the Clean Air Act become applicable to a source, the permit must be revised (U.S. EPA, 1998b and 2002a).

Industrial facilities are potentially subject to three separate water permitting processes under the National Pollutant Discharge Elimination System (NPDES). Industrial facilities that discharge wastewater directly to surface waters are required to obtain an NPDES permit. Permits consist of effluent limits, monitoring and reporting requirements, any special conditions, and standard legal, administrative, and procedural requirements. Effluent limits are calculated based on best-available treatment technologies and on the impact of the discharge on the quality of the receiving water; the more stringent limit is applied. Stricter technology-based limits, known as new source performance standards (NSPS) are applied to new sources.

Industrial facilities that discharge wastewater to a municipal sewer system are covered by the NPDES pretreatment program. The pretreatment program includes both national standards for prohibited discharges and limits on pollutant discharges for particular industrial categories, and local limits developed to reflect specific needs and treatment capabilities at individual publicly owned treatment works. Facilities subject to these limits are required to show initial compliance, file periodic compliance reports at least every six months, and

⁶³Generally, a source is considered "major" if it emits 100 tons or more per year of a regulated air pollutant. Smaller sources are considered "major" in areas that are not meeting the national air quality standards for a particular pollutant. Large coal-burning utility boilers and industrial boilers subject to the Acid Rain Program must also have an acid rain permit as part of the air quality operating permit.

notify the treatment facility of any changes in discharges, noncompliance, or potential problems. New sources also face higher pretreatment standards than do existing sources.

Storm water that runs off the property of an industrial facility or a construction site into a municipal storm sewer system or directly to surface water may require an NPDES permit under the storm water program. Facilities with manufacturing operations or effluent limitations under other programs must obtain a permit unless they can show that their industrial materials and operations are not exposed to storm water.

The U.S. EPA also delegates authority to states and territories to administer the NPDES program. As of March 2002, EPA had authorized 44 states and one territory to administer individual permits for industrial and municipal facilities, but only 39 states had authority to regulate federal facilities, and 33 had authority to administer the pretreatment program (U.S. EPA, 1999 and 2002b).

Thus, although existing GOCO and COCO plants may be subject to somewhat less strict water quality regulations than new COCO sources, and some GOCO plants may be subject to U.S. EPA jurisdiction rather than state jurisdiction, it does not appear that GOCO facilities have a significant advantage over COCO facilities in obtaining environmental permits for ammunition production. Existing permits are subject to renewals and must be revised if new environmental requirements come into effect.

Bankruptcy

Another possible risk is that one or more of the new owners of the Army's divested organic industrial base could go bankrupt. Perhaps the most important fact to consider with regard to the privatization of the current GOCO plants is that the firms that now operate these plants are large, stable, and profitable. General Dynamics, BAE Systems, Alliant Techsystems, and Day & Zimmerman operate 8 of the 11 plants. Collectively, they represent the robust part of the market.

More generally, the purpose of Chapter 11 bankruptcy is to restructure the firm's finances by passing control from equity holders to debt holders so that fiduciary responsibilities can be maintained, and the company reorganized. Production of goods and services typically continues, often under the supervision of court-appointed management, although unprofitable activities can be suspended.

When forecasted cash flows indicate that required payments to debt holders are at risk, and therefore bankruptcy is imminent, two types of market failures

could ensue. First, attractive investment opportunities could be forgone if the firm cannot induce the capital markets to lend to it. Potential investors are unwilling to finance new projects, because the firm's value will be reallocated to debt holders in order of seniority under Chapter 11 reorganization, regardless of the success of the particular project they invested in.

Second, when a firm is threatened with bankruptcy, its management (selected by equity holders) has an incentive to make very risky investments, because equity holders (and probably management themselves) have very little to lose and much to gain if they pull off a successful risky investment.⁶⁴ To circumvent these types of market failures, U.S. bankruptcy laws allow debt holders to negotiate or sue the firm into foreclosure so that its finances can be reorganized while it continues to operate. As a result, firms emerging from Chapter 11 bankruptcy are often stronger and more innovative, because new management can be brought in, and the experience causes stakeholders, such as middle management and unions, to renegotiate the way the firm operates to make it more innovative and competitive.

In the short term, an imminent bankruptcy could cause supply disruptions. If a firm has corrupt management or becomes financially unsound, it might have trouble accessing financial markets to obtain or maintain sufficient capital funding to complete an Army contract. This phenomenon is sometimes called the "present value of financial distress." Bankruptcy typically alleviates these short-term problems by giving the firm temporary protection from its creditors while it reorganizes its finances. The Army has a number of strategies to reduce the risk of financial distress and help it through any short-term supply disruptions.

First, DoD monitors the finances of defense contractors through the Defense Contract Audit Agency (DCAA), which examines not only the cost structure of all defense firms that bid on DoD contracts, but also the financial health of these firms, to ensure that they have the financial resources to execute their commitments. (See, for example, Ratnam, 2002.) Second, the Army plans to execute the national military strategy with existing stocks and replenish during peacetime, so sufficient ordnance stocks should be available in times of emergency. As mentioned earlier, there is a risk that underfunding of war reserves may, by default, change the strategy to one of surge during an actual operation. Third, stockpiles could be increased to mitigate any additional risk from potential bankruptcies, although this risk should be minor if the Army exercises financial due diligence in the source-selection process. As a last resort, if a firm

⁶⁴For example, it was reported on CBS's *60 Minutes* that when his television station WTBS was under a cash flow crunch in the 1970s, Ted Turner financed its payroll by playing roulette.

facing bankruptcy threatened national security in wartime by refusing to produce ordnance, the President could seize control of its assets and assume liabilities for financing its operations. Finally, it should be kept in mind that these strategies are felt to be adequate to handle the threat of bankruptcy for the vast majority of ammunition production. Two-thirds of DoD ammunition requirements are already produced in COCO facilities, and most of the remainder is produced by contractors in GOCO facilities, all of whom are already subject to the risk of bankruptcy.

An example of a recent bankruptcy that affected DoD is the Iridium satellite telephone system. The Iridium consortium raised \$5.5 billion during the 1990s to put a constellation of 66 satellites into low earth orbit. In November 1998, the system began providing global service, including oceans, airways, and the polar regions. However, it was never able to attract enough customers to finance the initial investment because its handsets were relatively large and expensive and could only work in direct line with a satellite (i.e., they did not operate inside buildings or cars). The company's bondholder group filed an involuntary Chapter 11 petition, which was followed by a voluntary petition from Iridium, in August 1999. Although it was rumored that Iridium would have to cease operation and destroy its satellites, Iridium's assets (the satellite constellation, terrestrial network, real property, and intellectual capital) were sold to Iridium Satellite LLC for \$25 million in November 2000.

Iridium Satellite's first customer for its relaunched service was the Defense Information Systems Agency, which awarded a \$72 million, two-year contract for mobile phones and paging. The contract, which includes options to extend the deal through 2007 at \$252 million, gives unlimited airtime to 20,000 government workers. Iridium Satellite resumed commercial voice services in March 2001, and it introduced data and Internet services in June 2001. The system appeals primarily to users who operate in remote areas where terrestrial telephone services are not available. More recently, Iridium Satellite has proposed that its system could be used by the FAA to provide real-time monitoring capability of cockpit voice and flight data.⁶⁵

As this example illustrates, a firm's physical assets do not disappear, or even necessarily go out of service (or out of production), if it enters Chapter 11

⁶⁵See Hodson (2000); Maney (2000); "Iridium Falls Out of Orbit," *Wired News Report*, August 13, 1999, <http://www.wired.com/news/business/0,1367,21267,00.html>, downloaded December 6, 2001; and "Defense Department Contract Keeps Iridium Satellites in Orbit," December 12, 2000, "Iridium Satellite LLC Launches Global Satellite Communications Services," March 28, 2001, "Iridium Launches Global Satellite Data and Internet Services," June 6, 2001, and "Iridium Satellite Proposes Real-Time Cockpit Voice and Flight Data Monitoring to Federal Aviation Administration," October 2, 2001, http://www.iridium.com/corpliri_corp-news.asp?newsid=14, downloaded November 21, 2001.

bankruptcy. The bankruptcy process is intended to revalue those assets to a level that can be supported by the firm's revenues and operating margin. In the case of ordnance materiel, the firm's physical assets would not go out of ordnance production unless its revenues did not cover its operating costs, or the assets could be put to a more productive alternative use. As discussed in the previous subsection, if these assets are unique or irreplaceable, the Army must take a proactive approach to ensure that ammunition producers have adequate financial incentive to keep them in production.

Responsiveness to Emergency Demands

Earlier in this chapter, we discussed the general problem of private-sector responsiveness to Army demands for ordnance during peacetime. During periods of crisis, the Army faces the additional problem that it needs to obtain ammunition or ordnance items quickly to meet emergency needs. It is sometimes argued that only GOGO facilities can offer the responsiveness needed in a crisis, citing a recent example from the conflict in Bosnia. The commander in Bosnia identified an urgent requirement for metal plating to protect occupants of HMMWVs from mines. Rock Island Arsenal received the requirement to design and fabricate the items in a matter of days and did so. No contracting was required; the federal employees at the arsenal simply went to work without bureaucratic or contractual delay. Although this anecdote conveys an important attribute of GOGO governance at Rock Island, it is not clear that it is unique to GOGO facilities.

On a recent trip to McAlester AAP, two project team members were briefed on a crisis that occurred in July 2000, when all the joint standoff weapons (JSOWs) of the Pacific fleet were found to have a flaw in their payload dispenser rails that required immediate correction. DoD turned to a Raytheon element, which happens to be located at McAlester but could just as easily have been located at a commercial facility, to refit the entire complement of 112 JSOWs. Without bureaucratic or contractual delays, the Raytheon team turned to the task immediately. Upon receiving the weapons on July 10, the team worked around the clock and refitted the entire stock of missiles. Eighteen days later, the missiles were back at Port Hadlock ready for transport back onboard the aircraft carriers. The Raytheon team points proudly to the congratulatory letter from Admiral Jack Chenevey commending the team for their responsiveness and dedication.⁶⁶

Since the beginning of Operation Enduring Freedom in Afghanistan, Boeing has doubled the production rate of the Joint Direct Attack Munition (JDAM), a

⁶⁶We are indebted to Mike Chitwood of the McAlester Raytheon team for this information.

\$20,000 precision-guidance kit that is attached to 1,000-pound and 2,000-pound "dumb bombs," from 700–800 a month to 1,500 a month by adding a second production shift. Production rates are expected to nearly double again to 2,800 a month by August 2003. The JDAM program manager is facilitating the production rate increases by funding additional capacity at Boeing and its critical suppliers. Boeing's production facility is also a model of lean manufacturing, where fewer than 30 workers are needed to produce 1,500 kits per month. Only a handful of additional workers are expected to be needed to further increase production rates, since Boeing plans to reduce assembly time by simplifying parts designs (Weinberger, 2002; Wallace, 2002; and Selinger, 2002).

In sum, both GOGOs and contractors can be responsive when called upon to satisfy emergency demands. Interviews with contracting and procurement authorities lead us to the conclusion that smart contracting and the maintenance of healthy relationships with contractors can ensure responsiveness.

ECONOMIC REGENERATION MODEL

An alternative proposal for long-term management of the GOCO plants that has received some attention is the Economic Regeneration Model (U.S. Army Materiel Command Deputy Chief of Staff for Ammunition, 2002). Under this model, the Army would continue to invest in upgrading building space at the ammunition plants to attract commercial tenants through the ARMS program.⁶⁷ ARMS tenant revenues could then be used to pay off the costs of environmental remediation and other liabilities, such as unfunded retiree benefits, before the plants were privatized. Its proponents argue that this approach is preferable both to the Army's past practice of declaring ammunition plants "excess to need" and to the option of privatization.

When installations are declared excess to need, under the Federal Property and Administrative Services Act of 1949, they must first be offered to other military services, then to other federal agencies, and then to state agencies, which in turn can offer the property to any public agency or nonprofit organization. As a result, they typically generate little or no revenue to the Army, whereas the Army must fund environmental remediation and other liabilities before an installation can be turned over to the new owner. Since funding is not usually available to pay off these liabilities immediately, installations declared excess to need tend to remain under Army ownership awaiting disposal for many years. (See Table 4.1.)

⁶⁷A similar program for the arsenals, the Arsenal Support Program Initiative (ASPI), is being initiated in FY02.

Although the Economic Regeneration Model may be preferable to declaring ammunition plants excess to need, it does not appear to be preferable to privatization. Under the privatization option, the ammunition plants would be sold as “going concerns,” so they would be considered excess-to-ownership, but not excess-to-need. On this basis, they could be sold to the current GOCO operators or to other ammunition producers. Privatization revenues could then be used to offset environmental remediation and other liabilities. In most cases, the estimated sales values of the ammunition plants exceed their liabilities, so the Army could be freed from most of these liabilities. (See Appendix E, Table E.2.) Additional gains could potentially be made by selling the plants in groups that combined high-liability, low-value plants with low-liability, high-value plants. Furthermore, the privatization option has the advantage of giving the new owners access to capital markets to fund modernization of ammunition production facilities. Since the ammunition plants would remain under government ownership in the Economic Regeneration Model, they would continue to face the problems associated with constrained investment resources in the DoD budget. And they would continue to distract the Army leadership from its core functions.

There are also problems associated with evaluating the true costs and benefits of the ARMS program, as noted by Hix et al. (2003), Appendix A. First, some ARMS investments, such as upgrading buildings to modern safety and access standards, demolition of excess buildings, or environmental remediation, may represent costs the Army would eventually have incurred in the absence of ARMS. Second, ARMS tenants pay rent to the facilities contractors, not to the government. Contractors then provide in-kind benefits to the Army, such as reductions in ammunition prices or payments for maintenance of inactive facilities, or making an investment in the plant that has been approved by the Army. In some cases, however, it is difficult to determine whether the Army would have incurred these expenses in the absence of ARMS. Third, real estate development is not a core competence of the Army or of ammunition producers, so the ARMS program most likely is not making the same investments that a profit-maximizing private-sector owner would make.

A final objection to the Economic Regeneration Model is that if a facility is truly excess to the Army's ownership requirements, it is probably not appropriate for the Army to retain ownership simply to generate revenues to pay off environmental and other liabilities. Generation of revenues from real estate operations to fund other functions is not an Army mission.

CONCLUSIONS

In sum, three arguments are typically made as reasons for not privatizing the ordnance base:

- The markets will not respond to the Army's needs.
- It will cost more to produce ordnance in private plants.
- It is too risky to transfer a key capability to the private sector.

Our reading of the economic literature, analysis of the arsenals and ammunition plants, and examination of comparable examples suggest that these rationales are not persuasive. To the limited extent they do apply, the issues they raise can be addressed by careful contracting and monitoring of performance. Indeed, the greater cost and risk to the Army may well lie in the status quo. It is not difficult to imagine a scenario in which the Army finds itself with obsolete facilities that either cannot respond to critical needs or can do so only slowly and at far greater cost than establishing new ones.



FEDERAL GOVERNMENT CORPORATION OPTION

The last chapter addressed the privatization option. This chapter turns to the federal government corporation (FGC). We consider the FGC option an intermediate business arrangement that could lead to full privatization. As an intermediate arrangement the FGC option should simplify the managerial complexities of converting GOGO and GOCO facilities to private ownership. This chapter begins by providing some background on FGCs, briefly characterizing them and recounting the legislative underpinning for them. Then, using the two arsenals as an example, it describes how they might be converted into an FGC, suggesting a notional organization, corporate mission, charter, and exemplar business plan. As part of the business plan, the chapter analyzes the business areas that the arsenals could compete in, given their facilities and workforce. It also describes the level of efficiency the arsenals would have to achieve to compete with industry, and it makes some estimates of the revenues they might generate as an FGC.

The reader will note the absence in this chapter of a lengthy discourse on the potential objections to an FGC similar to that on costs and risks in the previous chapter on privatization. Such a section is unneeded in this chapter for two reasons. First, an FGC as an end state simply carries less than even the modest risk associated with privatization. This chapter deals with FGC costs in some detail. Second, if the Army decides to use the FGC as an interim solution on the way to privatization, the discussion in the previous chapter applies.

BACKGROUND

As explained briefly in Chapter Four, FGCs operate at the boundary between the public and private sectors and have some of the characteristics of both types of organization. Congress establishes federal government corporations to serve public purposes while acting free of many of the legal and regulatory constraints of executive branch agencies. They operate as self-sustaining commercial organizations that provide goods and services of national importance that are not provided adequately by the private sector. Unlike government

agencies, FGCs may borrow money in capital markets. Their profits and losses do not appear in the federal budget deficit or surplus. Their employees are not necessarily subject to civil service rules, nor are they bound by federal procurement regulations.

The FGC option we consider is as an intermediate stage of business development on the way to ultimate privatization. Provision should be made, however, to continue the FGC indefinitely if, after several years of operation, the government considers the FGC preferable to full privatization. USEC, formerly the United States Enrichment Corporation, provides an example of this approach. Split off from the Department of Energy in 1992 as an FGC, the United States Enrichment Corporation remained an FGC for five years, at which time its board of directors recommended that it be privatized, which it was. The board could have recommended continuance as an FGC.

In our analysis of the FGC option, we considered the following goals:

- Fulfill the primary mission requirements for the facility.
- Fulfill the replenishment mission.
- Simplify management.
- Reduce the cost to the Army for products it requires.
- Eliminate subsidies of all sorts.
- Maintain a constant workforce.
- Enter commercial markets where there is room for growth.
- Position the FGC for an acquisition or an IPO in five years.

An FGC would temporarily retain government ownership of manufacturing assets but relieve the Army and the DoD from managing a peripheral function. The assets would be placed in the hands of an organization whose primary missions would be manufacturing and the management of real estate to support necessary defense-related manufacturing. An FGC partially achieves the goal of relying on the private sector. It introduces many of the benefits of the incentives that private firms employ, thus improving efficiency and innovation and responsiveness while mitigating any supply disruption risks associated with private ownership of assets. Operation as an FGC is intended to position an organization for privatization.

It is assumed that legislation would convey property to the FGC without compensation to the Army as a means of capitalizing the new entity. Legislation could, however, provide appropriated compensation to the Army without encumbering the FGC with debt.

ABOUT FEDERAL GOVERNMENT CORPORATIONS

During the 20th century, FGCs have been used as instruments of national policy because of the flexibility, freedom, focus, and finance alternatives uniquely available with such organizational structures (U.S. GAO, 1995; Froomkin, 1995; 31 USC 9101). In keeping with the general sentiment that forces of the free market system lead to efficiencies of operation, FGCs are freed from encumbering regulations with regard to civil service rules (Lilienthal and Marquis, 1941) and federal acquisition and disposal requirements (41 USC 251). Generally, the congressional charter grants the FGC the right to sue and to be sued, which right is a waiver of sovereign immunity and clearly differentiates the FGC from government organizational forms (Court, *U.S. v. Nordic*).¹ Moreover, FGCs can settle litigation against them without involving the Justice Department (28 USC 516). They are granted freedom from the political forces driving congressional actions. They are allowed to focus on a single product or service and on a limited customer base or constituency by being insulated from the demands of a multimission agency. Finally, FGCs are allowed financial freedoms unavailable to other federal agencies. In particular, they can borrow money from commercial sources, issue debt in the form of bonds, be exempt from local, state, and federal taxes, and benefit from “off-the-balance-sheet” status, multiyear federal funding, and exemption from deficit reduction spending caps.

The basis for the congressional authority to create government corporations derives from the “necessary and proper” clause of the Constitution—Article I, Section 8, Paragraph 18—which states:

To make all laws which shall be necessary and proper for carrying into execution the foregoing powers and all other powers vested by this Constitution in the Government of the United States or in any Department or Officer thereof.

There is a long history of Supreme Court rulings and case law using this paragraph as the foundation of the ability of Congress to create corporations (Court, *Osborn v. Bank of the U.S.*, *Federal Land Bank v. Bismark*, *Pittman v. Home Owners*’).

FGCs are neither new nor rare. Congress has created over 50 since World War II. Most people are quite familiar with some, not realizing that they are FGCs. Three basic groups of organizations are considered FGCs. The first group is the Government Sponsored Enterprises (GSEs), very large financial organizations such as Federal Home Loan Banks, Fannie Mae, Freddie Mac, Financing Corporation (FICO), Resolution Funding Corporation (REFCORP), and six other

¹Court cases are indicated by “court” followed by the case name. More complete citations appear in the list of references.

specialized lending organizations. These organizations have special financial privileges and were established to facilitate the creation of credit for specific economic groups or for a specific financial purpose such as recapitalizing insolvent savings and loans. Congress usually categorizes GSEs as mixed-ownership FGCs. In practice, the amount of private ownership varies from none to 100 percent.

The second group has only one member, the United States Postal Service (USPS). This organization is officially categorized as an Independent Establishment of the Executive Branch of the U.S. Government. The special category is drawn in part from the specific constitutional citation that empowers the Congress to create "Post Offices and post roads" (U.S. Constitution, Article 1, Section 8). In the same way, the constitutional provision for Army arsenals ("the erection of forts magazines, arsenals, dock-yards and other needful buildings") (U.S. Constitution, Article 1, Section 8) could form the basis for a new Independent Establishment.

The third group comprises about 50 government corporations that are chartered by Congress to achieve specific national policy goals. For example, the first Clinton Administration's belief that a domestic "Peace Corps" might solve some of the problems of the inner city led Congress to create the Corporation for National and Community Service (AmeriCorps) in 1993 (PL 103-82). The most recent FGC is the Valles Caldera National Preserve and Trust, which authorizes the acquisition and independent management of the Valles Grande, an undeveloped area in northwestern New Mexico (PL 106-248). Other familiar FGCs are the Tennessee Valley Authority (TVA), the National Railroad Passenger Corporation (AMTRAK), and the Smithsonian Institution. Other, less familiar FGCs include the Federal Prison Industries, Inc., the Saint Lawrence Seaway Development Corporation, and the Pennsylvania Avenue Development Corporation. In this list, we exclude the national banks that have a federal charter but no government ownership or government-appointed members of their boards of directors (12 USC 21). Neither do we include the more than 80 patriotic or charitable organizations that have a federal charter but receive no federal funds and are responsible for their own business affairs (36 USC 1). In addition, the federal government has directed the establishment of some corporations not directly chartered by Congress but nevertheless owned, funded, or directed by the government, such as the Corporation for Public Broadcasting (47 USC 396) and the American Institute in Taiwan (22 USC 3301).

A central premise in our constitutional form of government is that organizations that implement public policy should be held accountable to the public for their actions. A private organization is responsible only to its owners. Moreover, public organizations supported by public funds should not benefit private

organizations. All benefits from public funds should flow to the public. The FGC straddles the divide between federal and private roles and responsibilities.

A common concern in the formation of an FGC is the possibility of unfair competition with the private sector. This can be addressed by properly crafting the charter so that the competitive playing field is level between the FGC and the others in the market. For example, the charter should make the FGC subject to local, state, and federal taxes, as are all others in the market. When selling to the government, the FGC should abide by all the federal acquisition regulations (FARs) and not treat the acquisition as an interagency transfer. The FGC should have the right to sue and to be sued, thus waiving sovereign immunity. Finally, if the ownership of the property, plant, and equipment is an issue in the competitive environment, then the charter might provide for a capital lease of these assets. The competitive structure of the markets in which the FGC will compete will determine the intensity of concern over each of these issues.

The government may hold the stock, and the President may appoint some of the members of the board of directors, but the organization itself is in the private sector in that it pays local, state, and federal taxes; it has access to the capital markets through debt, bonds, and stock; it can sue and be sued without the benefit of Justice Department legal assistance; it may even have a capital lease for its machining centers and tooling. This is as level a competitive playing field as can be achieved for the FGC. So, not only is the FGC not a government organization, but it also has no advantage over other corporations in the markets in which it competes.

To be prepared for these possibilities with a clear path of action, an FGC needs a well-crafted congressional charter making clear the roles and responsibilities of the corporation itself, the executive management, and the board of directors. Crafting clear charters for FGCs has not been an area of excellence for the Congress in past decades. Although the FGCs that Congress has created have served the government well as instruments of federal policy, this service has been executed with some difficulty. Many of these difficulties derive from an unclear path of accountability to the President, to the Congress, and to the American people.

Crafting good FGC charters has been the subject of considerable effort in the public administration arena (U.S. GAO, 1983; Leazes, 1987; Froomkin, 1995). Several sample charters, along with examples of the types of considerations that should be raised in drafting these documents, are available (NAPA, 1981; Moe, 1983). All issues and concerns can be addressed in a well-crafted corporate charter and a well-designed board of directors (BOD). The lessons learned from extant FGCs can provide considerable insights into the proper course.

CREATING A FEDERAL GOVERNMENT CORPORATION

FGCs are instruments of national policy. The Army, the executive branch, and the Congress need to be clear on what policy they seek to promote in forming an FGC. The formation of an FGC requires an agreement between the executive branch and the legislative branch that the action best serves the interests of the government and the American people. FGCs are executive branch organizations with a chief executive officer (CEO) and a BOD generally appointed by the President, although the allocation of appointments depends on the congressional charter. Some FGCs have only one or two BOD members as presidential appointees and a CEO chosen by the board. Other FGCs may have all principals as presidential appointees. These and many other issues need to be resolved by the executive branch and the Congress.

FGCs are created by enabling legislation, which lays out the national policy being implemented, the powers and responsibilities of the corporation, the composition of the BOD, a list of assets, and a host of other issues. This legislation also appropriates the needed funds to set up the corporation and get it into operation. A nationwide search is initiated for an interim manager who will guide the transition from a government organization to a corporation. This interim manager is sometimes made the CEO of the newly formed corporation, and a BOD is appointed. In parallel with this search, a corporate charter is drafted and filed with the board of corporations in the District of Columbia or other competent jurisdiction. The President appoints the interim manager, whose many initial tasks will involve the renegotiation of union contracts and the transition of former government employees to the private sector. Typically, government employees are offered the opportunity to maintain that status in a different position. The senior leadership team is assembled, and a business plan is adopted.

OPTIONS FOR ORDNANCE FGCs

A spectrum of options is possible for the formation of FGCs that encompass the two GOGO arsenals and the eleven GOCO ammunition plants under analysis. (The three GOGO ammunition plants are not considered here because of the additional encumbering legislation and the nonmanufacturing missions they serve.)² On one end of this spectrum, all these organizations could become one large FGC. At the other end, there could be 13 FGCs, one for each. Choosing

²PL 99-661, Section 317, prevents the conversion of workload performed by government personnel when the law was enacted from ever being converted to contractor performance. Further, Crane AAA is owned by the Navy. Finally, all three GOGO plants are heavily engaged in depot and demilitarization, functions that lie outside the scope of this analysis.

the best option from within this spectrum is a matter of understanding how these various options fulfill the eight goals of the FGC option analysis set forth at the beginning of the chapter.

In addition, it is important to understand what businesses or markets these organizations are in and how they can best compete in these markets. Other important considerations are managerial ease and the overall cost effect on products for the government.

Consider first the arsenals. These GOGO organizations offer to largely government customers a full range of industrial machine shop services, from forge and foundry through detailed machining and heat treatment to final coating and electroplating. The arsenals do not now have a customer base in the private sector, although recent test programs described in Chapter Three are intended to move them in that direction. This makes an arsenal FGC unusual. Most FGCs have a substantial customer base outside of the government. This means that the arsenal FGC will perhaps have a steeper learning curve than would other FGCs.

In the commercial marketplace, the arsenal FGC would be viewed as a vertically integrated industrial machine shop: one-stop shopping for the manufacture of metal and composite parts. The arsenal workforce has a specific set of skills, knowledge, and abilities that allows it to deliver its products and services. In addition, the arsenals have a specialized group of property, plant, and equipment that similarly supports these products and services. Finally, the customers and clients the arsenals serve all demand a similar product with similar standards for performance and quality—all classic characteristics of a well-defined market (Hax and Majluf, 1996).

Consider now the ammunition plants. These are GOCO plants owned by the government and operated by an on-site contractor. The business model for these organizations is very different from that of the arsenals. Here the government is in the facilities management business, providing property and plant. All aspects of the manufacture of ammunition are left to the on-site contractor, who in essence runs an industrial park whose main product line is ammunition, with some additional products and services that fit into the available property, plant, and equipment (PP&E). The boundary between the contractor as tenant and the government as industrial park owner differs in detail from plant to plant, but the overall business model still obtains. The government workforce has skills, knowledge and abilities in the management of industrial facilities. The PP&E are specialized for ammunition production, although some of the facilities could be used for more general manufacturing or business tasks. Finally, the customers and clients served by the owners of the ammunition plants—in this business model the on-site contractors—all demand a similar

service with similar standards for performance and quality, classic characteristics of a well-defined market.

Unlike the business model for the arsenals, the presence of a third party in the GOCO relationship, the on-site contractor, complicates the business model for the ammunition plants. This option will not satisfy the goal of managerial simplicity. In the case of the arsenals, the Army (as the customer) and the FGC will be present in any business dealings, but for the ammunition plants it will be the Army, the FGC, and the on-site contractor. In any business dealing, each party involved must make a margin on the transaction. Even if one of the parties is a nonprofit, the margin will include the costs of doing business. So, in principle, a trilateral business model will always involve higher costs than will a bilateral one, even if one of the parties is a nonprofit. Consider, for example, a business dealing between the arsenal FGC and the Army for a gun tube. The two parties negotiate in good faith for delivery of a product with defined specifications, schedule, and cost. The cost includes margin for the costs of doing business with the government and a regulated profit. Consider now a business dealing between the ammunition plant FGC and the on-site contractor who is supplying, under an ongoing contract, ammunition to the Army. In this business interaction, the role of the FGC is to provide efficient facilities to the contractor to produce ammunition. The difficulty is that to capitalize for improved facilities, the FGC must charge higher rents to the contractor. The contractor may decide to capitalize rather than expense these costs, believing that he or she knows better than some government-owned FGC what capital investments to make with regard to ammunition production and may be in a different tax situation than the FGC. The on-site contractor may decide simply to pass on the additional costs to the government in the guise of future cost savings. All these decisions depend very much on the strategic positioning of the contractor in the marketplace and the competitive structure of that market. Moreover, the organizational interactions are much more complicated with the third party involved. Regardless, the costs for ammunition with an FGC as an intermediary are likely to be higher than if the whole operation were simply privatized. Consequently, this option does not meet the goal of lower costs for the Army.

Given the increased complexity and probable higher costs of moving the GOCO ammunition plants to an FGC, we do not recommend that option and focus now on describing the arsenal FGC.

CHARACTERISTICS OF THE ARSENAL FGC

This section describes a hypothetical FGC for the two arsenals. We do this to illustrate how such an organization might be created and what lines of commercial business it could pursue.

Organizational Structure

One important instrument for implementing a corporate strategy is organizational structure (Miles and Snow, 1978). There are many standard templates for organizational structure, ranging from functional to customer focus. A functional structure is preferred if the route to competitive advantage in the marketplace requires excellence in a variety of technical specialties. Universities are often organized this way, with separate departments for mathematics, physics, or biology. A customer-focused organizational structure is preferred if advantage is gained from emphasizing the needs and requirements of customers. Service companies are often organized this way. For the arsenals, a customer-focused organization might have top-level divisions serving government customers and commercial customers, with the lower tiers organized functionally. One of the first things the FGC's senior leadership will do is set forth a corporate strategy and design an organization that can implement it.

The arsenal FGC, which we call here the United States Ordnance Corporation (USOC), would have two geographically separated and differently equipped operations: Rock Island Arsenal (RIA) and Watervliet Arsenal (WVA). A notional organizational structure for USOC appears in Figure 6.1.

In the figure, USOC would keep the geographical partition inherent in its organization and recognize that each division sells products and services in two

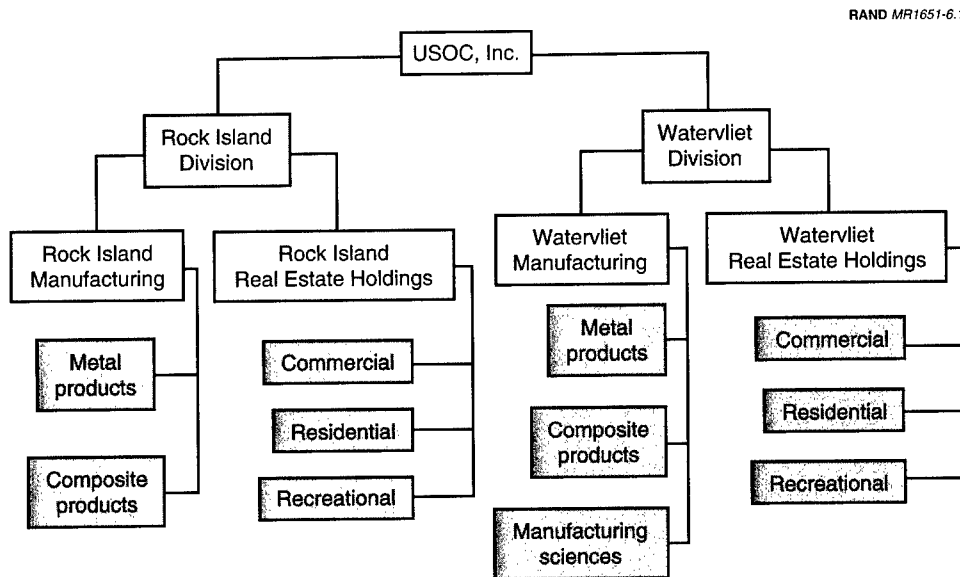


Figure 6.1—USOC, Notional Organizational Chart

markets—metal and composite products and real estate management. The Watervliet division would have a department for manufacturing sciences, recognizing its close ties with Benet Laboratories and local universities. The Rock Island division might consider adding such a department because many manufacturing firms have some connection to manufacturing sciences to help keep their techniques and processes competitive. The real estate division would be subdivided into commercial, residential, and recreational departments, recognizing that each division has property that is or could be used in these ways. The balance sheet for USOC in our model lists all land, buildings, and equipment as assets. While the charter could transfer some of the financial (but not the legal) liability for environmental remediation from the Army to the FGC, we assume here that the Army would retain the financial responsibility as well. This would prevent the fledgling FGC from being saddled with immediate debt during its transition.

The relationship to the government and in particular to the DoD and the Army would be established in the charter by setting performance goals for the new organization and requirements that there be quarterly or twice-yearly reviews and an annual report meeting Financial Accounting Standards Board (FASB) standards. Congressional testimony in this regard may also be required. In addition, government control of the FGC would be maintained through the BOD. This is a more strategic relationship than the current operational relationship. The Congress or the BOD would treat the FGC like any other government contractor with no special considerations except those deemed necessary. Such special considerations may be, for example, the movement of the workforce from civil service to the private sector and the associated grandfathering of benefits.

Corporate Missions

In the enabling legislation, every FGC has a statement of corporate mission or purpose. This statement is intended to capture the essential elements of the national policy that the FGC is created to implement and to set forth the general principles of how it will achieve that end. A draft statement of corporate mission for USOC might have the following elements:

- To help maintain a reliable and economical domestic source of integrated heavy machine shop services for ordnance materiel.
- To continue to ensure the nation's common defense and security.
- To market and sell its products and services to the Department of the Army and other government customers, and commercial domestic and foreign companies and organizations.

- To operate as a profitable and efficient business enterprise.
- To maximize the long-term value of the corporation to the U.S. Treasury.
- To operate as a self-financing corporation and end the need for federal funding.
- To conduct research and development to meet business objectives to identify, evaluate, improve, and test other manufacturing technologies.
- To comply with laws and regulations to protect public health, safety, and the environment.
- To take all other lawful actions to further these purposes.

The national policy to be implemented by USOC is set forth in the first bullet. This FGC would be created to have customers in the government and commercial sectors and to operate as a profitable and self-sustaining organization. This means that after a period of time, say five years, USOC would no longer depend on a special appropriation to cover its costs, or it will be fully privatized, as in the case of USEC. Every new company needs some working capital to cover operating expenses and restructuring costs. The statements concerning sustainability would ensure that these costs would quickly be borne by operating revenues, not special appropriations.

Corporate Charter Outline

The corporate charter is the most important part of the enabling legislation. The charter sets forth the powers and organization of the FGC and defines its privileges and assets. A section may call for a review of the FGC's corporate status after some period of time. This review would examine whether the FGC had succeeded in its mission and whether to recommend continued status as an FGC. It could turn out that the Army leadership would be completely satisfied with the commercialization of the arsenals and would wish to take the next step to full privatization through an acquisition or an initial public offering of stock. Similarly, the Army leadership might wish to maintain the control allowed by the FGC organizational form as a hedge against a continually uncertain future. Finally, the leadership could be totally dissatisfied with the FGC construct and wish to return the arsenals and ammunition plants to Army ownership.

The basic elements of a corporate charter could include the following:

ESTABLISHMENT OF THE POWERS AND ORGANIZATION OF THE CORPORATION	PRIVILEGES AND ASSETS OF THE CORPORATION
<p>Establishment of the corporation. Corporate offices. Powers of the corporation. Board of directors. Employees of the corporation. Audits. Annual reports. Accounts. Obligations. Status in regard to local, state, and federal taxes. Cooperation with other agencies. Applicability of certain federal laws. Security. Control of information. Transition. Working capital account.</p>	<p>Marketing and contracting authority. Pricing. Capital structure of corporation. Patents and inventions. Liabilities. Transfer of property, plant, and equipment.</p>
	<p>PRIVATIZATION OF THE CORPORATION</p>
	<p>Strategic plan for privatization.</p>

During the 20th century, FGCs have been a common instrument of national military strategy to capture the manufacturing efficiencies of the U.S. economy for both the execution of and preparations for the two world wars (Lilienthal and Marquis, 1941). In the current era, the FGC can continue to be an instrument of national military strategy. In a time of decreasing federal budgets, increasing personnel constraints, and growing emphasis on greater efficiency and productivity, the FGC structure can be used to renew the focus on primary responsibilities for the Army as well as the other services.

BUSINESS PLANS

The first consideration in starting a new business is to determine what business to be in. Such analysis involves not only the internal capabilities of an organization but also how the prospective markets that the new business will be in are structured in terms of market size and growth, the number and size of competitors, profit margins, and the productivity per worker needed to be competitive.

The arsenals are in the heavy industrial machine shop business. Because they offer a full spectrum of services from forge and foundry to integrated assembly and engineering design, the arsenals are in an excellent position to enter several heavy industrial markets.

Generally, if a new business does not have some special market-entry advantage, it wants to enter large and rapidly growing markets (Porter, 1985). This entry strategy arises from anticipating how the existing companies in that market are going to respond to a new competitor. If markets are small and growing

slowly, entry of a new business could mean that entrenched competitors might lose a significant fraction of the market, so they may resist the new entrant with predatory pricing strategies, disinformation, political opposition to the creation of an FGC, and a host of standard competitive practices. If the market is large and growing at a reasonable rate, chances are that there are already many businesses in the market with room for more (Porter, 1985; Primožic et al., 1991; Hamel and Prahalad, 1994).

Market Type

The research team analyzed more than a dozen prospective heavy industrial markets and selected four for a preliminary look at the manufacturing capabilities of WVA and RIA—machine shops, fabricated structural metal manufacturing, industrial valve manufacturing, and oil and gas field machinery and equipment manufacturing. The economic data on these markets were derived from the Economic Census of 1997 (U.S. Department of Commerce, 1999d, 1999g, 1999j, and 1999m). In this work, these markets are described as follows:

- **Machine shops.** This U.S. industry comprises establishments known as machine shops primarily engaged in machining metal parts on a job or order basis. Generally, machine shop jobs are low volume and use machine tools such as lathes (including computer numerically controlled); automatic screw machines; and machines for boring, grinding, and milling.
- **Fabricated structural metal manufacturing.** This U.S. industry comprises establishments primarily engaged in fabricating structural metal products, such as concrete reinforcing bars and fabricated bar joists.
- **Industrial valve manufacturing.** This U.S. industry comprises establishments primarily engaged in manufacturing industrial valves and valves for water works and municipal water systems.
- **Oil and gas field machinery and equipment manufacturing.** This U.S. industry comprises establishments primarily engaged in manufacturing oil and gas field machinery and equipment, such as drilling machinery and equipment; production machinery and equipment; and field derricks. The industry also includes the manufacture of water well drilling machinery.

The machine shops do not manufacture many of anything. Machine shops are in the job-shop business, making limited builds of all items. This is closer to the processes in place at the arsenals than to those involved in the manufacturing of many units of the same item. This market also does not involve the integration of many diverse parts into an assembled system, again better matching the experience base at the arsenals. Finally, the types of equipment and the scale of the pieces being machined matches the scale of the equipment as well as the

skills, knowledge, and abilities of the arsenal workforces. In terms of processes, personnel, property, plant, and equipment, the arsenals closely resemble businesses in the machine shop market. The other three markets all involve a higher level of manufacturing and system integration skills and are in more-competitive businesses.

Market Size

The annual revenues of these markets range from about \$7 billion in the oil and gas industry to about \$30 billion in the machine shop industry, as shown in Figure 6.2.³

The machine shop market is about \$30 billion in size, and the structural steel market about \$17 billion. The others are between \$5 billion and \$10 billion. By comparison, the budget for Rock Island in 2001 was about \$150 million and for Watervliet about \$80 million (U.S. Department of the Army, AWCF, 2001, Exhibit 1). These amounts are tiny fractions of the total market sizes, less than 1 percent of the machine shop market.

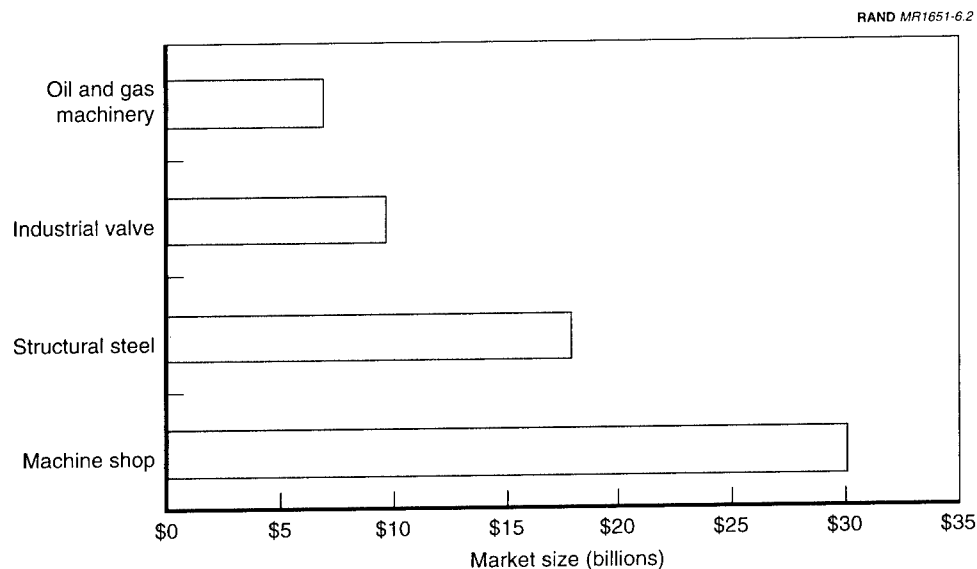


Figure 6.2—Comparative Market Sizes

³The data for these figures are taken from U.S. Department of Commerce (1999d, 1999g, 1999j, and 1999m) and adjusted using the Bureau of Labor Statistics (BLS) inflation factor (equal to 1.11) to bring the market sizes up to 2001.

Turning to market growth, between 1992, the last year of the economic census, and 1997, the machine shop market grew at an annual rate of 6 percent, structural steel grew at 8 percent, industrial valve at 3 percent, and oil and gas machinery at 9 percent (U.S. Department of Commerce, 1999d, 1999g, 1999j, and 1999m). The arsenal budgets in 2001 were again small fractions of even the growth rate in these markets.

In the past two years, the general economic decline has slowed growth and caused the markets to contract. The Department of Commerce conducts the economic census every five years and will not have detailed data available until late 2003 for the markets under consideration here. More general indicators of the economy show that the fabricated metal products market, of which these four markets are a small part, stopped growing in 2000 and 2001 (Lum and Moyer, 2000; Moulton et al., 2001). More specifically, the machine shop industry has reported a slowing of growth in the years 2000 and 2001 and an anticipated contraction of the market in the first half of 2002 (Jablonowski, 2001). In the latter half of 2002 and beyond, this survey forecasts renewed growth and expansion.

Gross Margin

Another indicator of market structure is gross margin. This is a measure of funds available after costs for labor and materials are paid. These remaining funds can be used to build infrastructure, conduct R&D, develop new products, and of course yield profit. The larger the gross margin for a market, the more attractive it is, because funds beyond the cost of goods sold will allow for greater growth and profit potential. An additional concern is the amount of capital needed to compete in the market. However, we consider that the arsenals are already capitalized enough for competing in heavy machine shop markets and only need to find a place to market their products and services. The gross margins for the markets considered in this analysis are shown in Figure 6.3.

On the basis of gross margins shown in the figure, the most attractive market to enter is the industrial valve market, which has about a 37 percent margin. The least attractive market to enter based on this metric is the structural steel market. The machine shop market consists of about 24,000 companies, and the structural steel market has about 2,800 companies. There are about 400–500 firms in the oil and gas machinery and industrial valve markets (U.S. Department of Commerce, 1999d, 1999g, 1999j, and 1999m). In markets with such large numbers of competitors, it is difficult for firms to collude to bar the entry of new competitors. However, new entrants such as USOC would have to match competitive market prices to attract business.

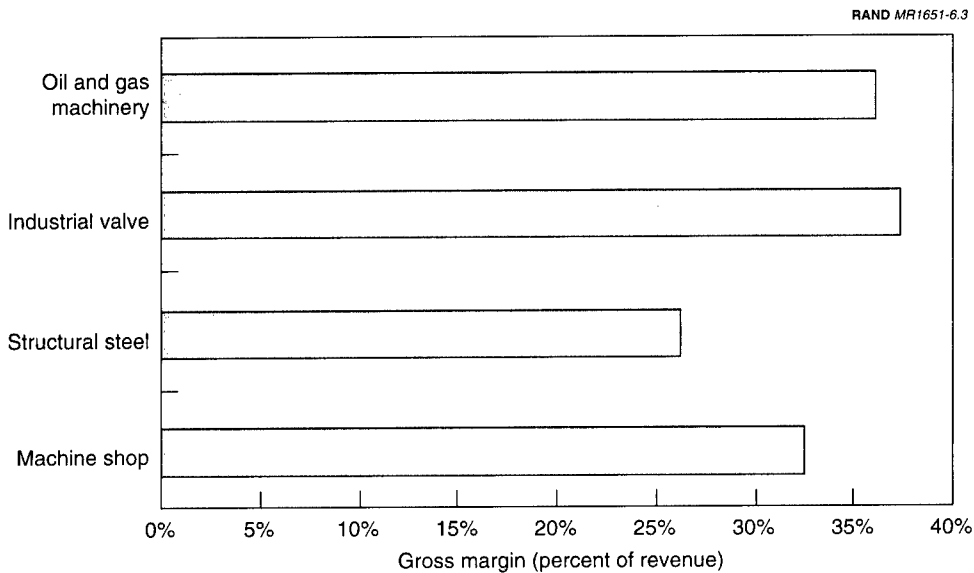


Figure 6.3—Gross Margins as a Percentage of Revenues

Organized political opposition would be minimized if the bite of total market size captured by the new entrant is a small fraction of the market size, even better if it is a small bite of the growth. All the FGC needs is \$90 million for WVA and \$150 million for RIA to enter the machine shop market. This represents far less than 1 percent of the total market size, and when the markets are growing, as in the 1990s, a small fraction of the annual growth rate. After getting familiar both with the industrial environment and with modest competitive pressure, the business plan could initiate entry into other markets where the profits are greater and the competition stiffer. The other markets—structural steel, oil and gas machinery, and industrial valve—are smaller and require technical skills somewhat different from those of the machine shop market, which is the best match for the arsenals' current workload. Therefore, we allow more time for the USOC to enter these markets.

Market Structure

To be competitive with the firms currently in these commercial markets, USOC would restructure its workforce and costs. The companies in these markets are themselves structured in particular ways that have proved efficient and essential to survival. Two indicators of internal company structure that are revealing of how USOC must be structured are the level of indirect staffing and the hourly direct labor rate. The level of indirect staffing in the industries considered in this analysis is shown in Figure 6.4. For comparison, the indirect staffing levels at Rock Island and Watervliet are also shown. As can be seen, the primary mar-

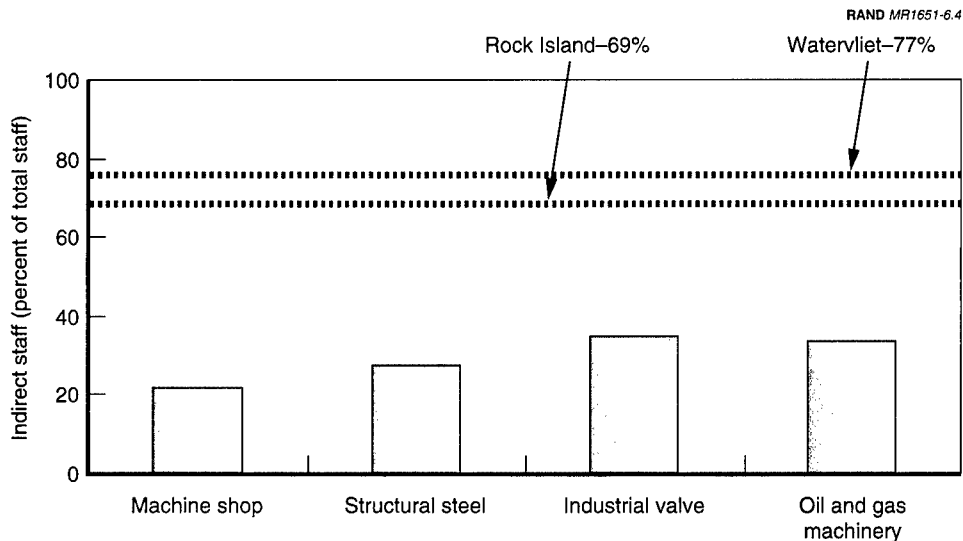


Figure 6.4—Indirect Staffing Levels

ket for the arsenals, the machine shop market, has about a 22 percent indirect staff, as a percentage of total staff, whereas RIA has 69 percent and WVA has 77 percent (U.S. Department of the Army, AWCF, 2001, Exhibit 24a). The other markets have overhead staffing levels that range from 30 percent to 40 percent. It is clear from this disparity that without restructuring, neither arsenal would be able to compete in the commercial sector. One major effort in the business plan is to restructure this overhead charge to make USOC competitive.

The other indicator of internal competitive capability considered here is the direct labor rate for a market. All companies in these markets compete in part on the basis of price. If the labor rate for a company is high, then its products will be higher-priced than those of its competitors and will not sell. It would be critical to the competitive posture for USOC to have labor rates consistent with other companies in the markets in which it competes.

The fully burdened direct labor hour (DLH) rate is defined to be the annual revenue for a calendar year divided by the total direct labor hours available during the year. To calculate DLH for the commercial markets, we take the annual revenues for the year from the 1997 economic census for the industry inflated to 2001 by the BLS inflation factor. We do not use a growth rate calculated from 1992–1997 growth because it may be overly optimistic for the period 1997–2001. The BLS inflation factor is a conservative way to estimate the 2001 revenues. This method does not account for work in progress, which consumes direct labor hours but does not produce revenue until subsequent fiscal years. Nevertheless, using the annual revenue figure for comparison purposes is justified

because in a steady-state condition, carry-in work roughly equals carry-out work; annual revenues are like an average revenue value.

The number of direct labor hours available in 2001 is taken to be the same as those available in 1997. In principle, we know that there are more workers in any industry in 2001 than in 1997, but there is no reliable way to estimate this increase. The conservative course is to keep the number of workers the same. This approach overestimates the industry rates. The direct labor hours available in a year are determined by multiplying the direct labor personnel count in 1997 by 2,080.⁴

To get a DLH rate for the arsenals that can be compared with industry, we take the revenue for all new orders in the year 2001 and divide it by the direct labor end strength personnel count times 2,080 to get a final rate in units of \$/DLH. As for the industrial case, this approach does not account for work in progress. This work in progress is excluded because the rate basis for this carry-in and carry-out work can differ in untraceable ways from the rate basis for the new orders in the current year (2001). The presumption is that all new work cost estimates to clients are based on a common rate basis. Even this assumption is violated by the arsenals' use of stabilized and unstabilized rates depending on the client. In any event, the new orders for the current fiscal year are taken to be the annual revenues for the arsenal. This is justified on the same steady-state basis used for the industry figures (U.S. Department of the Army, AWCF, 2001, Exhibit 29).

The DLH results for the industries in this analysis and for the arsenals are shown in Figure 6.5. We see that the DLH rate for the primary business for the arsenals, the machine shop business, is about \$64/hr, whereas the rate at RIA is \$201/hr and at WVA is \$331/hr (U.S. Department of the Army, AWCF, 2001, Exhibits 24a and 29). For example, for RIA the total new orders for 2001 are \$152.32 million. The end strength body count for direct labor in 2001 is 364. Assuming 2,080 hours in a year results in a DLH rate for RIA in 2001 of

$$DLH_{RIA} = \$201.17/\text{hr}.$$

For WVA, total new orders for 2001 are \$89.22 million. The end strength body count for direct labor in 2001 is 129. Assuming 2,080 hours in a year results in a DLH rate for WVA in 2001 of

$$DLH_{WVA} = \$332.51/\text{hr}.$$

⁴For example, in the machine shop industry, annual revenues were \$27.131 billion in 1997 and the workforce had 225,752 members. Inflating revenues to 2001 and taking 2,080 hours per year results in a DLH rate for the industry of \$64.14.

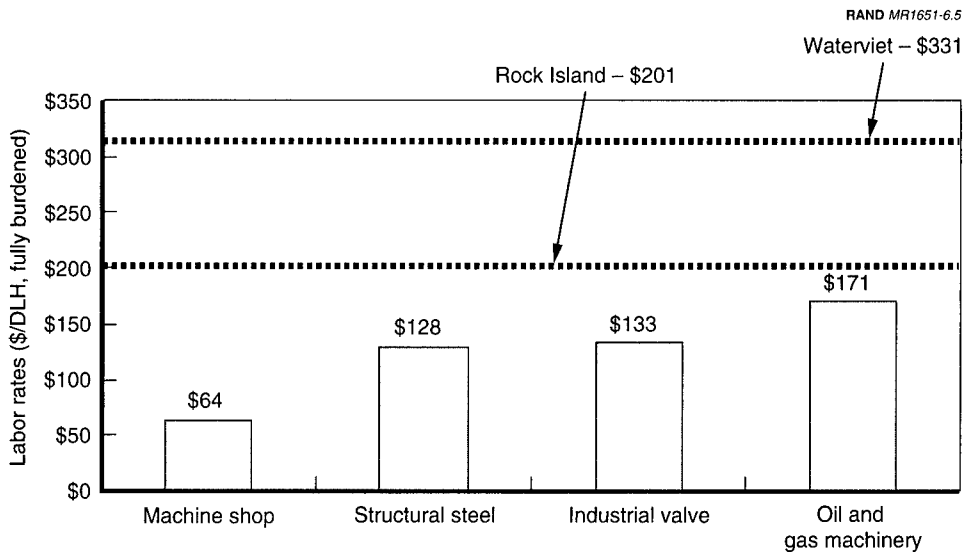


Figure 6.5—Direct Labor Rates, Fully Burdened

The DLH rates at the arsenals are four to six times greater than those in the commercial machine shop market. The DLH rates at the arsenals are greater than those in any of the markets in this analysis. To be competitive, USOC must bring its DLH rate into line with other companies in the markets. After restructuring the rates, the costs for work at USOC will drop by roughly a factor of five from current costs at the arsenals.

The business plan we have developed for USOC spans five years and focuses on migrating the workforce from government work to large, rapidly growing industrial areas such as the machine shop and structural steel markets. In addition, to make USOC competitive in the commercial marketplace, the restructuring of overhead staffing and direct labor rates to match industry standards are top priorities. Our business model holds staffing levels constant at FY01 levels.

In principle, the market-entry strategy could span more than five years. A longer entry period would entail slower expansion into new markets, perhaps reflecting a less favorable business environment than anticipated in our baseline five-year model. Conversely, the business environment could be favorable and the expansion into new markets could actually require an expansion in staffing levels. The five-year business model presented here is our baseline. Parametric extensions for longer periods or for differing staffing levels or for other market entries can be considered as variations on this baseline.

The arsenals are large compared with the companies in this large, lower-margin market. As a consequence, the arsenals would diversify into other markets, preferably ones with higher gross margins, that is, industrial valves and oil and gas machinery. Each has a different overhead structure and company size. All share the same types of equipment and the skills, knowledge, and abilities of the workforce at the arsenals. Other markets could have been selected for analysis. These selected are examples.

The market-entry strategy is to enter slowly, capturing only a small percentage of the growth rates so as not to trigger retaliatory competition. The penetration into the industrial machine shop market would continue to expand yearly. The staff for these market penetrations would be drawn from the other government work activity at the arsenals.

In addition to the machine shop business, the arsenals would derive some revenue from the lease of their land and facilities, mostly to government tenants. The baseline plan does not change these rents. To identify the business areas in which the arsenals are involved, the research team used the data available in the AWCF budget estimates for new orders (U.S. Department of the Army, AWCF, 2001, Exhibit 29). This process sets up the financial plan for the beginning fiscal year of USOC, which we term "Year 0." In this analysis, the research team assumed the workforce to be constant for each arsenal (549 for WVA and 1,179 for RIA). The workforce could in principle be expanded if there is an aggressive marketing team at the FGC and economic trends permit. The baseline assumption is to keep the workforce constant. This assumption ends the decade-long trend of repetitive workforce reductions at the arsenals.

All Year 0 business activities are based on AWCF Exhibit 29 for FY01, which lists all the new orders for all the arsenals. In FY01, new orders totaled \$152.32 million at RIA and \$89.22 million at WVA. We first aggregate the many detailed work orders into broad categories for further analysis.

Each arsenal has a primary mission: WVA makes gun tubes and RIA builds gun mounts and other ordnance material. From the detailed list of new orders for each arsenal, any item having to do with the primary mission of the arsenal is put in that category. This categorization includes products such as spares and supporting activities for the primary mission such as foreign military sales. Based on this definition, the primary mission revenue from new orders is \$11.74 million for RIA and \$52.89 million for WVA. This analysis assumes that in Year 1 through Year 5, all primary mission work will be restructured to the average costs and staffing levels of the heavy industrial machine shop market. The overhead restructuring alone and consequent DLH reduction would bring the costs for mission work down by a factor of 3 to 5. We assume that this primary mission work will remain constant for the five years of the business plan. If this

assumption should become invalid, the workforce could be easily utilized in one of the other markets in which the arsenals compete and thus be available for an increase in primary mission work in future years.

A second category of funding for the arsenals associated with the primary mission is LIF and MIIF funding. These items are easily identified in the detailed list of new orders. LIF and MIIF totaled \$2.56 million for RIA and \$2.63 million for WVA. Again, we assume that in Year 1 through Year 5, all LIF and MIIF work will be restructured according to industrial standards and will remain constant for the five years of the business plan.

The third category we consider in our analysis is the aggregate of all new orders for products or services involving work for the government in secondary areas. For WVA, this category includes, for example, helicopter swage plates and research development and engineering (RDE) projects for Benet. For RIA, this category includes tool sets and bridge components. This category totals \$3.59 million for WVA, \$82.88 million for RIA.

The next category of revenues we consider arises from tenants at the facilities. With the sole exception of a golf course at RIA, all tenants at both arsenals are other government entities. RIA tenant revenues total \$27.99 million; those for WVA total \$3.55 million. We assume the rental costs to be constant for the five years of the business plan. In principle, these rental revenues could be increased to meet industry standards, and the real estate and buildings could be developed and expanded. This again depends on how aggressive USOC's teams of real estate and facility developers would be. The baseline assumption is that the rental revenues remain the same. According to industry standards in the Albany-Troy area and the scale of the revenues at WVA, about 37 indirect staff would be involved in this activity. Similar standards for the Rock Island area and the revenues at RIA would require about 149 indirect staff.

In our model of the real estate market at USOC, we set aside 500,000 square feet at WVA and 1.1 million square feet at RIA for their respective manufacturing operations. We assume that the remaining space would be leased at commercial rates prevailing in the metropolitan areas as shown in Table 6.1.

Table 6.1
Commercial Lease Rates

Category	WVA Area	RIA Area
Industrial	\$4.5/sqft	\$4/sqft
Office	\$10/sqft	\$12/sqft
Residential	\$10/sqft	\$10/sqft

SOURCE: Loopnet, 2001.

The final category of revenue considered is that of other government-funded activities. This category includes such things as morale and welfare expenses, child development services, Army community services, etc. For RIA these services total \$27.15 million, and for WVA they total \$26.56 million.

Table 6.2 shows each category of revenue as a percentage of total revenue.

To estimate the number of direct and indirect staff for each activity, we used the same percentage of the total direct and indirect staff at each of the arsenals. For example, at RIA the total end strength of direct labor staff in Year 1 is 364, whereas the total end strength of indirect staff is 815. From Table 6.2, 7.71 percent of the budget is involved in primary mission work. Consequently, 28 direct labor staff and 63 indirect labor staff are assumed to be involved in the primary mission area in Year 0. Implicit in this approach is that the direct labor rate charged for each of the revenue sources is the same.

Year 1 starts the restructuring of the overhead and the entry into new markets, notably the industrial machine shop market. The primary mission, secondary mission, and LIF-MIIF areas are assumed to meet the same standards as the commercial machine shop industry, with 22 percent overhead staffing and revenue productivity across all workers of \$103,545 per employee. This revenue productivity is calculated from the total revenue in the machine shop industry in 1997 divided by the total number of workers (both indirect and production workers) in 1997 times the BLS inflator (1.11) to project the value in 2001. This metric indicates how much revenue the entire workforce in a firm must raise to be successful in its industry. This metric also allows the calculation of the charges to the government for the primary mission work under the new management system in Year 1. For all the activity areas in our analysis in Year 1, we hold constant the number of direct labor personnel and adjust the number of indirect staff. For example, at RIA in Year 1 there would be 28 direct labor workers doing primary mission work, and 8 indirect staff. This would result in a charge to the government in Year 1 of \$3.73 million for primary mission work. This can be compared to the cost for the same work in Year 0: 7.71 percent of

Table 6.2
Revenues as a Percentage of Total

Revenue Source	RIA	WVA
Primary mission	7.71%	59.28%
Secondary mission	54.41%	4.02%
LIF-MIIF	1.68%	2.95%
Rental government	18.38%	3.98%
Other government activities	17.82%	29.77%

\$152 million, or \$11.72 million. Similar comparisons can be made for LIF-MIIF, which in Year 1 would cost \$0.55 million compared to \$2.55 million in Year 0, and for secondary mission work, which in Year 1 would cost \$26.28 million compared to \$82.70 million in Year 0. The level of effort and revenue for primary mission, secondary mission, and LIF-MIIF is held constant for the five years of the business plan developed here.

Real estate is a substantial part of the revenue stream at the arsenals. At RIA there are 4,600,000 square feet of industrial space, 1,500,000 square feet of office space, and 400,000 square feet of residential space. It is assumed that no other commercial development of land would occur at the arsenals. Setting aside 1,000,000 square feet of industrial space for the shops at RIA and 100,000 square feet for the offices would leave 3,600,000 square feet available for industrial lease and 1,400,000 square feet for office lease. Annual commercial rates in the Rock Island area are roughly \$4.00 per square foot for industrial space and \$12.00 per square foot for office space. A 75 percent occupancy rate would yield \$26.4 million in annual revenue. Annual residential lease rates in the Rock Island area are about \$10 per square foot, which at a 75 percent occupancy level would yield \$3 million in annual revenue from residential leasing. The total leasing revenue for RIA should reach \$29.4 million annually. From AWCF Exhibit 29, the tenant revenues from government tenants for Year 1 at RIA would be \$27.93 million. Because the detail needed to determine occupancy levels, rates, and the type of space leased is not available, we assume an additional \$1.47 million of annual revenue from other nongovernment tenants to make the total revenue for the real estate business \$29.4 million annually.

Staffing for the real estate business would be restructured in Year 1 as well. For Year 0 we assumed the same straight budget percentages of direct and indirect personnel: 18.38 percent of budget is tenant revenue, which implies 67 direct labor employees and 150 indirect labor. In Year 1 the real estate business would be run according to the standards for that business in the Rock Island area. This business would have only indirect employees; direct labor would all be done by contract. Based on the revenues and employment numbers in the Rock Island area for this industry, one employee should be able to handle \$198,844 worth of annual revenue. This means that for the government tenants, the real estate business should require 140 indirect staff, and 7 staff will be required for the nongovernment tenants. Government and nongovernment lease levels are held constant for the five years of the business plan developed here.

Now consider the real estate business at WVA, which has 1,900,000 square feet of commercial space and 256,000 square feet of residential space. Again, we do not include the possible development of land at the arsenals. Setting aside 500,000 square feet at WVA for the shops would leave 1,400,000 square feet for

lease. Assume that half of this space is office space at \$10 per square foot in the Albany-Troy area and half is industrial space at \$4.5 per square foot. The residential units should lease at \$10 per square foot. A 75 percent occupancy level for all of this property would yield annual revenue of \$9.5 million.

From AWCF Exhibit 29, the tenant revenues from government tenants for Year 1 at WVA would be \$3.55 million. As was the case with RIA, the detail needed to determine occupancy levels, rates, and the type of space leased is not available. Therefore, we assume there would be an additional \$5.98 million of annual revenue from other nongovernment tenants to make the total revenue for the real estate business \$9.5 million annually. We assume this increase in outside leasing occurs in two steps: \$2.99 million in Year 1 and the balance in Year 2 to make the full \$5.98 million.

We again restructure the real estate business at WVA in Year 1. For Year 0, we assume that the straight budget percentages of direct and indirect labor were involved—3.98 percent of budget is tenant revenue, which implies 5 direct labor personnel and 17 indirect. In Year 1 we assume the real estate business is run according to the standards for that business in the Albany-Troy area, again assuming that direct labor is done by contract personnel. Based on the revenues and employment numbers in the Albany-Troy area for this industry, one employee should be able to handle \$271,660 worth of annual revenue. This means

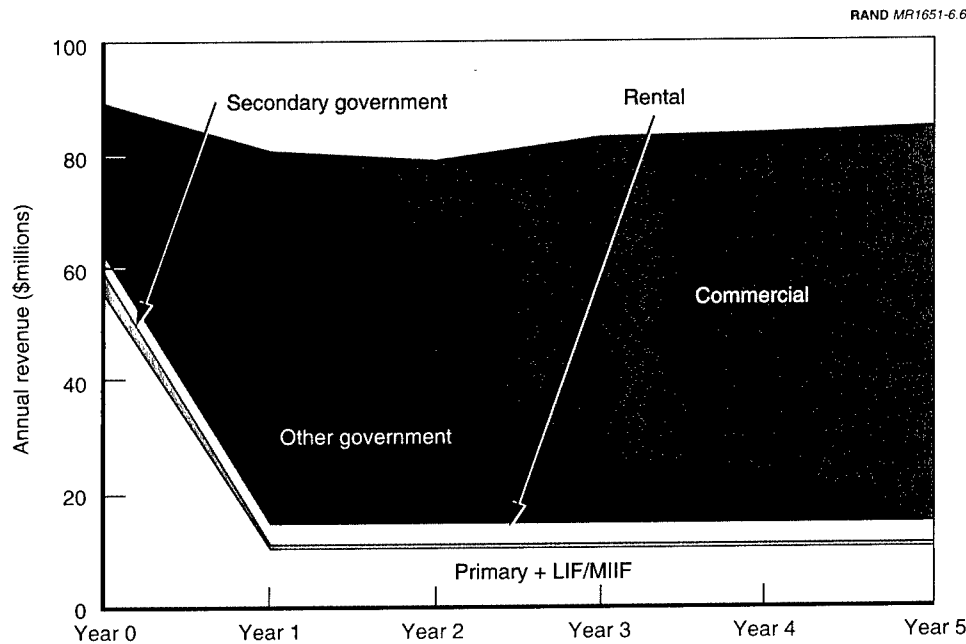


Figure 6.6—Revenues for WVA in the Five-Year Business Plan

that for the government tenants, the real estate business should require 13 indirect staff and for the nongovernment tenants, 22 staff will be required by Year 2. Government and nongovernment lease levels are held constant for the five years of the business plan developed here.

The business plan for Year 1 also marks the entrance of the arsenals into the first of the commercial markets: the industrial machine shop market. The plan is to capture about 0.5 percent to 1 percent of the growth in this market. For RIA, 192 individuals would be placed on projects in this market, resulting in \$19.91 million in revenues during Year 1. For WVA, 83 individuals would be placed on projects in this market, resulting in \$8.63 million in revenues in Year 1. These revenues are based on the productivity figure of \$103,545 per employee common in the industrial machine shop market. The revenues for Years 0 through 5 of the business plan are shown in Figures 6.6 and 6.7.

In our business model, the "other government work" activity is used as a buffer to absorb workers from one labor category while awaiting an opening in one of the direct or indirect labor categories in the new industrial markets being penetrated. It is modeled as IMC funding in the estimated budget impacts discussed in Chapter Eight. Initially, the other government work activity would grow sub-

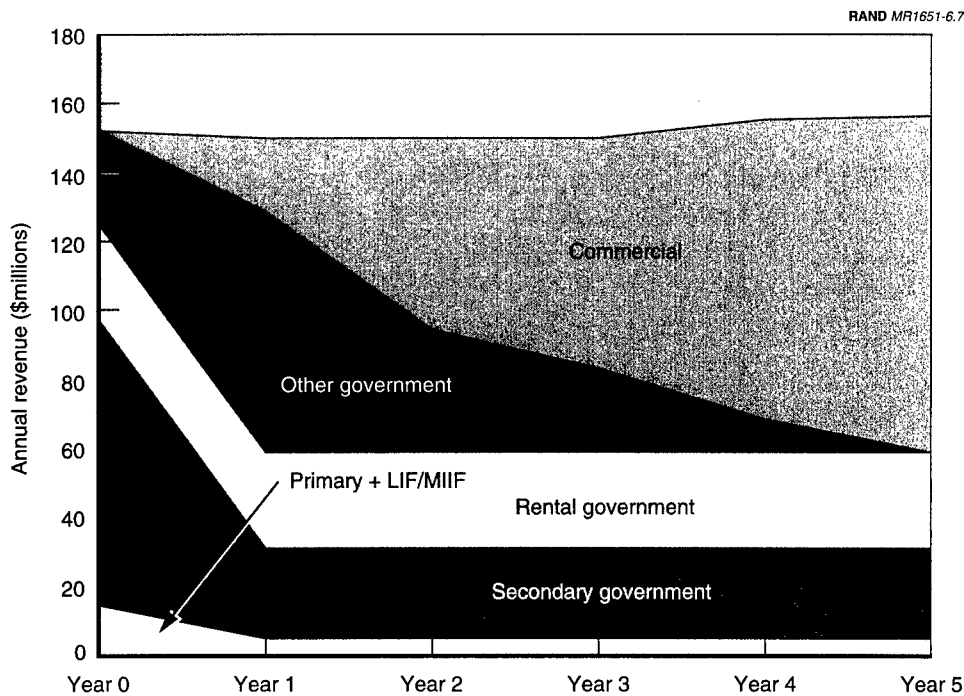


Figure 6.7—Revenues for RIA in the Five-Year Business Plan

RAND MR1651-6.8

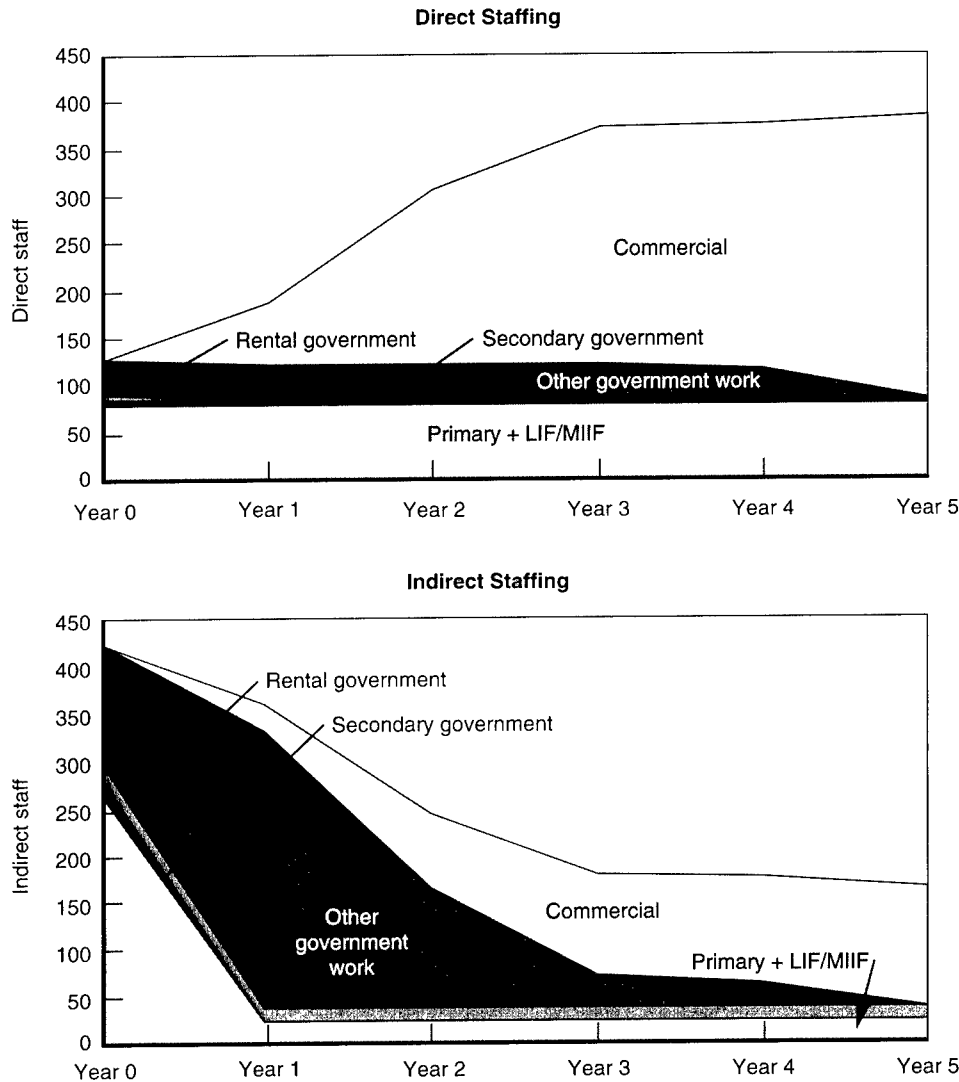


Figure 6.8—Staffing for WVA Business Plan

stantially in Year 1 as the overhead structure at the arsenals is redesigned. By Year 2 the total staff in this activity would be reduced to what it was in Year 0. In subsequent years the staffing would be reduced until by Year 5 the staffing is zero. Naturally, entry into commercial markets could be pursued at a slower pace, resulting in a longer time horizon for the financial plan. The restructuring of the staff can be seen in Figures 6.8 and 6.9 for WVA and RIA respectively. The direct labor staffing (top panel of each figure) in the primary and secondary

RAND MR1651-6.9

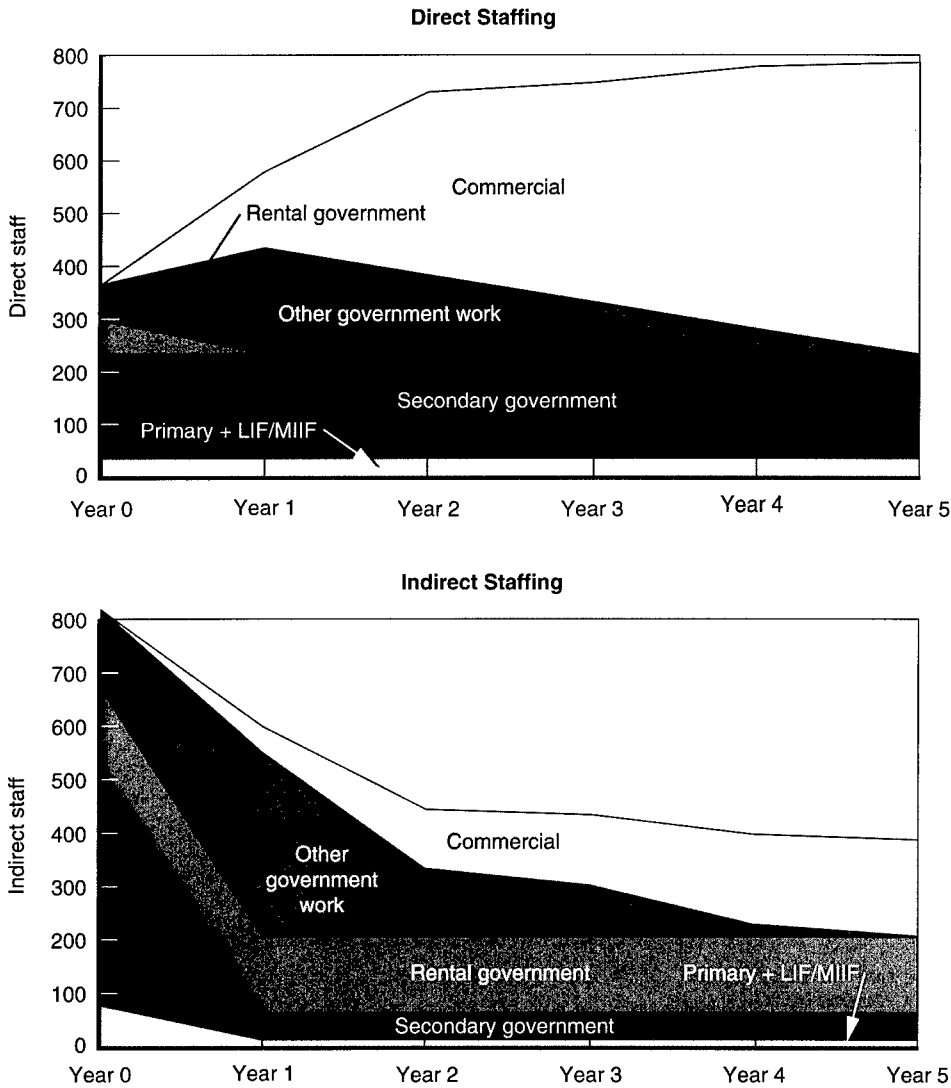


Figure 6.9—Staffing for RIA Business Plan

government areas would be held constant, whereas for the rental and other government work areas, the staffing would be reduced to zero by Year 5. The direct labor staff removed from these areas would be placed in the commercial businesses at the arsenals. The restructuring of the indirect staffing can be seen in the lower panel of each figure. All indirect staff in Year 0 is assumed to be absorbed by the indirect staff in the commercial markets in Year 1 through Year 5 or to be reassigned to the direct labor staff in these areas.

SUMMARY

The arsenals have two business lines: manufacturing and real estate. Our economic analysis indicates that there is room in the commercial markets considered here to absorb the productivity of the work force at both arsenals. Because the arsenals are very large, they would have to diversify and offer many products in a variety of markets, such as industrial machine shop, structural steel, industrial valves, or oil and gas machinery. This is a short list of possible markets to be explored by the arsenals. The arsenals offer forge and foundry as well as special coating and electroplating capability. Each arsenal's workforce remains constant. In principle, the work force could expand. There is machine time available. Because of the restructuring of the overhead, there would be a substantial decrease in charges to the government for primary mission, foreign military sales (FMS), and MIIF work at the arsenals over the course of the five-year business plan, as shown in Table 6.3. The total of secondary, other government, and rental costs would be reduced as well, as shown in Table 6.4.

This substantial decrease in cost to the government for primary mission products from the FGC is due completely to the restructuring of the overhead. For example, the number of direct labor hours required to build the gun tubes at WVA would be the same both before the formation of the FGC and after. In principle, there is no reason to change this level of effort. The FGC is assumed to pay the workforce at the same rates before and after. The work at WVA is basically that of a machine shop—a vertically integrated machine shop with services from forging and heat-treating to specialty coating and electroplating—but a machine shop nonetheless. There are special machining techniques in

Table 6.3

Charges to Government for Primary Mission Work, FMS, and LIF/MIIF

Arsenal	Year 0	Year 5
WVA	\$56 million	\$11 million
RIA	\$14 million	\$5 million

Table 6.4

Charges to Government for Secondary, Other Government Work, and Rental Costs

Arsenal	Year 0	Year 5
WVA	\$34 million	\$4 million
RIA	\$138 million	\$54 million

use and tooling available at WVA that are unique to the machining of gun tubes. However, the same is true for the machining of stator shafts for very large electric generators or for the manufacture of large diesel engine blocks and crankshafts. Consequently, the model for WVA adopts the best practices of companies in the machine shop market. In 1997, companies in this market had a 22 percent indirect staffing and a \$58/DLH fully burdened rate for direct labor. When inflated to 2001 levels, it only amounts to \$64/DLH. In 2001 at WVA, the indirect staffing was 77 percent and the direct labor rates were \$331/DLH. These direct labor rates are fully burdened and encapsulate the costs associated with the indirect staffing. It is the level of indirect staffing at WVA that drives the direct labor rates to their current levels. In the FGC, the restructuring of the overhead to resemble the machine shop industry would sharply reduce rates as well as the costs for primary mission products: gun tubes. A similar logic obtains for RIA.

Because the work encompassed by LIF and MIIF is basically machine shop-like in character, the costs for these accounts is assumed to be the same as for the primary government work at the two arsenals, with the consequential substantial savings to the government for this work.

The analysis also considered a pessimistic case in which the FGC does not succeed in entering all the markets it planned on and does not succeed in drawing down the "other government work" account to zero. In this pessimistic case, the staffing is kept constant, and the primary mission, FMS, and LIF/MIIF work is commercialized as in the baseline case. So, the costs to the government for these accounts would be as shown in Table 6.3. But in the pessimistic model, the FGC does not succeed at entering the oil and gas machinery and industrial valve markets, with the staff remaining in the other government work account. This means that in Year 5, this government cost has not been drawn down to zero, as in the baseline plan. In this pessimistic case, the costs to the government for secondary, other government work, and rentals are as shown in Table 6.5. Comparing these results with the results from Table 6.4, the cost savings in these accounts are less than if the FGC had succeeded in a full transition to a

Table 6.5

**Pessimistic Business Model Costs to the Government for
Secondary, Other Government Work, and Rental Costs**

Arsenal	Year 0	Year 5
WVA	\$34 million	\$32 million
RIA	\$138 million	\$90 million

commercial operation. Nevertheless, considering all the costs to the government, the FGC in the pessimistic model has still improved the situation over the current status quo.

The business plans we have presented here are termed pro forma plans because they describe only one of many possible futures for the arsenal FGC.

The key in pro forma analysis is to demonstrate that at least one plan can in principle achieve the goals laid out. The problem is one of demonstrating an existence proof: at least one possible future is reasonably achievable.

Again, the arsenal FGC is assumed to be an intermediate state between government and ultimate privatization. After getting the arsenals on a more commercial footing, settling retirement and benefit issues for employees, and generally demonstrating that each arsenal was a going concern, the arsenals are likely to be more valuable as either an acquisition target for another company or as stand-alone companies in their own right. If the arsenals were simply privatized from the outset, their valuation would be substantially less than if they were going concerns with most of the transition problems resolved and with a demonstrated track record at winning contracts and making a profit. The closer the arsenal FGC comes to a commercial basis without government subsidies, the more valuable it will be in any ultimate privatization effort.

Business forecasts contain uncertainties, the roots of which can be traced in part to the following:

- Cultural change at the arsenals may be more problematic and consequently slower than anticipated (Donaldson, 1994; Schein, 1992).
- The absence of familiarity in the arsenals with business transactions and best practices in the commercial sector could slow market penetration and growth.
- The economic situation nationally and internationally could sour substantially, decreasing demand for machined products.

All of these forces and many others could prevent the arsenal FGC from achieving the commercialization we envision in our business plan in the five-year time horizon we anticipate. The point is that ultimately the arsenals will be privatized, unless the government chooses to continue the FGC. The FGC is an intermediate stage that attempts to achieve as much value for the U.S. Treasury as possible by bringing the current state of affairs at the arsenals into closer alignment with commercial best practices. Even if the FGC achieves only half of the financial savings to the Army that we anticipate in our pro forma, that is still a substantial savings over the status quo. Moreover, this halfway achievement

will similarly boost the ultimate value of the arsenals for future mergers and acquisitions.

SUMMARY COMPARISON OF OPTIONS

This chapter compares the three feasible options—privatization, creation of a federal government corporation, and consolidation—against each of the five criteria: mission accomplishment, cost, consistency with national security policy, managerial ease, and external issues.

As described in Chapter Four, the fourth option, recapitalization and unification, is set aside as infeasible outside of a comprehensive BRAC strategy that encompasses eliminating the whole set of the Army's single-function installations.

The remaining feasible set of options appears in Table 7.1. For the GOCO plants, all three remaining options are feasible. For the GOGO ammunition plants, the peculiar conditions of protective legislation, other missions, and Navy ownership remove them from consideration, apart from possible A-76 competitions at Pine Bluff—a form of partial privatization.¹ For the arsenals, both the FGC and consolidation options remain viable, the latter with BRAC

Table 7.1
Options Assessed

	GOCO Plants	GOGO Plants	Arsenals
Privatization	√	A-76—Pine Bluff	A-76 or special legislation
FGC	√		√
Consolidation	√		√

√ = feasible.

¹As noted in Chapter Four, Pine Bluff Arsenal could be converted to a GOCO if a contractor won an A-76 competition to perform its workload, but it would remain a GOGO if the in-house "Most Efficient Organization" won. Crane AAA and McAlester AAP are exempt even from A-76 competitions by protective legislation that requires all functions performed by government employees when the legislation was passed in 1986 always to be performed by government employees (Section 317, PL 99-661, November 14, 1986).

authorization. Full direct privatization of the arsenals would not be feasible even under BRAC authority and would require special legislation of a sort that is apparently without precedent. A-76 competitions are feasible for the arsenals, but they could result in either GOCO status (under which the Army continued to own the facilities but contractors operated them) or continued GOGO status if in-house employees won the competition.

COMPARING THE THREE OPTIONS AGAINST THE FIVE ASSESSMENT CRITERIA

This section provides first a summary assessment of the relative desirability of the three options against specific metrics associated with the five criteria. It follows with a more detailed comparison.

Based on the discussion in Chapters Four through Six, Table 7.2 summarizes which options satisfy specific aspects of the five criteria. Not shown, the status quo mirrors the consolidation option except that it does not improve the overhead posture of the facilities.

In sum, we conclude that all options can meet all mission requirements, with modest risk from privatization. Only privatization relies entirely on the private sector, but the FGC moves partway there and can be an intermediate step to full privatization. Both privatization and the FGC offer substantial cost advantages over consolidation. Privatization completely relieves the federal government from its manufacturing responsibilities; the FGC at least relieves the Army and DoD from them. Finally, both privatization and the FGC reduce the potentially difficult external issues associated with consolidation, i.e., closing facilities and moving workload and workforces to new geographic locations, although workload could eventually migrate to other producers if the divested plants fail to win production contracts in a more competitive contracting environment. Clearly, consolidation represents a second-best solution, but it is worth pursuing should privatization or an FGC not be feasible. In the long term, it is likely to reduce overhead costs and enhance efficiency, but the Army would incur substantial upfront costs to relocate production lines and conduct environmental remediation at excess sites.

Below we amplify each of the above points in summarizing the discussion from Chapters Five and Six.

MISSION ACCOMPLISHMENT

Although our summary judgment is that all three options will permit all aspects of mission accomplishment, privatization of the GOCO plants carries a plausible risk, albeit a modest one. The status quo and consolidation carry a different,

Table 7.2
Criteria Satisfaction

Criteria	Privatization	FGC	Consolidation
Mission			
Meets mission requirements	√	√	√
Consistency with national policy			
Divests Army	√	√	
Divests government	√		
Cost			
Improves access to capital	√	√	
Strengthens investment incentives	√	√	
Enhances commercial use of property	√	√	
Maximizes revenue from divestiture	√		
Avoids costs of consolidation	√	√	
Avoids front-loaded remediation	√	√	
Reduces or spreads overhead	√	√	√
Managerial			
Places manufacturing with core organizational competency	√	√	
Reduces Army leadership distraction	√	√	
External considerations			
Reduces political issues of transfer of work	√	√	

√ = feasible.

but significant, risk. Because the two options leave assets under Army ownership with all the deficiencies that implies, the risk of further deterioration of the base that could threaten mission accomplishment is real. The extent of risk to mission accomplishment in privatizing can be mitigated by the Army's changing its requirements determination, procurement, and contracting processes to procure ammunition in stable, economic quantities while investing in manufacturing technology, ammunition innovation, and replenishment capacity.

The remainder of this section on mission accomplishment summarizes the points made in Chapter Five about privatization of the GOCO plants and, where appropriate, contrasts privatization with the other two options. Unfortunately, neither the benefits nor the risks associated with these options can easily be quantified. As with most policy decisions, a healthy measure of judgment is required. Table 7.3 summarizes our characterization of the mission accomplishment risk associated with each option and with the status quo. Clearly, the low workload and high costs associated with the two arsenals place them in jeopardy of solutions chosen to deal with their financial crises that could have detrimental long-term effects on their ability to meet mission needs.

Table 7.3
Summary of Mission Accomplishment Risk Assessment

	GOCO Plants	GOGO Plants	Arsenals
Status quo	Modest	Modest	Moderate
Privatization	Modest	Low (A-76)	Low (A-76)
FGC	Low		Low
Consolidation	Modest		Modest

NOTE: These risk assessments are both subjective and relative. For example, the subjective "moderate" rating for the arsenals under the status quo reflects our judgment that it poses the most risk when compared with the other options, but the absolute extent of that risk is not great.

In the sections below, we discuss five types of risk that can affect the outputs of the arsenals or ammunition plants under the different organizational schemes: program, replenishment, responsiveness, disruption, and technological obsolescence.

Program Risk

To the extent that commercial suppliers are unable to respond to Army ammunition needs, privatization imposes a risk. But in the GOCO plants, commercial providers are already responding to Army orders. Privatization changes only the ownership of the capital assets used in the production, not the workforce, which is already private. All contracts now executed in GOCO plants are competed, albeit imperfectly. If selling the GOCO plants would cause firms now operating them to leave the business, then other suppliers, who now compete for the production done in GOCO plants, would presumably remain to supply the Army's needs, either by buying the plants or by manufacturing in their existing facilities. We conclude that although the markets are highly concentrated on both the supply and the demand sides, reliance on private manufacturing is generally working today for the bulk of ammunition procurement and can be made to work for items now manufactured by commercial firms in the organic base. The organic base would simply become part of the commercial base; it would not necessarily go away, unless overcapacity drove it out of the market. As discussed in Chapter Five, if assets currently in the GOCO base are deemed unique and irreplaceable, the Army must take a proactive approach to create incentives for private-sector owners to maintain these assets by providing a steady peacetime demand for ordnance materiel and being willing to pay the cost of maintaining the desired level of replenishment capacity.

A second potential risk is that private-sector owners might not be willing to respond to Army demands. However, most of the Army's ammunition dollars

already go into completely commercial plants, where there is only a handful of serious supply problems. The risks lie not so much in the ability of this nation's formidable commercial manufacturing sector to respond to the Army's requirements, but rather in the Army's difficulty in becoming a smart buyer. Potentially nonresponsive markets can be overcome through investment in manufacturing technology and the design of ordnance (both ammunition and ordnance items), modernizing specifications, and finally by buying in economic quantities for multiple years. All these measures enhance the market's attractiveness to potential suppliers. Further, the Army in contracting should emphasize technological competence, due diligence, and past performance rather than cost in its source-selection processes and use pricing policy and award fees to motivate desired performance. Many of the commercial supplier problems that argue in favor of retaining an organic base or even of nationalizing manufacturing now done in the commercial base can be remedied, or at least ameliorated, by the above measures. Certainly there are problems with commercial suppliers, but markets can be made more responsive through Army actions short of nationalizing or retaining federal ownership of assets.

Because they retain ownership of manufacturing capacity, both the FGC and the consolidation options would avoid some of the program risk associated with privatization, but at the substantial cost shown in Chapter Eight and with the disadvantages of continued government ownership of plants. Creation of FGCs would require new operating relationships between the Army and the arsenals or ammunition plants, since ownership would pass from the Army to the federal government. For example, if the FGCs were not able to win production contracts in a more competitive environment, the Army or the federal government might have to decide whether to subsidize them or allow them to go out of business.

Replenishment Risk

As described in detail in Appendix B, the Army plans to meet its replenishment requirements for ordnance end items and critical components in two ways. Primarily, it plans to expand production on warm lines, both commercial and government-owned, by adding staff and work shifts. Secondarily, it plans to activate laid-away lines and plants. While both methods incur peacetime costs, laid-away capacity tends to be the more costly form of maintaining replenishment capacity. Virtually all laid-away lines and plants reside in the organic base.² Expansion capacity on warm lines is found in both commercial and organic plants.

²Commercial lines counted on for replenishment may be warm or cold today. Further, some warm lines today are warm from producing products that differ from those required for replenishment.

If plants with laid-away lines are privatized, the Army would exert less direct control over those lines. Unless the Army explicitly funds the maintenance of laid-away lines, they will deteriorate and lose their usefulness in replenishment. Privatization also runs the risk of the owner reconfiguring active lines for more efficient peacetime operation at the expense of replenishment expansion capacity. In other words, there is a risk that a private owner might eliminate a line that operates inefficiently on a single-shift basis and replace it with a new line that operates more efficiently on a three-shift basis, thereby forfeiting the multiple-shift expansion capacity.

Replenishment risk can be eliminated through explicit and separate contracting and funding of replenishment capacity, with a commitment to use that capacity when replenishment production occurs.³ Such a policy would offer two additional benefits. First, it would make more explicit the costs of both programmed production and replenishment, which are not transparent today and are not properly allocated to the respective customers. Second, it would stimulate more innovative methods for conducting replenishment.

The second potential replenishment risk posed by privatization is the loss of skills of current employees, both government and civilian. While loss of expertise is a legitimate concern, it is largely unrelated to privatization. Whether a facility is private or government-owned, manufacturing expertise and employment levels are maintained primarily through the actual employment of the workforce for peacetime manufacturing. The demand for ordnance materiel maintains the expertise. Explicit and separate contracting for replenishment capacity can also alleviate this issue. If there are personnel with skills unique to the manufacture of out-of-production ammunition items and such personnel are essential to conducting replenishment, a firm signing a replenishment contract will find that expertise essential and retain the personnel. The best means of maintaining specialized manufacturing expertise, however, remains the employment of a workforce in the actual manufacture of items that keep those skills sharp and train new employees in such skills.

None, however, is officially laid away. The only officially laid-away lines are those in government-owned plants. In the past, commercial plants housed laid-away lines; these were called plant equipment packages, or PEP. The practice was terminated in the 1980s when it was discovered that the cost of maintaining PEPs was being added as overhead on ongoing production contracts rather than being separately funded as a replenishment cost. However, this type of program could be revived after privatization, provided that replenishment funding was kept separate from production contracts.

³A model for this type of contingency contracting might be the Army's Logistics Civil Augmentation Program (LOGCAP). Under LOGCAP, the Army contracts with a base operating support services provider during peacetime to develop plans and budgets for supporting various contingency scenarios in cooperation with supported combatant commanders. When a contingency occurs, the combatant commander determines which of the planned services are needed, based on availability of organic support and funding, and activates a contingency contract with the provider. See, for example, Stollenwerk (1998).

Consolidation and the FGC option, because they both continue government ownership of plants and equipment, avoid some of the risk that inadequate funding of replenishment capacity might bring after privatization, but the true cost of holding replenishment capacity would remain obscure. These options also retain many of the disadvantages of government ownership discussed in Chapter Five.

Responsiveness Risk

Responsiveness risk has to do with the ability of a facility to meet unanticipated demands during hostilities. As with program and replenishment risk, the privatization option carries the most concern for responsiveness risk.

Despite the current national security strategy of relying on existing stocks to meet wartime requirements for ordnance materiel, unanticipated critical needs can arise. Even well-hedged scenarios do not anticipate every potential requirement; there is too much inherent uncertainty in warfare. Further, even if needs could be anticipated with perfect accuracy, DoD never buys the entire war reserve requirement. The Army must balance shortages among various claimants. Either unanticipated demands or underfunding can result in the unexpected need to surge during a crisis.

Capacity to meet unexpected surge requirements that fall outside the national security strategy can be maintained at a cost, whether facilities are government-owned or contractor-owned.⁴ If the Army decides it wants to maintain such a capacity, it should take one of two actions. First, it may recommend to the Secretary of Defense that the strategy be changed to make explicit the maintenance of surge capacity and provide the funds necessary to carry it out. Second, it may identify the cost of maintaining such capacity and request permission from the Secretary of Defense to divert some of its limited resources from programs intended to achieve the approved strategy to those that could support a surge demand. Finally, the Secretary of the Army may use his limited reprogramming authority to provide funds to maintain such a capability. But reprogramming funds to maintain a capability to support scenarios other than those specified by the national security strategy places such funds at risk. If approved, such surge capacity can be maintained either in commercial or government-owned facilities. As described in Chapter Five, ownership does not necessarily affect the risk. Cost is a separate issue, dealt with below.

⁴Alternatively, the examples of responsiveness to surge demands discussed in Chapter Five relied on expanding production on existing lines and *ex post* funding of increased capacity rather than *ex ante* funding of surge capacity. However, this type of responsiveness could benefit from advance planning, whether facilities remain under government ownership or are transferred to the private sector.

Divestiture of land has been raised as a concern should unforeseen future requirements outside of current strategy require large-scale surge. The privatization of 10 of the 11 GOCO plants (excepting Mississippi) would leave 55 percent (126,000 of 229,000 acres) of the current ammunition plant acreage still under Army control at Pine Bluff, Crane, McAlester, and Mississippi. Given the small workload at these plants relative to historical peaks, their retention represents a substantial real-estate hedge, a necessary but not sufficient component of a full hedging strategy.

Because the other options maintain government or quasi-government control of assets, responsiveness risk is less of an issue with them, but funding would still be required to build and maintain surge capacity above the existing replenishment capacity.

Disruption Risk

Disruption risk is an issue with the status quo in the GOCO plants and with the privatization option, but not for either the FGC option or the status quo in the GOGO plants.

Commercial firms, whether they operate on government facilities or on their own property, can decide to leave the ordnance business. They also can go bankrupt. In either case, land, equipment, and such intangible assets as environmental permits remain and would be in demand by other ordnance producers. The firms who now operate most of the GOCO plants—Day & Zimmerman, General Dynamics, BAE Systems—can be characterized as large, stable, and profitable. With regard to supply disruption risk during bankruptcy proceedings, Chapter Five laid out procedures for avoiding such events, for minimizing the risk that might occur during Chapter 11 reorganization, and for seizing assets should the events occur during wartime. Bankruptcy does not necessarily mean that operations cease. Further, many firms emerge from bankruptcy reorganization stronger than before. These risks and the measures to ameliorate them apply to the 70 or so firms producing ordnance materiel for the Army in COCO plants today.

Risk of Falling Behind in Manufacturing Technology

Here the risk falls heavily on the status quo as well as on consolidation. Government budgeting methods that limit access to capital in all the government-owned facilities have left much of the organic base undercapitalized. Because it lacks a separate capital budget, the Army must trade off the full cost of its capital expenditures with current budget items. Since the benefits of capital expenditures accrue in the future, they tend not to compete well with current

expenditures such as manpower, training, and other current readiness expenditures. The prevalence of World War II-era equipment and processes at the various plants bears witness to this problem; it is universally acknowledged. With proper contracting incentives, contractors who manufacture at the GOCO plants would have greater incentive to invest in productivity-enhancing equipment if they owned the assets themselves.

Both private manufacturing firms and federal government corporations have better access to capital markets and greater incentives to modernize than does the government as a holder of the assets. Continued ownership of manufacturing capacity risks further obsolescence and accompanying inefficiencies.

Mission Accomplishment: Comparative Assessment

The mission accomplishment risk associated with privatization is modest and outweighed by other factors. Nevertheless, the option of an FGC, because it retains at least quasi-government control of the assets, could result in a level of mission accomplishment risk indistinguishable from, perhaps even better than, that associated with the status quo, while offering many of the benefits of private ownership. Similarly, consolidation would offer roughly the same level of assurance of mission accomplishment as the status quo, but without the benefits of an FGC. However, one must also consider that the Army sometimes has difficulty in obtaining responsive support from in-house organizations and from defense agencies such as DFAS (Defense Finance and Accounting Service) and DISA (Defense Information Systems Agency). Furthermore, some FGCs, such as AMTRAK and the U.S. Postal Service, are not noted for their efficiency or responsiveness to customer needs.

CONSISTENCY WITH NATIONAL AND DoD POLICY

As described in Chapter Three, it is the policy of the current administration to adhere to the spirit and letter of 10 USC 2501 and 10 USC 2535, which encourage maximum practical reliance on the private sector. Further, as mentioned in Chapter Four, the Army has expressed its desire to divest its non-mission-critical logistics infrastructure within the period of its program. The logic implies that to be consistent with 10 USC 2501 and 2535, even mission-critical infrastructure can reside in the private sector. The term "mission critical" means simply that the capability is needed, not that the Army or even the government needs to own it. Today, the commercial side of the defense industrial base includes many mission-critical capabilities that the government does not own and sees no need to own. Such capabilities produce missiles, aircraft, ships, and other weapon systems. Many are one-of-a-kind and essential to DoD.

Hence, in determining which mission-critical infrastructure the Army needs to own, the first question to ask is, "Does this capability need to exist?" If the answer is "yes," then it is considered mission critical. But to determine whether this mission-critical capability requires some form of government ownership, four further questions require answering:

- Is the function inherently governmental?
- Is it impossible to interest the private sector in providing the capability?
- Can the government provide the capability at lower long-run cost?
- Is there a national security reason for government ownership?

A "yes" answer to any of the four implies some form of government ownership. But if all are answered "no," then no government ownership is implied.

So, how do the three options measure up against the standard of maximum practical reliance on the private sector? Only the privatization option fully satisfies this criterion, unless any of the above conditions apply. Our assessment in Chapter Five leads us to conclude that none applies, and that privatization of the GOCO plants is apt. Such would also be our conclusion for the GOGO facilities if privatization were feasible for them. But a lack of BRAC authority restricts this option. Further, for the GOGO plants, legislation protects two of them and other activities are ongoing on all three.

The FGC option partially satisfies the criterion in that it places ownership of capability in the hands of a quasi-government corporation with many of the advantages of privatization. Further, it relieves the Army and DoD from the management responsibilities of a peripheral function, and it provides a "second-best" strategy for moving toward privatization when legal and regulatory constraints prevent immediate privatization. Consolidation does nothing to move toward greater reliance on private manufacturing.

COST

The economic arguments laid out in Chapter Five show that privatization offers the greatest potential long-run savings relative to the status quo and the other options. According to estimates detailed in the next chapter, privatization of 10 of the GOCO plants should yield 20-year savings with a net present value between \$100 million and \$1.6 billion depending on assumptions.⁵ Even the pro-

⁵In cases where privatization of some individual plants yielded a negative NPV, it was assumed that the plants would not be sold. This assumption primarily affects the "pessimistic case" described in Chapter Eight.

gram year savings (FY03–09) net of one-time costs would be significant, on the order of a present value between \$160 million and \$840 million.⁶ The ranges of savings estimates result primarily from uncertainty surrounding assumptions about changes in ammunition prices and revenues from sale. Despite the wide range of estimates, even the most pessimistic assumptions yield a positive net present value for 5 of the 10 plants.

We have not costed out the options set aside earlier for reasons of feasibility, namely any options for the GOGO ammunition plants or privatization of the arsenals. Further, based on the assessment in Chapter Six of the relative undesirability of an FGC for the GOCO plants, that option has not been costed either.

For the arsenals, we have estimated the substantial operating savings relative to the status quo that would be expected from the creation of an FGC, whose organization, incentives, and business base would approximate those of a private corporation. Hence, although privatization of the arsenals is not feasible at this time, we can conclude that the operating savings from privatization should equate roughly to those that could be achieved from creation of an FGC. But since we assume that the FGC would acquire Army assets without compensation, the savings from privatization would be greater. As detailed in Tables 8.11 and 8.12 in the next chapter, the 20-year net present value of the savings to the Army from creation of an arsenal FGC would be between \$871 million and \$1.73 billion, depending on assumptions. Present value of savings from FY03 to FY09 are estimated to run from about \$361 million to \$551 million.⁷

As Table 7.2 summarizes rather dramatically, privatization offers the greatest potential for cost savings, although an FGC may not differ greatly.⁸ Consolidation, while worthwhile from a cost perspective, improves only the overhead

⁶Some projections resulted in net costs of privatization in years beyond the program (FY10–22) because of optimistic assumptions about growth of tenant revenues under the ARMS program. (These revenues are assumed to accrue to the new owner rather than the government after privatization.) PricewaterhouseCoopers (2001) assumes that over 2001–2025, up to 90 percent of available square footage at the ammunition plants could be rented at the same average renovation costs and rental rates as in the 1993–2000 period, adjusted for inflation. This assumption could be considered optimistic if the most desirable space was renovated and rented first, for example.

⁷The lower end of these savings ranges is based on the assumption that an FGC is not able to attain private-sector levels of productivity, charges above-market prices, and requires continued subsidies from the Army to maintain current capacity levels at the two arsenals. Substantial savings should still be possible if the FGC is able to bring in commercial workload to spread its overhead and labor costs.

⁸As discussed in Chapter Six, it is important that the FGC's charter be carefully crafted to ensure that the competitive playing field is level between the FGC and others in the market, and that the roles and responsibilities of the corporation, its executive management, and its board of directors are clear. A badly designed charter could hamper an FGC's ability to improve operations at the arsenals or ammunition plants.

structure of the installations consolidated. Because it leaves the plants under Army ownership, consolidation

- fails to improve access to capital and provide the incentives and ability to modernize and improve productivity,
- fails to place the property in the hands of a private firm that is likely to better develop the real estate value of the property,
- requires substantial front-end investment in transferring plant and equipment and perhaps conducting environmental remediation before excess plants can be disposed of.

Because consolidation results in the declaration of property as excess to need rather than excess to ownership but not excess to need, as under the privatization option, the divestiture must follow the screenings required by the Federal Property and Administrative Services Act of 1949. This law requires the property to be offered first to other DoD and federal agencies, then to state and local agencies. As mentioned, these agencies may acquire property without compensation to the Army in certain cases.

Transition Cost

The transition from Army ownership to private ownership of the ammunition plants should not involve much more disruption than a recompetition of the current GOCO facility-use contracts. The contracts at 8 of the 10 GOCO plants are currently expiring or will expire in the near future and thus would soon require recompetition if they were not privatized. In a recompetition or a privatization, either the incumbent contractor or a competitor could win control of a plant. If the incumbent wins a competition, the entire management structure and workforce may remain the same, whereas if a new contractor takes over, management may be replaced but the production workforce could remain in place.⁹ Some government staff members currently located at each plant, and at OSC and higher headquarters, may no longer be needed after privatization. Our budget projections for privatization include a cost for conducting the sale of each plant, as well as the costs of separating government employees at the plants. (See Chapter Eight and Appendix D.) We also suggest how the Army can address some transition issues in the section below on divestiture implementation.

⁹The privatization plan envisions that initial 5-year production contracts would be coupled with the sale of the plants. After these initial contracts expired, ammunition contracts would be subject to full and open competition between the former GOCO plants and other COCO plants. Thus, continued employment at the plants would depend on the ability of the new owners to continue to win contracts in a more competitive environment.

The creation of an FGC for the two GOGO arsenals is likely to involve a more significant transition. The business plan outlined in Chapter Six assumes that a new management team would be brought in but that most of the workforce would remain in place. Workers would gradually transition from indirect to direct labor as more commercial workload was brought into the arsenals. Many of the indirect workers were formerly part of the direct workforce when the arsenals had higher workload, and we allow for retraining costs in the budget projections. The budget projections also account for the costs of hiring a new management team for the FGC, an initial infusion of working capital, payoff of any accumulated AWCF losses, and continued subsidies for excess capacity during the transition period. (See Chapter Eight and Appendix D.)

MANAGERIAL EASE

As laid out in Chapter Four, manufacturing is clearly a peripheral function to the Army. Management of an organic base diverts senior leader attention from core problems and asks that managers decide issues that lie outside their principal competencies. Either privatization or the FGC would eliminate this distraction for both the Army and DoD. Further, either option would place manufacturing in an organization whose central mission is manufacturing. Neither consolidation nor recapitalization offers such benefits.

EXTERNAL FACTORS

Because they involve closing installations and dislocating hundreds of jobs, both consolidation and recapitalization bring into play formidable external issues. In contrast, both the privatization and the FGC options envision continued employment at all the current installations at roughly current levels, perhaps even increased to the extent that the options enhance commercial use of the facilities. Under the status quo, the arsenals face further declines in their core government workload and job cuts that could possibly be avoided if an FGC could bring in commercial workload. Further, the privatization option would benefit local economies by adding to the property tax base. However, public unions typically oppose any outsourcing, even to union shops. Benefits can decline when work is privatized. A soft landing for current government employees is absolutely essential to the success of any privatization or FGC.

SUMMARY OF COMPARATIVE ASSESSMENT

Private ownership of this manufacturing capability is the preferred means of meeting DoD's needs. Our assessment is that a completely private base could meet DoD's requirements at lower cost and without appreciable risk. A private

base would remove a leadership distraction and place manufacturing in organizations whose core competencies include ordnance manufacturing. Both privatization and the FGC option offer substantial cost and other benefits over consolidation, but the FGC option fails to achieve complete privatization.

Legal constraints render any changes to the GOGO plants highly problematic. Further, there appears to be no authority to privatize the arsenals directly, although A-76 competitions at the arsenals are certainly feasible. Because they employ more than 300 DoD civilians, consolidation of the arsenals would require BRAC authority. All three options appear feasible for the GOCO plants.

For the GOCO ammunition plants, privatization is the preferred option. An FGC for these facilities introduces an awkward three-way relationship among the Army, the FGC, and the contractors that appears unwieldy and less likely to reduce costs.

For the arsenals, where direct privatization cannot be achieved, the FGC option should bring dramatic reductions in the price the Army pays for the products it now makes at the arsenals, and gradually reduce the subsidies the Army pays for holding idle capacity. Further, retention of arsenal assets within a quasi-government organization should alleviate any latent concerns over the risk of maintaining capability in the private sector. The nation would have the option of retaining the FGC permanently, or privatizing it after a time. Should for any reason the FGC not be achievable, the Army could consolidate the two arsenals as part of a possible future BRAC.

DIVESTITURE IMPLEMENTATION CONSIDERATIONS

Sequencing and grouping of plants for divestiture represents an important implementation consideration. The creation of an FGC for the two arsenals would be accomplished in a single action.¹⁰ Hence, sequencing would not be a consideration. But the privatization of the GOCO ammunition plants raises the questions of sequencing and bundling divestitures.

A decision to privatize production assets under excess to ownership (ETO) but not excess to need implies the need for a second set of decisions about the implementation of divestiture. These decisions must articulate a divestiture plan that clearly signals to potential buyers a credible Army exit from ordnance production, yet also sets the conditions for an orderly transition of ownership that

¹⁰The notion of creating an FGC initially from one arsenal and then folding in the other would permit the corporation to get the bugs out before full implementation but would also require complicated legislation and stretch out implementation time. Hence, the option was set aside.

does not disrupt programmed ordnance materiel procurement.¹¹ Divestiture implementation design may also affect the post-privatization structure of the ordnance market and the financial value that the Army recognizes from divestiture. Divestiture design will generally vary according to the timing of sales (simultaneously or over time) and whether the plants are bundled into groups or sold individually. While revenue from sale is an important—perhaps the most important—decision criterion, the Army may use multiple criteria for deciding on an offer.

In this section, we suggest some possible divestiture designs and how they might affect the Army's ability to achieve the desired goals of privatization. However, it is difficult to predict how government decisionmakers and potential bidders will view these designs. For this reason, we recommend that the Army engage in a privatization planning process that involves the GSA, which is responsible for disposal of government property, an investment bank to provide financial advice on structuring the sales, and potential bidders for the plants. This information-gathering and planning process could include issuing a Request for Information (RFI) to potential bidders, conducting a presolicitation conference, developing a preliminary divestiture plan including the bundling of plants and the timing of sales, issuing a draft Request for Proposals (RFP) to obtain further comments, and refining and issuing a final RFP.

Divestiture Design

Many permutations of divestiture execution options are possible. If we consider the different types of bundling that could occur and whether the plants should be sold simultaneously or in sequence, we arrive at the set of options in Table 7.4. The plants could each be sold separately, or as one large bundle. Other bundling options could be based on position in the value chain, current facility use contractor, or contract termination dates (shown in Table 7.5). Under the current organization of the organic ammunition production base, there are three distinct links in the value chain: production of energetics (explosives and propellants), production of metal parts (such as shell cases), and LAP of end items. The Army could consider bundling within value-chain categories (groups of energetics, metal parts, or LAP plants), or across value-chain categories (an energetics plant and a LAP plant, or a metal parts plant and a LAP plant, for example). Plants currently operated by the same facility-use contrac-

¹¹As discussed in Appendix E, the two keys to realizing the value of ordnance asset sales from privatization are a credible Army exit from ordnance manufacturing, *and* the competitive auction of these assets to the maximum number of qualified buyers. Economic literature on asset sales has consistently found that asset auctions earn monopolistic sellers *more* than negotiated sales, and that "maximizing the number of bidders in an open auction is usually the best way to maximize revenues" (Megginson and Netter, 2001, p. 20).

Table 7.4
Divestiture Options

Bundling Option	Simultaneous	In Sequence
Sold individually	√	√
Bundled within value chain category	√	√
Bundled across value chain category	√	√
Bundled by current facility use contractor		√
Bundled by contract termination dates (facility use and supply)		√
All plants sold in one bundle	√	

tor may represent logical bundles. Or the Army may wish to bundle or time the sale of plants based on contract expiration dates to reduce contract termination costs.

Timing of assets sales is crucial. The Army could sell all of the parcels at one time, or it could stage sales over time in groups or individually. Determining the length of time between sales should be influenced by factors such as the timing of completion of ongoing facility use or production contracts, anticipated complexity of auctions and negotiations, and the complexity of managing ongoing production contracts during divestiture.

The striking fact in Table 7.5 is that all but three AAPs are operating under expired or imminently expiring facility-use contracts and that the dates of these contract expirations align generally with the same facility-use contractor. Additionally, Day & Zimmerman, or partnerships involving Day & Zimmerman, operate four of the five LAP AAPs. These facts suggest that the Army might execute divestiture of its GOCO AAPs using a combination of the strategies in Table 7.4.

Production Contract Bundling

The bundling of some significant long-term ordnance production and replenishment maintenance contracts with the sale of each parcel of real property is likely to increase the attractiveness of the plants to potential bidders and ease the transition of the GOCOs to full and open competition.¹² This explicit linkage of initial production business to ownership of the property is also likely to increase the sales prices of these parcels at auction (see Appendix E (Valuation of Parcels)). However, the Army should be careful to not create unneeded complexity (and loss of flexibility) by attempting to bundle all possible near-

¹²Such bundling is currently inherent in most GOCO facility use contract competitions.

Table 7.5
AAP Key Management Characteristics

AAP	Facility Use Contract Expiration	Value Chain	Contractor
Kansas	2001	LAP	Day & Zimmerman
Scranton	2001	Metal parts	Chamberlain
Louisiana	2002	Metal parts	Valentec
Radford	2002	Energetics	ATK
Lone Star	2003	LAP	Day & Zimmerman
Iowa	2003	LAP	American Ordnance (D&Z/General Dynamics)
Milan	2003	LAP	American Ordnance (D&Z/General Dynamics)
Riverbank	2005	Metal parts	Norris
Holston	2023	Energetics	BAE
Lake City	2025	LAP	ATK

future ordnance contracts into the sale. Additionally, the Army should avoid bundling ordnance production contracts simply for administrative convenience, because such action runs counter to congressional guidance in the Small Business Reauthorization Act of 1997.¹³

Divestiture Option Considerations

In deciding upon a divestiture strategy, the Army should consider the following criteria:

- **Reduce managerial complexity.** The Army and GSA must manage the complexity of divestiture across both the transition to new parcel ownership and the continuation or cancellation of existing ordnance production contracts.
- **Increase sales value.**

¹³The act (Section 2(j)(3)) directs agencies to "avoid unnecessary and unjustified bundling of contract requirements that precludes small business participation in procurements as prime contractors." To avoid running afoul of the federal Small Business Administration (SBA) oversight of this aspect of federal agency contracting, the Army should ensure that its Office of Small and Disadvantaged Business Utilization (OSADBU) reviews the proposed scope of bundling and proactively handles any necessary interface with the SBA (Baldwin interview, June 4, 2002).

- **Enable financial engineering.** Both the Army and the buyers of the plants may benefit if buyers agree to perform remediation of known environmental liabilities in exchange for a reduced purchase price.¹⁴
- **Promote market competitiveness.**
- **Leverage lessons learned from early sales.**

These criteria imply different benefits and concerns for the various options, depending upon timing, bundling, and interactions between the two. Generally, longer time between sales and smaller or more homogenous bundles of transactions should make it easier to manage complexity and to take advantage of lessons learned during the divestiture process. However, longer gaps between sales could be interpreted as a sign of weak (or negotiable) resolve to exit the industry, because more time is available to back away from complete divestiture. If potential bidders believe the Army may change its mind and retain some plants, and continue to give the retained plants a competitive advantage in winning production contracts, the potential value of the plants that are sold will be reduced. Low bids on initial parcel sales might then induce the Army to halt the divestiture, making a noncredible divestiture plan a self-fulfilling prophecy. Thus, it is important to involve potential bidders in the privatization planning process to ensure that such misunderstandings do not occur.

Generally, bundling of ordnance parcels is likely to influence the consolidation of ammunition production and the competitive playing field after divestiture. Bundling also helps ensure that the economic value of the parcels is efficiently translated into reduction of Army environmental liabilities.¹⁵ Bundling similar parcels, or parcels currently operated by the same firm, may encourage faster consolidation of ammunition production,¹⁶ enable the realization of industrial

¹⁴40 USC 485 authorizes the Army to retain the proceeds from the sale of non-BRAC excess real property disposed of by GSA, after GSA recoups its expenses. However, the Army can benefit if the buyer performs remediation in exchange for a reduced purchase price, because the buyer may have greater incentive, experience, and funding to complete environmental clean-up; the clean-up remedy can be designed with the final site reuse in mind; and the buyer may accept remediation costs with a higher net present value than the reduction in purchase price because industry typically has a higher discount rate than the government, and because environmental remediation expenses are tax-deductible. See SAFM-RBA (2002) and General Services Administration (2001). The legal responsibility for environmental contamination remains with the federal government.

¹⁵For example, at auction, the Army will discover the true economic value of these properties, and this value may be more or less than the known environmental liability at that parcel of land. Bundling plants whose environmental liabilities are greater than their purchase prices with those in the opposite condition could increase the total gains to the Army from sale.

¹⁶Bundling parcels according to their position in the ammunition value chain (i.e., energetics, metal parts, large-caliber LAP, and small-caliber/specialty LAP) could enable private owners to quickly rationalize and recapitalize these operations to gain efficiencies, since some production contracts will initially be tied to each plant. These economic gains would be partially realized to the

synergies, and simplify some managerial challenges under divestiture by reducing the number of separate transactions, but it could also reduce competition for ammunition production contracts in the future. Large-scale bundling or bundling *across* the value chain that artificially induces vertical process integration may lead to a less competitive post-market structure and lower sale values from bidders who might not wish to purchase parcels whose operations are unrelated to their core competencies.¹⁷

The alternative to bundling is to sell the plants individually and allow bidders to determine the most desirable combinations of plants to buy during the divestiture process. Although market-driven consolidation may lead to greater efficiency, bidders could also choose groups of plants to increase market power. The Army will need to consider the competitiveness and antitrust implications of its divestiture plan, and possibly limit the number of plants an individual contractor can buy, whether it chooses to bundle the plants or sell them separately. Selling the plants individually may also limit opportunities for the Army to trade off environmental remediation costs for reduction in the purchase price of the plants.

Divestiture Design Option Evaluation

These various qualitative criteria for alternative divestiture design options are not easily quantifiable. Divestiture design is substantially more art than science, in part because it depends on the decisionmaker's preferences for weighting the various criteria. However, these criteria are not necessarily mutually exclusive. Table 7.6 summarizes a qualitative comparison of the various options across the divestiture criteria posited by this study. We also suggest a "tailored hybrid design" that combines various bundling and timing options, and which we believe best satisfies the five criteria. We use this hybrid design as the basis for our budget projections in Chapter Eight and Appendix D.¹⁸ However, our interpretation of these criteria and selection of a divestiture

Army on an *ex ante* basis by higher parcel sales value, and on an *ex post* basis by lower ammunition prices under competitive contracts.

¹⁷Interviews with the current GOCO contractors indicated that metal parts production is regarded as a separate competency, but there may be some synergies between energetics and LAP (e.g., reducing the need to transport explosive materials between plants). However, if the small number of energetics plants were bundled with LAP plants, it could enable vertical foreclosure of competing LAP contractors. Furthermore, although some ammunition producers may be interested in combining different parts of the ammunition value chain, others may not. Forcing all potentially interested bidders to take on an energetics or metal parts plant along with a LAP plant might be viewed as a "poison pill" that would reduce bidding interest from some firms.

¹⁸Although the budget projections use the timing recommended by the tailored hybrid design, they do not assume that bundling affects the valuation of the plants by potential bidders. Thus, it is relatively easy to change the projections to reflect variations in the timing of sales.

Table 7.6
Divestiture Design Option Summary

GOCO AAP Divestiture Options	Reduce Managerial Complexity	Increase Sales Value	Enable Financial Engineering	Promote Market Competitiveness	Leverage Lessons Learned from Earlier ETO Divestitures
Individual parcels in sequence		Black	Black		
Individual parcels simultaneously	Black		Black		Black
Bundled by value chain category in sequence	Gray		Gray		Gray
Bundled across value chain in sequence	Gray	Gray	Gray	Black	Gray
Bundled by value chain category simultaneously	Black		Gray		Black
Bundled across value chain simultaneously	Black	Gray	Gray	Black	Black
Bundled by facility contractor		Gray	Gray	Gray	Gray
Bundled by contract termination date (facility-use and supply)	Gray	Gray	Gray	Gray	Gray
All plants sold in one bundle	Gray			Black	Black
Tailored hybrid design					

Criteria Evaluation:

Black: Serious reservations.

Gray: Some reservations.

White: No significant reservations.

design should be examined through the Army's privatization planning process, particularly through consultation with potential bidders.

Creating a Tailored Hybrid Design: One Approach

One approach that could satisfy the five criteria would be to begin by privatizing the four LAP plants that the Army planned to consolidate through a LAP

competition, Iowa, Kansas, Lone Star, and Milan AAPs.¹⁹ The two plants currently operated by American Ordnance (Iowa and Milan) could be bundled, as well as the two plants currently operated by Day & Zimmerman (Kansas and Lone Star). As indicated in Table 7.3, all of these plants' facility-use contracts have either expired or will expire in 2003.²⁰ Ammunition production contracts at these plants are also scheduled to terminate on those same dates. Early privatization of the LAP plants could facilitate a transition to greater use of system contracting for ammunition end items, since LAP contractors are logical candidates to manage the entire production process.

Of the remaining plants, Holston and Lake City AAPs were recently recompeted under long-term facility-use contracts and so may require some advance planning to reduce contract-termination costs. This leaves only four AAPs to consider for the interim stages: Scranton, Louisiana, Riverbank, and Radford. Since Radford is an energetics plant and potentially one of the most valuable assets (measured by cash flow) in the organic industrial base, it seems reasonable to delay its sale slightly to reap the benefit of learning and marketing synergies.²¹

Of the remaining three metal parts plants, Scranton has the largest workload, but it has no known environmental liability. Therefore, the Army would have relatively little opportunity to offset cash revenue from its sale against environmental remediation costs. The Army could increase its financial engineering opportunities by bundling Scranton with Louisiana, which among the three metal parts plants has the highest known environmental liability as a proportion of its workload.

Based on these considerations, we suggest the timing and bundling approach summarized in Table 7.7. As noted above, we use this timing of plant sales as the basis for our budget projections in Chapter Eight, but these projections can be relatively easily adjusted to account for changes in the timing of divestiture. We also reiterate that the actual divestiture option should be chosen as part of a consultative process with GSA, an investment bank, and potential bidders.

¹⁹In the LAP competition, all four facilities were to be competed under a single facility-use contract, with bidders proposing consolidation plans to reduce long-term costs. This competition was scheduled to take place in 2002 but was suspended pending the outcome of the Army Industrial Base Review and other Army initiatives.

²⁰Furthermore, in discussions with OSC, Army officials indicate that they believe these plants have significant efficiency gains to be realized under private reorganization and recapitalization.

²¹In 2002, the Army held a competition for the facility-use contract at Radford but received only one bid, and eventually decided to terminate the competition. The Army plans to extend ATK's contract for one year while it determines a long-run strategy for the plant.

Table 7.7
Tailored Divestiture Design Summary

Stage	AAP	Sale Target Date	Facility Use Contract Expiration	Value Chain Category	Current Contractor
1.1	Iowa	2004	2003	LAP	American Ordnance (D&Z/GD)
1.1	Milan	2004	2003	LAP	American Ordnance (D&Z/GD)
1.2	Kansas	2004	2001	LAP	Day & Zimmerman
1.2	Lone Star	2004	2003	LAP	Day & Zimmerman
2.1	Louisiana	2005	2002	Metal parts	Valentec
2.1	Scranton	2005	2001	Metal parts	Chamberlain
2.2	Riverbank	2005	2005	Metal parts	Norris
3	Radford	2006	2002	Energetics	ATK
4.1	Holston	2006	2023	Energetics	BAE
4.2	Lake City	2006	2025	LAP	ATK

SUMMARY

The design of GOCO divestiture can vary by timing and bundling of plant sales. Many considerations affect divestiture design, but the major ones include reducing managerial complexity, increasing sales value, enabling financial engineering, promoting market competitiveness, and leveraging lessons learned from earlier sales. Divestiture design is by nature more art than science, since it is hard to quantify outcomes of proposed options and because decisionmakers may weight the criteria differently. A privatization planning process involving GSA, an investment banking firm, and potential bidders can provide valuable assistance to the Army in designing and executing the divestiture.

A RECOMMENDED STRATEGY

This chapter recommends a strategy that moves the Army's industrial base toward the vision offered in Chapter Four, namely:

A responsive, innovative, efficient manufacturing base, capable of meeting national security requirements while relying to the maximum practical extent on the inherent advantages of competition and private ownership of capital.

The strategy offers a number of advantages. It recognizes real-world constraints. It can be accomplished without special BRAC authority. However, certain aspects of the proposal require legislation. Further, the strategy is prudent in that it maintains a substantial hedge of organic assets against unforeseen requirements. Therefore, it does not move as far toward the vision as some might desire. It provides another hedge in that the assets the Army gives up are likely to continue as active manufacturing assets in other hands, with provisions for the Army to reclaim them in an emergency. It promises significant budget savings both within the Program Objective Memorandum (POM) and over the longer term. Finally, the strategy permits the divestiture of Army assets without the substantial front-end costs associated with declaring assets excess to need either as a part of BRAC or outside it. Equally important, it offers the prospect of maintaining, perhaps even increasing, employment at each of the sites divested. In sum, the proposed strategy offers substantial benefits to the Army and to the taxpayer with modest risk.

Perhaps the most difficult prerequisite of successful implementation of the strategy is overcoming the Army's unique cultural attachment to the organic base. Because it is based on deeply held values and beliefs, culture is the most difficult property of an organization to change. For that reason, should the Army adopt the strategy proposed here, its decision will need to be accompanied by a strong statement of the Army's intent to carry it out. And that strong statement will need to be followed by reinforcing guidance, specific milestones, monitoring, and enforcement.

In the end, the financial and managerial benefits will be substantial, and mission accomplishment should be strengthened. The alternative of continuing current policies carries the risk of a decline in support for eroding, underutilized capabilities, increasing unit costs, a continuing drain on the precious time of the Army's leadership, and failure to tap the full potential of private-sector competition and innovation.

THE STRATEGY

The proposed strategy consists of three paths, one for each of the three segments of the base, as follows:

- Privatize the GOCO plants, except for Mississippi AAP, which the Army does not own. Declare the plants excess to ownership but not excess to need, so that the buyers—ammunition producers—agree to maintain specific capability for a specific period. Sell the plants as going concerns to increase sale revenue. Use legal authorities to transfer property before remediation is completed and trade sale revenue for agreement of buyers to conduct remediation. Package divestitures to maximize benefits to the Army. Sequence divestitures to enable early lessons learned to be applied to later experience.
- Create a federal government corporation to own and operate the two manufacturing arsenals. Recommend that the Congress charter the FGC not only to meet DoD needs for ordnance materiel but also to use its substantial capabilities and capacities to manufacture commercial products. The FGC may be chartered either as a permanent entity or, preferably, as a transitional organization to full privatization after a set number of years. We recommend that the charter require the board of directors to recommend at the end of five years whether to continue the organization as an FGC or to privatize it.
- Retain the three GOGO ammunition plants, along with Mississippi AAP, as a hedge against unforeseen need for Army-owned property. This retains more than half of the current government-owned acreage. The office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology) suggests that these three GOGO plants can meet most of the Army industrial reserve requirements. Their retention can mitigate any risk associated with this report's privatization recommendations.

FALLBACK STRATEGIES

Should the primary strategy fail, the Army still has options.

For the GOCO Plants

In attempting to reach an agreement on divestiture of a particular GOCO plant, a situation may arise in which, for whatever reason, there may be insufficient competitive pressure among potential buyers to generate an agreement the Army, the GSA, and/or their congressional oversight bodies would consider fair compensation. Such a situation would preclude the sale of the plant. If such a situation arises, the Army has two recourses, one near-term and one mid-term.

In the short term, the Army could sell property and perhaps buildings while retaining land, which it would lease for a very long term to provide incentives for lessees to invest as if they owned the land. While falling short of complete privatization, such a fallback would bring some of the benefits of complete privatization. Manufacturing capital would be in the hands of a firm with access to capital and incentives to modernize. As simply a landowner, the Army is able to reduce its management attention. The small number of remaining Navy and Air Force GOCO plants operate in this minimalist manner. But retaining the land forgoes the benefit of using sale proceeds to offset the environmental liability.

In the medium term, the Army might consolidate some of these facilities to achieve overhead savings. But, as pointed out earlier, consolidations entail large front-end costs of moving assets and building facilities at receiving installations. Further, they incur the human and political costs associated with moving the workload of hundreds of employees to new geographic locations. It is one matter for a private firm to relocate a commercial workforce; it is quite another for the federal government to propose such a move. Finally, the consolidation leaves the remaining assets in government hands, doing nothing to move toward the vision of private-sector reliance and forgoing the other benefits of private-sector reliance. Consolidation, while potentially worthwhile, clearly represents an inferior solution.

Creating a federal government corporation to manage the real estate at the GOCO plants and own the equipment operated by private firms appears to offer no significant benefit over the current arrangement and simply introduces another government entity into the equation. While certainly feasible, it is not recommended. Privatization presents a better opportunity.

For the Arsenals

If either the Army or DoD rejects the proposal to create an FGC to own and operate the arsenals or if the Congress looks unfavorably on an administration proposal to create one, there are alternatives to consider. A second option would be to request special legislation authorizing the privatization of one or

both of the arsenals. While we know of no precedent for such a proposal,¹ in a fallback situation, it appears worthy of exploration.

Because the arsenals employ more than 300 DoD civilians, the requirements of 10 USC 2687 make it impractical to close an arsenal outside of BRAC authority, and directly privatizing one results in its closure as a DoD installation. But past BRACs have not concerned themselves with issues of privatization. Instead, they consider only where to house government activities, not whether those activities should be performed by government or private entities.

An option available outside of BRAC authority would be to conduct A-76 competitions to possibly convert one or both of the arsenals to GOCO operation, but the small and uncertain anticipated demand makes this prospect unlikely. That leaves only consolidation or divestiture under a possible future BRAC as an option. As noted earlier, this is clearly an inferior option, but one that may represent an improvement on the status quo.

SEQUENCING

The FGC may be initiated at any time. For the purpose of estimating the potential budget impacts of creating an arsenal FGC, we assumed that the proposal would be developed during calendar year 2002 and submitted as a legislative proposal with the FY04 budget in January 2003.² But this action may be taken independent of any privatization sequencing of the GOCO plants.

With regard to the GOCO plants, we propose that the Army implement a divestiture design that clearly signals its intent to exit from the industry by selling its LAP AAPs with expired or imminently expiring facility-use contracts in two bundles nearly simultaneously at the first stage of divestiture. The following stages of divestiture would auction two bundles of metal parts plants, and Radford, Lake City, and Holston AAPs individually. This or a similar approach is most likely to achieve a credible divestiture design that maximizes the benefit to the Army.

¹Congress authorized the privatization of military housing in the 1996 Military Housing Privatization Initiative, and Defense Reform Initiative Directive #9 directed the Army to privatize its utility systems (Pint et al., 2001, pp. 42, 64), but DoD has never privatized an entire installation employing more than 300 DoD civilians since the codification of 10 USC 2687.

²Since the Army's implementation decision has already slipped beyond this timeline, the estimated seven-year savings will be deferred into the next fiscal cycle. However, we do not expect the delay to significantly affect the magnitude of such savings.

AN INTEGRATED REPLENISHMENT STRATEGY

For replenishment we recommend three steps that are detailed in Appendix B.

- Define the Army's policy for replenishment. Such a definition is beyond the scope of this research project, but absent an official policy, it is impossible to plan replenishment strategies in a meaningful way.
- Take a life-cycle approach to ammunition design and production. A life-cycle approach includes any replenishment requirements so that replenishment production effects (i.e., making production restart economical and timely) are a design consideration. The recent establishment of a Program Executive Officer for Ammunition should greatly facilitate planning and executing a life-cycle approach to replenishment strategy.
- Contract for replenishment capability rather than maintaining specific replenishment capacity. Replenishment capability may take the form of a validated plan to build a new production facility or continued maintenance of idled plants. Maintaining capability instead of capacity allows greater flexibility in the allocation of ammunition resources. Also, implicit in contracting for capability is the notion that replenishment planning and production decisions should be explicit in the budgeting process and not hidden in the cost of peacetime ammunition buys. By making the cost of replenishment explicit, decisions concerning the allocation of resources and the attendant risks associated with replenishment capability may be better balanced with the Army's competing requirements.

ESTIMATED BUDGET EFFECTS

In this section, we estimate the potential effects of the proposed changes in the governance of the arsenals and ammunition plants on the budgets of the Army and the U.S. government as a whole. First, we consider the budget implications of privatizing the GOCO ammunition plants, which are virtually the same for the Army and the government as a whole.³ Next, we estimate the budget effects of creating an arsenal FGC, which differ for the Army and the government, since ownership will pass from the Army to the government as a whole. These estimates indicate that savings could vary over a wide range, based on variations in assumptions. They should be considered preliminary and subject to

³Although some ammunition is purchased by the Air Force and the Navy, the data are not detailed enough to separate the effects on their budgets from those on the Army's.

revision during the planning and industry consultation process described in Chapter Seven.⁴

Privatization of GOCO Ammunition Plants

We estimate how privatizing 10 of the 11 GOCO ammunition plants⁵ might affect the Army's budget with two horizons: over the FY03–09 budget and Program Objective Memorandum (POM) period and over the 20 years from FY03–FY22. The base case uses a relatively conservative set of assumptions. To test the sensitivity of the results to these assumptions, we also considered an “optimistic” case and a “pessimistic” case. Table 8.1 illustrates our base case budget analysis over the POM showing total values for all 10 plants to avoid revealing proprietary data on individual plants.⁶ The remainder of the results are shown in a summarized format, with the full detail over 20 years for each of the three cases given in Appendix D.

For the status quo base case, ammunition costs (including production costs, production base support, LIF, and MIIF),⁷ the Contracting Officer's Representative (COR) budget, and agriculture and forestry revenues are assumed to remain the same as in FY01. Environmental remediation spending projections through 2015 were provided by OSC. ARMS investments and incentives and ARMS savings are based on “most likely scenario” projections in PricewaterhouseCoopers (2001).

For the privatization base case, in the years before privatization, we assumed that ammunition costs, environmental remediation costs, COR budgets, and agriculture and forestry revenues would remain the same as in the status quo. However, we assumed that there would be no further spending on ARMS investments and incentives, and no increase in ARMS savings beyond the FY01 level. The one-time costs of privatization include termination of facility use and production contracts if the plants are not sold to the current contractors, separation of government employees in each plant's COR office, conducting the sales, and reimbursing the current contractors for any unfunded retiree

⁴Army commentators on a draft version of this report suggested that we should develop “business plans” for the privatized plants. Such plans are the responsibility of potential bidders for the plants, given the divestiture option chosen by the Army. They would require inside knowledge of the ammunition industry and, as such, are beyond the scope of this study.

⁵We did not consider the impacts of privatizing Mississippi AAP, since it is located on land owned by NASA.

⁶Budget projections and other proprietary data on individual plants are available to authorized Army personnel in a proprietary appendix.

⁷Ammunition costs also include ammunition produced for the other services and for foreign military sales.

Table 8.1
 Example of Estimated Budget Impacts: Base Case Privatizing 10 GOCO Plants

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total*
Status quo								
Ammunition costs	661.2	661.2	661.2	661.2	661.2	661.2	661.2	4,628.5
Environmental remediation	27.2	31.5	30.9	33.4	35.6	30.9	29.0	218.5
COR budgets	10.7	10.7	10.7	10.7	10.7	10.7	10.7	74.8
ARMS investments and incentives	24.2	23.9	22.6	21.5	21.4	21.3	20.2	155.0
ARMS savings	-25.3	-26.7	-27.8	-29.0	-30.1	-31.3	-32.6	-202.8
Agriculture and forestry revenues	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-29.1
Total	693.9	696.5	693.4	693.6	694.6	688.6	684.3	4,845.0
Privatization								
Ammunition costs	661.2	651.3	648.0	628.2	628.2	628.2	618.2	4,463.1
Environmental remediation	27.2	12.9	10.5					50.6
COR budgets	10.7	6.0	4.4					21.1
ARMS investments and incentives	0.0	0.0	0.0					0.0
ARMS savings	-25.3	-20.3	-16.4					-61.9
Agriculture and forestry revenues	-4.2	-1.2	-0.1					-5.4
Termination of facility contracts		0.0	0.0	0.0				0.0
Termination of production contracts		18.2	6.2	37.3				61.7
Government employee separation costs		2.3	0.6	2.2				5.1
Cost of conducting sales		4.0	3.0	3.0				10.0
Unfunded retiree benefits		0.0	0.0	77.0				77.0
Residual sale revenue		-76.1	-67.5	-325.7				-469.3
Total	669.7	597.1	588.7	421.9	628.2	628.2	618.2	4,151.9
Difference (status quo total - privatization total)	24.2	99.4	104.7	271.7	66.5	60.4	66.1	693.0

*Not discounted to present value.

benefits.^{8,9} Based on information provided by OSC, the cost of terminating the facility use contracts is set at zero¹⁰ and the cost of conducting a sale is set at \$1 million.¹¹ Government employee separation costs are estimated based on cost factors provided by OSC of \$48,600 per employee for transfers, \$26,000 per employee for reductions in force (RIFs), and \$33,000 per employee for early retirement incentives (VSIPs). In the base case, we assume all military personnel transfer, 25 percent of civilians are subject to RIF, and 75 percent of civilians receive VSIPs (based on recent experience at the arsenals and ammunition plants). The costs of terminating production contracts are based on compensating contractors for work already completed at the time of termination. However, the maximum length of a production contract is five years, and some contracts can be timed to expire before the facilities are sold. In the absence of more detailed information, we estimated termination of production contracts at 10 percent of production costs (ammunition costs minus production base support, LIF, and MIIF).

We estimated potential revenue from the sale of each plant based on standard corporate financial valuation techniques (see McKinsey, 2001, for example) and available data. These techniques and the resulting estimates are discussed in greater detail in Appendix E. The two primary valuation techniques used are discounted cash flow (DCF) and multiple of sales. Since data on market valuations, capital costs, and earnings before interest and taxation (EBIT) or earnings before interest, taxation, depreciation and amortization (EBITDA) are not available at the plant level, the valuations are based on industry average figures.¹²

⁸By agreement with the Study Advisory Group, we do not include the costs of environmental characterization studies (estimated at \$1.5 million per plant) as a one-time cost of privatization, since these studies would need to be undertaken regardless of the option chosen. In principle, conducting these environmental characterization studies could result in the discovery of additional environmental liabilities. We did not have a basis to estimate any additional liability or to attribute additional remediation costs across future years. In any case, these costs would be incurred both under the status quo and the privatization option.

⁹The Army's liability for post-retirement benefits other than pensions is determined on a case-by-case basis. These liabilities can be triggered by a change in the facility use contractor or a change in production contracts from cost reimbursement to firm fixed price, as well as a privatization. Although these costs are included in our budget projections, it is debatable whether they should be attributed to privatization. (Telephone conversation with AMC Office of General Counsel, June 26, 2002.)

¹⁰Facility use contracts for most of the plants are set to expire in the next few years and could be temporarily extended if necessary pending a sale. (See Table 7.5.) The contracts at Holston and Lake City have recently been recompeted to extend to 2023 and 2025, respectively, but financial penalties from termination are associated mainly with production contracts.

¹¹This estimate is based on projected costs of the LAP competition and recompetition of facility use contracts.

¹²Since we are estimating valuations of the plants from the perspective of potential bidders, we use industry weighted average cost of capital to calculate DCF valuations. However, budget projections are estimated from the perspective of the government, so we use government discount rates as specified in OMB Circular No. A-94 to calculate net present values.

To estimate a lower bound on plant valuations, we calculated the land value of each plant based on the local cost per acre of farmland.

Although the AAPs may have lower cash flow than the industry average, they may also have greater opportunities to increase cash flow through process improvement and investments with positive net present value, or through sale or conversion of excess capacity to other uses.¹³ Industry insiders, particularly the incumbent contractors, are likely to have the most accurate information about how individual plants should be valued. In practice, only a competitive sale can determine the market value of the plants.

For the base case, we assumed that revenues from the sale of each plant were 85 percent of the DCF valuation to allow for the possibility that some ammunition sales could be lost when production contracts are subjected to greater competition.¹⁴ These revenues were first used to offset any remaining environmental liabilities at the time of the sale.¹⁵ Any remaining revenue is shown as “residual sale revenue,” which could be used to offset other one-time costs or to reduce ammunition costs over the first five-year production contract, which we assume would be linked to the sale of the plant. In the base case, the total estimated revenue from the plants (based on the 85 percent of DCF valuations) is \$777.8 million, which is used to offset remaining environmental liabilities of \$308.4 million,¹⁶ so the residual sale revenue is approximately \$469.3 million (allowing for rounding error).¹⁷

Finally, we assume an arbitrary 5 percent reduction in ammunition costs relative to the status quo in each of the first two five-year ammunition production contracts after privatization at each plant. Ammunition costs are assumed to remain 10 percent below the status quo in the remainder of the 20-year period for the base case. Since the ammunition plants appear to be undercapitalized

¹³Army commentators on a draft version of this report suggested a number of possible alternative techniques for valuation, including the use of lower sales revenues, lower operating margins, higher capital costs, and higher tax rates. These alternative techniques produce valuations that fall within the range of valuations in our optimistic, base, and pessimistic cases.

¹⁴As discussed in Chapter Five, firms can earn above-normal profits if they pay less than the actual value of the plant in a privatization. The Army’s ability to obtain the full value of the plants will depend on the competitiveness of the sale.

¹⁵For plants where the environmental liability exceeded the sales revenue, we assumed that all of the sales revenue would be used to offset as many remediation costs as possible, beginning with the year of sale. When funds ran out, the Army would be responsible for the remainder of the liability.

¹⁶This figure represents the entire known environmental remediation liability at the ten plants at the time each plant is sold, so it is greater than the expected remediation spending of \$218.5 million during FY03–09 shown in Table 8.1.

¹⁷Alternatively, we could count the entire \$778 million as a benefit of privatization in the year of sale. This approach would tend to increase the estimated savings, since under the current approach we do not account for any discounting by the contractor for trading an up-front purchase price for paying future environmental remediation costs.

and production contracts will be subjected to greater competition when the plants are no longer protected by the Arsenal Act and other government subsidies, some savings in the total costs of ammunition (including production base support, LIF, and MIIF) should be possible after privatization.

We were not able to obtain any estimates of the number of personnel at OSC and higher headquarters who might be separated if the Army no longer owned each ammunition plant, or the number of any additional contracting or auditing personnel needed if the plants were privatized. Accounting for these personnel could result in additional one-time separation costs, and recurring savings or costs.

Army commentators on a draft version of this report also suggested a number of additional costs that could be included in the budget projections. One of the most significant was the cost of insurance after the plants were privatized.¹⁸ However, Army indemnification of insurance risks at GOCO AAPs is not costless, even though it is not currently budgeted. When casualty losses occur, they are typically paid out of the capital budget for AAP investments (telephone conversation with AMC Office of General Counsel, June 4, 2002). Thus, unless private-sector insurance premiums are higher than the actual risk warrants, insurance costs should be approximately the same whether the Army self-insures a GOCO plant or a privatized plant buys insurance. If the Army believes that private-sector insurance premiums are excessive (for example, because of a misperceived increase in risk after the September 11 terrorist attacks), it still has the option of indemnifying COCO plants for unusually hazardous or nuclear risks under PL 85-804 (50 USC 1431-1435). Therefore, insurance costs for the GOCO plants should not differ significantly after privatization.¹⁹

A second issue was whether an allowance of 35 percent of the plants' estimated operating margins was sufficient to cover both profit taxes and property taxes. However, further calculations indicated that an estimated property tax of \$100 per acre would be offset by considering the deductibility (against profit taxes) of property taxes, environmental remediation costs, and depreciation of the price paid by the new owner for buildings and equipment as part of the privatization. Therefore, 35 percent of the operating margin should be sufficient to cover both types of taxes.²⁰

¹⁸The Army currently indemnifies energetics and LAP operations, but not metal parts production.

¹⁹PL 107-297, which took effect in November 2002, provides for the federal government to cover up to 90 percent of insured losses in the event of an act of terrorism that causes losses exceeding \$1 billion. As a result, insurance premiums for privatized ammunition plants should not be affected by an increased risk of terrorism.

²⁰As an additional technical note, if one believes that operators of the privatized plants could raise the price of ammunition to cover any additional costs such as insurance or property taxes, estimated valuations should be calculated on the basis of these higher revenues.

Finally, it was suggested that up to 75 percent of the current COR staff (120 out of 160 government personnel) would be needed to monitor contracts at the privatized plants. However, some COCO plant operators we contacted indicated that one or fewer full-time government personnel were currently monitoring their plants. In any case, it seems likely that any additional personnel needed to monitor contracts at the privatized plants would be offset by reductions in the number of government personnel needed at OSC and higher headquarters to manage the organic industrial base, although the Army could not provide an estimate of this number.

The final row of Table 8.1 shows the estimated net savings and revenues from privatizing the ammunition plants in each year. It is calculated by subtracting the privatization total costs from the status quo total costs. We summarize the optimistic, base, and pessimistic case estimates of net savings and revenues over the budget and POM in Table 8.2.²¹

For the “optimistic” case, we varied the assumptions in ways that were likely to favor privatization. For the status quo, we used the “conservative” projections of ARMS investments and incentives and ARMS savings. We assumed that the expiration of production contracts could be timed so that there would be no termination costs, that all government civilian employees would be subject to RIF (the least expensive alternative), and that privatization revenue would be based on the multiple of sales valuation. In addition, we assumed that ammunition costs would be reduced by 5 percent relative to the status quo after each

Table 8.2
Privatization Savings and Revenues over the FY03–09 Budget and POM

Scenario	Savings and Revenues (FY01 \$ million)							Total*
	FY03	FY04	FY05	FY06	FY07	FY08	FY09	
Optimistic case	10.7	144.7	123.5	447.5	64.0	58.8	66.4	915.6
Base case	24.2	99.4	104.7	271.7	66.5	60.4	66.1	693.0
Pessimistic case	39.1	40.0	70.3	6.5	27.3	11.8	-12.1	182.8

*Not discounted to present value. These savings and revenues represent benefits to the federal government, a criterion set forth in Chapter Four. The computations assume that the savings and revenues to the federal government would accrue entirely to the Army program and budget. Even if the savings and revenues were for some reason to be used for other, non-Army, purposes, our decision recommendation would not be affected.

²¹Annual savings are not uniformly higher in the optimistic case than in the base and pessimistic cases, primarily because of differences in assumptions about the growth of the ARMS program. For example, we used the most optimistic projections of ARMS program growth from PricewaterhouseCoopers (2001) in the pessimistic budget projections for privatization. Thus, increases in ARMS savings under the status quo outstrip the cost savings from privatization in FY09 in the pessimistic case, but privatization savings are larger in FY03, because higher ARMS investments and incentives are needed up front to achieve higher future ARMS savings.

recompetition of the five-year ammunition production contracts at each plant, so that they would be 20 percent below the status quo at the end of the 20-year projection. Although the overall net savings are higher than in the base case, in some years the optimistic case savings are lower than the base case because of higher spending on ARMS investments and incentives in the base case.²²

For the “pessimistic” case, we varied the assumptions in ways that were likely not to favor privatization. For the status quo, we used the “aggressive” projections of ARMS investments and incentives and ARMS savings. We increased the cost of terminating production contracts to 15 percent of production costs, and we assumed that all government civilian employees would receive VSIPs (the most expensive alternative). We based privatization sale revenue on the higher of discounted cash flow with a 10 percent annual decline or the land value,²³ and we increased the cost of conducting each sale to 3.5 percent of the purchase price. In addition, we assumed that ammunition costs would remain the same as the status quo. Even under these pessimistic assumptions, there is a net savings from privatization in almost every year in the POM. The cost increase attributed to privatization in FY09 is due primarily to optimistic assumptions about the increase in ARMS savings in PricewaterhouseCooper’s “aggressive” scenario. The variations in the assumptions for the base case, optimistic case, and pessimistic case are summarized in Table 8.3.

Table 8.3
Variations in Privatization Assumptions

	Pessimistic	Base Case	Optimistic
Ammunition cost reduction	None	5% in first 2 5-year contracts (10% cumulative)	5% in each 5-year contract (20% cumulative)
Revenue from sale	DCF with 10% decline	85% of DCF	Multiple of sales
ARMS program	Aggressive scenario	Most likely scenario	Conservative scenario
Cost to terminate production contracts	15% of FY01 revenues	10% of FY01 revenues	None
Government employee separation costs	100% VSIP	25% RIF/75% VSIP	100% RIF
Cost of conducting sale	3.5% of sale price	\$1 million per plant	\$1 million per plant

²²Although the increases in ARMS program savings eventually exceed spending on investments and incentives at most plants, typically this does not happen until the “out-years” of the projections.

²³We assume that the land value sets a lower bound on privatization revenue.

Table 8.4
Net Present Values of Privatization Savings and Revenues
 (amounts in FY01 \$ million)

	FY03-09		FY03-22	
	3%	7%	3.5%	7%
Optimistic case	840.3	754.1	1,583.3	1,239.7
Base case	634.6	568.2	1,061.6	860.9
Pessimistic case	174.3	164.3	-64.3	6.1

Table 8.4 shows the net present value of privatization savings and revenues over the FY03-09 budget and POM and over the entire 20-year projection. We calculate each group of net present values based on two interest rates specified in OMB Circular A-94. Real discount rates for cost-effectiveness analysis are specified in Appendix C of the circular as 3.0 percent for a 7-year time horizon and 3.5 percent for a 20-year time horizon. The real discount rate for public investment is specified on page 7 as 7 percent. Note that the net present value of privatization is positive for each set of assumptions, time horizon, and interest rate, except the pessimistic case over the FY03-FY22 period, when discounted at 3.5 percent. This occurs primarily because of optimistic assumptions about the growth in ARMS savings in PricewaterhouseCoopers (2001), particularly in the out-years of the budget projections. Although we would argue that the Army should not accept a bid for an individual plant that has a negative NPV,²⁴ such decisions should be based on the sale revenue from privatization and projected ammunition costs, not assumptions about the growth in ARMS revenues that may not be realized.

Creation of Arsenal FGC

Since ownership of the arsenals would be transferred from the Army to the federal government under the FGC option, we estimated the potential effects of creating an arsenal FGC on both the Army budget and the federal government budget as a whole over the FY03-09 budget and POM period and from FY03 to FY22. As in the privatization analysis, we chose a relatively conservative set of assumptions for the base case, and varied some of these assumptions in "optimistic" and "pessimistic" cases to test the sensitivity of the results. As an illustration of the methodology, the base case budget analysis over the budget

²⁴In this particular case (pessimistic assumptions, FY03-22 time horizon, 3.5 percent interest rate), five of the ten individual plants have positive NPVs for privatization; the other five have negative NPVs. Information on individual plants' NPVs is given in a proprietary appendix.

and POM for the government and the Army is shown in Tables 8.5 and 8.6, respectively, using Rock Island Arsenal as an example. The remainder of the results are shown in a summarized format, with the full detail over 20 years for both arsenals given in Appendix D.

For the status quo base case government budget effects, ordnance costs include all AWCF funding except foreign military sales (FMS),²⁵ government tenant assessments and upkeep of Army housing, and IMC and other supplemental funds added to the AWCF. The latter two items are listed separately. Projected IMC funding for FY03–07 was provided by OSC; we extended the FY07 level to future years. Projected environmental remediation spending through 2015 was

Table 8.5

Example of Estimated Government Budget Impacts: Base Case for Rock Island Arsenal

Cost Category (FY01 \$m)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total*
Status quo								
Ordnance costs (excl. FMS)	108.5	108.5	108.5	108.5	108.5	108.5	108.5	759.2
Government tenants	28.0	28.0	28.0	28.0	28.0	28.0	28.0	195.9
IMC	27.4	27.8	28.5	29.3	30.0	30.0	30.0	203.1
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.8
Agric. & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	164.1	164.5	165.2	166.0	166.7	166.7	166.7	1160.0
FGC								
Ordnance costs (excl. FMS)	108.5	30.5	30.5	30.5	30.5	30.5	30.5	291.6
Government tenants	28.0	27.5	27.5	27.5	27.5	27.5	27.5	193.3
IMC	27.4	70.1	35.9	25.0	9.8	0.0	0.0	168.2
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.8
Agric. & forestry revenues	0.0							0.0
Employee retraining		1.1	0.8	0.1	0.2	0.0	0.0	2.1
FGC transition costs	8.0							8.0
Working capital infusion		45.7						45.7
Payoff of AWCF AOR		11.8						11.8
Unfunded retiree benefits		0.0						0.0
Profit accruing to gov't		-6.2	-10.3	-11.7	-14.2	-15.5	-15.5	-73.5
Total	172.1	180.8	84.7	71.7	54.0	42.8	42.8	648.9
Difference (Status quo – FGC)	-8.0	-16.3	80.5	94.3	112.7	123.9	124.0	511.1

*Not discounted to present value.

²⁵We excluded FMS from government and Army budget and savings estimates because these costs and savings accrue to foreign governments. FMS represents less than \$100,000 of FY01 revenues at Rock Island, but approximately 75 percent of FY01 revenues at Watervliet.

provided by OSC. For the FGC base case government budget impacts, the costs of ordnance, government tenants, and IMC are based on the business plans discussed in Chapter Six. Ordnance costs are assumed to transition immediately to market levels; additional funding needed to cover the costs of temporarily retaining excess capacity and paying workers who have not yet transitioned to commercial work are shifted to IMC. Government tenant costs are assumed to stay the same as the status quo, but funding for Army housing is eliminated, since maintenance of the housing is assumed to be funded by the FGC. The Army is assumed to retain the liability for environmental remediation.²⁶

During the year before the creation of the FGC, the federal government is assumed to hire a transition manager to develop a business plan and draft a

Table 8.6
Example of Estimated Army Budget Impacts: Base Case for Rock Island Arsenal

Cost Category (FY01 \$m)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total*
Status quo								
Ordnance costs (excl. FMS)	106.8	106.8	106.8	106.8	106.8	106.8	106.8	747.7
Army tenants	24.9	24.9	24.9	24.9	24.9	24.9	24.9	174.3
IMC	27.4	27.8	28.5	29.3	30.0	30.0	30.0	203.1
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.8
Agric. & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	159.3	159.7	160.5	161.2	162.0	162.0	162.0	1126.8
FGC								
Ordnance costs (excl. FMS)	106.8	30.1	30.1	30.1	30.1	30.1	30.1	287.1
Army tenants	24.9	24.5	24.5	24.5	24.5	24.5	24.5	171.6
IMC	27.4	69.0	35.4	24.6	9.6	0.0	0.0	166.0
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.8
Agric. & forestry revenues	0.0							0.0
Employee retraining								0.0
FGC transition costs								0.0
Working capital infusion								0.0
Payoff of AWCF AOR		11.8						11.8
Unfunded retiree benefits		0.0						0.0
Profit accruing to govt								0.0
Total	159.3	135.6	90.2	79.4	64.4	54.8	54.8	638.4
Difference (Status quo – FGC)	0.0	24.2	70.3	81.8	97.6	107.2	107.2	488.4

*Not discounted to present value.

²⁶Since environmental liabilities at the two arsenals are low, this assumption does not have much impact on the overall results.

charter for the FGC.²⁷ When the FGC is created, the federal government must provide working capital to launch the business. For the base case, we estimate working capital requirements at 30 percent of FY01 revenues, based on similar industries in the 1997 Economic Census. The Army is responsible for each of the arsenals' AWCF Accumulated Operating Results (AOR), which we based on the FY01 recoverable AOR in Exhibit 14 of the June 2001 AWCF budget submission for each arsenal. We also assume that the FGC incurs training costs of \$5,000 per worker transitioned from indirect to direct work. Finally, as the owner of 100 percent of the FGC's equity, the federal government is assumed to be entitled to the profit stream of the FGC, net of state and local taxes. To estimate annual profits, we applied the average industry operating margin of 13.57 percent (Ibbotson Associates, 2001) to ordnance revenues from government customers and FMS and to commercial revenues, less an estimated tax rate of 10 percent.²⁸

The effects on the Army budget shown in Table 8.6 vary from the government effects in several respects. Revenues from non-Army ordnance customers and non-Army tenants are excluded from both the status quo and FGC budget impacts. In the FGC budget impacts, IMC funding is prorated to reflect higher-than-market prices charged to non-Army customers during the transition to commercial workload.²⁹ Funding for environmental remediation and the AWCF AOR is assumed to remain with the Army. However, the federal government is assumed to pay FGC transition costs, provide initial working capital for the FGC, and receive FGC profits. Employee retraining costs are assumed to be deducted from the FGC's operating margin.

Table 8.7 summarizes the base case government and Army budget impacts over the FY03–09 budget and POM from the creation of an arsenal FGC. Over a seven-year time horizon, budget effects do not differ very much for the government and the Army, since additional transition costs paid by the federal government are offset by the accrual of FGC profits. However, over a 20-year time horizon, government savings and revenues tend to be higher than Army savings and revenues because profits continue to be earned, whereas no addi-

²⁷By agreement with the Study Advisory Group, we do not include the costs of environmental characterization studies (estimated at \$1.5 million per arsenal) as a one-time cost of creating an arsenal FGC, since these studies would need to be undertaken regardless of the option chosen. In principle, conducting these environmental characterization studies could result in the discovery of additional environmental liabilities. We did not have a basis to estimate any additional liability or to attribute additional remediation costs across future years. In any case, these costs would be incurred both under the status quo and the FGC option.

²⁸The state corporate tax rates for New York and Illinois are 7.5 percent and 7.3 percent, respectively. The remainder is an allowance for property taxes.

²⁹Since FMS represents a large share of revenues at Watervliet, it seemed appropriate to assume that other customers would continue to bear some of the costs of excess capacity during the transition period.

Table 8.7
FGC Savings and Revenues over the FY03–09 Budget and POM: Base Case

	Savings and Revenues (FY01 \$m)							Total*
	FY03	FY04	FY05	FY06	FY07	FY08	FY09	
Rock Island Arsenal								
Government	-8.0	-16.3	80.5	94.3	112.7	123.9	124.0	511.1
Army	0.0	24.2	70.3	81.8	97.6	107.2	107.2	488.4
Watervliet Arsenal								
Government	-8.0	-33.9	23.3	33.7	36.1	44.2	44.2	139.6
Army	0.0	-9.3	18.7	26.5	28.2	35.0	35.0	134.1
Total								
Government	-16.0	-50.3	103.8	128.0	148.8	168.1	168.2	650.7
Army	0.0	14.9	89.0	108.3	125.8	142.2	142.2	622.5

*Not discounted to present value.

tional transition costs are incurred. Although there are likely to be some additional costs in FY03 to both the government and the Army, and to the government in FY04, there are large potential savings from the FGC's transition to commercial workload in FY05–FY09.

For the “optimistic” case, we varied the assumptions in ways that were likely to favor creation of an arsenal FGC. We reduced employee retraining costs to \$3,000 per employee, FGC transition costs to \$5 million, and working capital requirements to 28 percent of FY01 revenues. We also assumed that the arsenal FGC would be able to bring in additional commercial workload beyond Year 5 of the business plans in Chapter Six, so that total ordnance and commercial revenues would increase at 3 percent per year. Profits were calculated based on the industry average operating margin for large firms, 14.56 percent (Ibbotson Associates, 2001). The summary results for the optimistic case are shown in Table 8.8. In practice, these changes did not cause a large variation in the resulting government budget impacts, particularly over a seven-year horizon. They resulted in no change to the Army budget impacts, since the changes in assumptions only affected federal government costs and revenues.

For the “pessimistic” case, we varied the assumptions in ways that were likely to be unfavorable to creation of an arsenal FGC. We increased employee retraining costs to \$10,000 per employee, FGC transition costs to \$10 million, and working capital requirements to 36 percent of FY01 revenues. We also assumed that the arsenals would not be able to complete the transition to commercial work. We fixed total ordnance and IMC cost reductions at Year 2 of the business plans in Chapter Six, representing a 47 percent cost reduction at Rock

Table 8.8
FGC Savings and Revenues over the FY03–09 Budget and POM: Optimistic Case

	Savings and Revenues (FY01 \$m)							
	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total*
Rock Island Arsenal								
Government	-5.0	-12.4	81.5	95.2	113.8	125.1	125.6	523.8
Army	0.0	24.2	70.3	81.8	97.6	107.2	107.2	488.4
Watervliet Arsenal								
Government	-5.0	-31.8	23.9	34.4	36.7	44.9	45.2	148.2
Army	0.0	-9.3	18.7	26.5	28.2	35.0	35.0	134.1
Total								
Government	-10.0	-44.2	105.5	129.6	150.5	169.9	170.8	672.0
Army	0.0	14.9	89.0	108.3	125.8	142.2	142.2	622.5

*Not discounted to present value.

Island and a 55 percent cost reduction at Watervliet. Prices charged to government and FMS customers did not fully fall to commercial levels, but the FGC had to set market prices for commercial work in order to attract business. As a result, the Army had to continue to provide IMC funding for underutilized capacity. We also froze commercial work at Year 2 of the business plans and reduced the operating margin to the industry median of 10.27 percent (Ibbotson Associates, 2001). Although these assumptions resulted in a reduction in expected savings to the government and the Army, the overall budget and program effects were still positive, as shown in Table 8.9. We summarize the variations of the assumptions for the base case, optimistic case, and pessimistic case in Table 8.10.

Table 8.9
FGC Savings and Revenues over the FY03–09 Budget and POM: Pessimistic Case

	Savings and Revenues (FY01 \$m)							
	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total*
Rock Island Arsenal								
Government	-10.0	-28.1	77.2	79.5	80.3	80.3	80.3	359.5
Army	0.0	24.0	70.2	70.9	71.7	71.7	71.7	380.2
Watervliet Arsenal								
Government	-10.0	-40.2	21.5	23.2	23.8	23.8	23.8	65.9
Army	0.0	-9.3	18.7	19.3	19.9	19.9	19.9	88.3
Total								
Government	-20.0	-68.2	98.7	102.7	104.1	104.1	104.1	425.4
Army	0.0	14.7	88.9	90.2	91.6	91.6	91.6	468.5

Table 8.10
Variations in FGC Assumptions

	Pessimistic	Base Case	Optimistic
Conversion to commercial workload	Year 2 in Ch. 6 business plan	Year 5 in Ch. 6 business plan	Year 5 in Ch. 6 business plan + 3% annual growth
Retraining costs per employee	\$10,000	\$5,000	\$3,000
FGC transition costs	\$10 million	\$8 million	\$5 million
Working capital requirement	36% of revenues	30% of revenues	28% of revenues
Operating margin	10.27%	13.57%	14.56%

The final two tables show the net present values of savings and revenues from creation of an arsenal FGC over the FY03–09 budget and POM (Table 8.11) and over the entire 20-year projection (Table 8.12) for both the government as a whole and for the Army. As in the case of the privatization savings and revenues, we use both types of interest rates specified by OMB Circular A-94. For each set of assumptions and for both the Army and the federal government as a whole, the net present value of creating an arsenal FGC is positive.

Table 8.11
Net Present Value of FGC Savings and Revenues: FY03–09 Budget and POM
(amounts in FY01 \$ million)

	3% Interest Rate			7% Interest Rate		
	Pessimistic	Base	Optimistic	Pessimistic	Base	Optimistic
Rock Island Arsenal						
Government	316.1	449.2	461.1	268.1	381.0	392.0
Army	340.0	433.7	433.7	295.2	373.2	373.2
Watervliet Arsenal						
Government	54.1	119.1	127.3	41.1	96.7	104.3
Army	77.7	117.4	117.4	66.0	99.1	99.1
Total						
Government	370.2	568.3	588.4	309.2	477.6	496.3
Army	417.6	551.1	551.1	361.2	472.2	472.2

Table 8.12
Net Present Value of FGC Savings and Revenues: FY03–22
(amounts in FY01 \$ million)

	3.5% Interest Rate			7% Interest Rate		
	Pessimistic	Base	Optimistic	Pessimistic	Base	Optimistic
Rock Island Arsenal						
Government	982.3	1478.8	1536.0	715.1	1071.3	1111.0
Army	934.9	1324.2	1324.2	694.6	970.4	970.4
Watervliet Arsenal						
Government	251.7	486.6	521.6	173.7	342.9	367.5
Army	242.5	408.0	408.0	176.6	293.8	293.8
Total						
Government	1234.1	1965.4	2057.6	888.8	1414.2	1478.5
Army	1177.4	1732.2	1732.2	871.2	1264.3	1264.3

DEPOT DUPLICATION

As part of this study, we were asked to examine the question of whether duplicative capabilities between the arsenals (Watervliet and Rock Island), on the one hand, and the repair depots, on the other, currently allow for consolidating workload between these facilities. For the purposes of this limited inquiry, we assume that these facilities will remain government-owned. Additionally, since the overall study focuses on the Army's manufacturing facilities (arsenals and ammunition facilities), we have limited our assessment of the depots to the question posed at the beginning of this paragraph. We therefore avoid doing an in-depth analysis of the government depot system similar to what we have done for the government arsenals and ammunition facilities in the main body of this report.

While the scope of the question posed to us is quite narrow, the larger question of consolidating the workloads at the Army's depots and arsenals is clearly one that should be addressed. Today, the depots are primarily staffed, organized, and equipped for repairing and rebuilding military equipment. The arsenals, on the other hand, are staffed, organized, and equipped for manufacturing of new military equipment. This division of labor and missions occurred several decades ago in response to conditions at the time and may not be appropriate to current missions and workloads. Therefore, in the context of a larger organic Army industrial base reorganization, there may be efficiencies to be gained by consolidating functions between these two types of organizations and facilities.¹ While a study to examine those issues is beyond the scope of our current effort, we recommend that the Army conduct the study in the near future.

The Army has five repair depots. These are Anniston Army Depot (ANAD), which primarily focuses on ground combat systems; Red River Army Depot (RRAD), responsible for ground combat and support systems; Corpus Christi

¹This study should be done regardless of whether all the facilities remain GOGO or whether, as we recommend in Chapter Seven, the arsenals are organized as FGCs.

Army Depot, the Army's repair depot for helicopters; Tobyhanna Army Depot, an electronics repair facility; and Letterkenny Army Depot, the Army's primary missile repair depot. To limit the scope of this inquiry, we focus the current discussion on ANAD and RRAD, since these two facilities have capabilities and missions most closely related to the two manufacturing arsenals.

Examination of the above question requires an understanding of the various facility missions, commonality between products, equipment and capabilities, and the scale of their respective capabilities. The information and data used in this appendix are based on interviews and data provided primarily by HQ AMC and its subordinate organizations. We also relied on information published by the Joint Group on Depot Maintenance to get an overall view of depot characteristics.

MISSION ANALYSIS

We start the analysis by looking at the missions of the respective facilities. The primary mission of Rock Island Arsenal (RIA) and Watervliet Arsenal (WVA) is the manufacture of weapon systems or major components of weapon systems. In the case of RIA, its historically important products are gun mounts and towed artillery systems. WVA is primarily responsible for manufacturing large-caliber cannon for tank and artillery systems as well as mortars.

Both arsenals have peacetime and replenishment production requirements. Peacetime requirements are determined solely on the basis of customer orders. As noted elsewhere in this report, peacetime production at both arsenals has declined precipitously. Since the end of the Cold War, production of cannon, guns, and mortar tubes at WVA has declined roughly 90 percent. In 1989, approximately 2,000 large-caliber guns and mortars were produced, while now only about 200 are produced annually. The decline at Rock Island is similar. In 1989, over 900 gun mounts and towed howitzers were produced. Today, fewer than 100 similar items are produced annually.

Replenishment production missions at the arsenals are for the same kinds of items the arsenals produce in peacetime. In the past, the type and quantity of these items was derived from a critical items list (CIL) provided by the Department of the Army. Such a list, however, has not been published for at least five years. Consequently, the Army Materiel Command derived a list of major weapon system losses based on Department of the Army guidance.² As a result of this effort, AMC estimates that the combined replenishment requirement at both RIA and WVA includes approximately 80 types of items with an approxi-

²Importantly, this list only contains legacy systems, not systems planned for future procurement.

mate total quantity of 6,500 piece parts. Many of the items produced at RIA are in quantities of less than 100, and those produced at WVA are split between quantities of less than 100 and quantities between 200 and 400. Production for replenishment purposes is planned to take a total of three years.

The repair depots perform repair and remanufacture of weapons systems and vehicles during peacetime and in support of military operations.³ Unlike the arsenals, though, the Army has no current estimate of maintenance requirements at the depots within the context of the Total Army Analysis.

The mission to “manufacture” has some processes that are similar to “remanufacture and repair,” but there are also distinct processes. Manufacture at the arsenals involves the fabrication of components, assembly of components into subassemblies and finished products, inspection, and test. Remanufacture and repair also requires the assembly of components into subassemblies and finished products, inspection, and test. In addition, however, the depot mission implies disassembly processes and significant diagnostic capability. Repair functions, particularly when needed because of combat damage or accidents, also often require nonstandard inspection and restoration of damaged material.

The distinctions between the manufacturing mission and the remanufacture/repair mission result in important differences between the arsenals and the depots. Disassembly is labor-intensive and difficult to automate. Also, the remanufacture and repair mission typically does not involve the fabrication of components, which is a part of manufacturing. Instead, the depots tend to rely on the Army/DoD supply system for any parts needed. They do maintain, however, some capability to manufacture or rebuild components when they are not available from the supply system. This is a limited capability and typically is used only when a maintenance program might be delayed because the original manufacturer has no current production and the part is not in the standard supply system.⁴

COMMON PRODUCTS

Some product similarities exist between RIA and ANAD, though the similarities are not deep. As the depot-level repair and overhaul facility for the Abrams tank

³10 USC 2464 requires the United States to maintain government-owned and -operated facilities to perform core logistics functions. Paragraph 3 of the statute defines that capability as including “those capabilities that are necessary to maintain and repair the weapon systems and other military equipment.”

⁴In some cases, a supply item manager may also request the depot to make sufficient parts for sustainment stocks.

and for towed and self-propelled artillery systems,⁵ ANAD has a capability for the repair and remanufacture of gun mounts and towed artillery systems that are manufactured by RIA. As an example, ANAD rebuilds 105mm towed howitzers.⁶ At the end of the rebuild process, an artillery piece emerges that is in a condition similar to when it was delivered new from RIA. Although the *product* is similar, the *processes* to produce the product are quite different. ANAD starts with a worn-out or damaged weapon and rebuilds it through parts replacement and the limited remanufacture of some components. RIA starts from scratch and fabricates most of the components on site. The same is true for other RIA products that are rebuilt or repaired at ANAD. RRAD does not generally work on artillery or tank systems that use RIA products. As a result, its product line is not common with RIA.

Neither depot produces or remanufactures WVA products: large-caliber cannon and mortars. While tanks and artillery pieces are repaired and remanufactured at the depots, when that process includes the replacement of a cannon, WVA supplies the cannon.

COMMON EQUIPMENT

Table A.1 provides a top-level accounting of equipment at the arsenals and depots. An examination of the table suggests, as one would expect, that the equipment at each location supports the mission of that particular facility.⁷ The cleaning, painting, and pressing machines prevalent at the depots are usual for repair facilities. Not shown on the chart is that the vast majority of specialized test equipment is also located in the depots in support of their repair mission. Notably, metal-working machines are prevalent at the arsenals and are indicative of the manufacturing mission there. Furnace, foundry, and forging and forming equipment and facilities are also concentrated in the arsenals to support the fabrication of metal components from scratch. This indicates that absent the relocation of specific equipment from one location to another or the purchase of new equipment, consolidating the arsenal missions to the depots, or vice versa, would pose significant difficulties.

⁵Anniston Army Depot website, December 17, 2001, <http://www.anad.army.mil/Mission/missions.htm>.

⁶This requires, in part, adding metal to the recuperator piston and machining this piece back into very fine tolerance. The machining of this part is a process for which RIA previously claimed a unique capability.

⁷Importantly, what a high-level accounting such as Table A.1 does not reveal is the highly specialized equipment that supports facility-specific requirements. For example, swaging and rifling machines are unique to WVA because of the unique role this equipment plays in the manufacture of large-caliber cannon. Likewise, only RRAD has the rubber processing equipment used to remove and install rubber products from combat vehicle suspension components. They have developed a manufacturing capability around this equipment and are the only facility that has that mission.

Table A.1
Summary of Production Equipment at the Army Arsenal and Depots

Type of Machine	RIA	WVA	ANAD and RRAD
Painting	6	2	16
Electric discharge	4	5	6
Shearing	9	3	7
Mills	25	3	13
Clean and blast	34	11	31
CNC & NC mills	33	27	8
Pressing	49	20	81
Drills	53	31	11
Furnace and foundry	78	42	6
Cut and weld	95	9	11
Plating	109	5	8
Conventional lathes	94	106	22
CNC lathes	62	62	5
Grinding	190	150	14

SOURCES: All data were provided by arsenal and depot personnel between June and October 2001. Data for RIA represents the required equipment inventory. Required inventory was provided to RAND because RIA is in the process of reducing equipment inventories to their required level. Data for WVA, ANAD, and RRAD represent on-hand inventory, which is the same as the required inventory in those cases.

SCALE

A related issue to that of equipment commonality is the issue of scale. By scale we mean the facility size, in terms of equipment, personnel, and other infrastructure, to carry out the missions assigned to each location. Scale complicates the ability to consolidate the missions of arsenals and depots when, as shown above, the missions of the various facilities require relatively specific equipment and facilities. Figure A.1 is a graphical layout of Table A.1, and it makes clear the scaling issue. To meet peacetime and replenishment production missions, the ratio of many types of general manufacturing equipment at the arsenals to that at the depots is high. Even the reduced production levels required of the arsenals today would be difficult for the depots to achieve.

For example, ANAD is rebuilding fewer than 20 105mm artillery pieces per year using a labor-intensive process, but the RIA requirement for peacetime plus replenishment production of similar items is nearly an order of magnitude greater. Not only is the quantity much greater, but also the equipment required to manufacture from scratch, as opposed to remanufacture, precludes a simple consolidation of this RIA mission to ANAD.

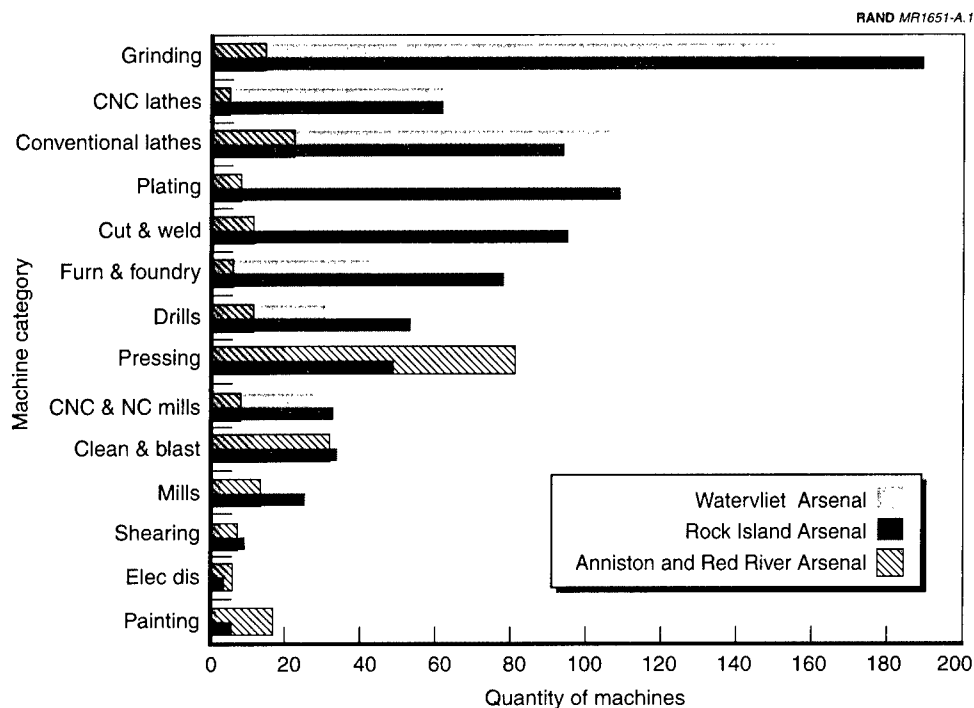


Figure A.1—Production Equipment at Army Arsenals and Depots

In a similar manner, both ANAD and RRAD have some capability to duplicate some of WVA's secondary item manufacturing or use distinct manufacturing processes that yield acceptable product.⁸ Neither, however, could produce such items in replenishment quantities.

Scale is also an issue in determining whether the mission of the depots could be consolidated at the arsenals. Here the problem is less equipment than it is people.⁹ WVA employs 400–500 personnel, of whom about a quarter are direct labor.¹⁰ Few, if any, of these employees are experienced in remanufacture, particularly concerning areas of depot expertise in automotives, electronics, and optics. While the skills of the WVA labor force are probably similar enough to those at the depot to allow retraining for remanufacture, that would take a substantial amount of time. More importantly, the two depots employ 3,800 personnel to accomplish their missions. For WVA to take on the mission of one

⁸Neither facility has the capability to produce WVA's primary products, large-caliber gun tubes.

⁹A significant equipment problem remains, particularly for test equipment.

¹⁰U.S. Department of the Army, AWCF, 2001, Exhibit 24a.

or both depots would therefore require a severalfold increase in the size of its workforce. The situation at RIA is similar, though not as severe. RIA employs 1,100–1,200 personnel, so a significant workforce increase would still be required.¹¹ Like WVA, the employees at RIA would also need to be retrained in the repair and remanufacture mission.

CONCLUSION

Returning to the question asked at the beginning of this appendix—whether duplicative capabilities between the arsenals and the repair depots allow for consolidating workload between these facilities—we answer in the following manner. ANAD and RRAD can make many Rock Island core products and secondary WVA components¹² at low volume. However, producing the quantities of items required for replenishment, or even significant peacetime production, would be difficult. Additionally, producing larger products (e.g., shaping artillery trails) would be a challenge, while the lack of specialized equipment and facilities preclude the depots from manufacturing large-caliber gun tubes. The arsenals have a limited potential capability to remanufacture depot items, but this capability is limited by the smaller employee populations at the arsenals and their lack of experience in the remanufacture of materiel, particularly automotive and electronics. In sum, while the consolidation of workloads from the arsenals to the repair depots appears straightforward at first glance, such an endeavor is far from trivial.

¹¹Ibid.

¹²E.g., breech components.

REPLENISHMENT

A perceived requirement to maintain sufficient production capability to replenish ordnance materiel used during hostilities emerges as one of the most important, perhaps *the* most important, justifications for maintaining government ownership of an organic industrial base. Although an overall analysis of the options for the Army's industrial base may be undertaken with only a general discussion of the replenishment requirement, the importance of the subject requires a more detailed discussion. This appendix serves that purpose.

Our discussion of replenishment begins by describing current policy and how implementation of current policy has justified the retention of the government's organic industrial base. We also compare the policy for missile production and replenishment with that of conventional ammunition.¹ Finally, we outline and recommend an integrated replenishment policy that treats the maintenance of a replenishment capability as a separate good or service that must be justified, planned, and budgeted for in the annual budget cycle.

DEFINITION OF REPLENISHMENT

Replenishment is the replacement of consumed stock. Consumption may be the result of use, disrepair, destruction, or obsolescence. For ammunition and other ordnance materiel, replenishment typically refers to the replacement of stocks expended, lost, destroyed, or degraded after a military conflict. Replenishment has to do with replacing stocks that have already been consumed and occurs after conflicts and in preparation for other potential, but not imminent,

¹DoD Directive 5160.65 defines the following as being conventional ammunition: small arms, mortar, automatic cannon, artillery, ship gun ammunition, bombs (cluster, fuel air explosive, general purpose, and incendiary), unguided rockets, projectiles and submunitions, chemical ammunition with various fillers (incendiary, riot control, smoke, toxic agents, burster igniters, peptizers, and thickeners for flame fuel), land mines (ground-to-ground and air-to-ground delivered), demolition materiel, grenades, flares, and pyrotechnics.

hostilities. Replenishment, a peacetime concept, is the basis of our current national security strategy.

A contrasting concept is that of surge. Here we define surge as increased production to meet increased demand for a product needed to meet the requirements of an ongoing or imminent military conflict. Surge, a wartime policy, is not part of the current national security strategy.

CURRENT REPLENISHMENT STRATEGY

DoD policy requires the services to be able to replenish in kind or with reasonable substitutes, the projected consumption, damage, or destruction (for one major theater of war) of troop support items, spares, components, and assemblies, generally within three years. While ordnance items made at the arsenals generally fall under this directive, whether ammunition does is ambiguous. According to interviews with DoD officials (Melita, personal communication, 2001), the ambiguity is calculated and is intended to allow, indeed require, the Army to formulate replenishment policies for conventional and other munitions. The process of formulating these policies remains somewhat undirected and is further described in Chapter Three. Current assumptions concerning ammunition replenishment² are therefore based on previous DoD policy. That policy called for the replenishment of each planned ammunition item, over a three-year period following the end of hostilities, of the planned consumption of that item from the more severe of two major theater wars (MTW).

For the ordnance materiel made at the Watervliet and Rock Island Arsenals, replenishment planning is reasonably straightforward. Approximately every two years, an Army planning process culminates in a Total Army Analysis (TAA) that defines, among other things, expected replenishment requirements of ordnance items through combat losses. These numbers are provided to Army Materiel Command and ultimately to OSC for planning purposes. In the case of items produced at the arsenals, the total replenishment requirements are small compared to total capacity at the arsenals.

Figure B.1 shows the average production of the major ordnance items at the arsenals over the last three years, the currently planned replenishment requirements for major items,³ and the production capacity of the respective

²By "current" we mean those assumptions documented in the current Production Base Plan (PBP) that have been embedded in the numerous briefings received from Operational Support Command personnel over the course of this study.

³Each arsenal also has replenishment requirements for spare parts that will be required due to the increased usage of systems during the MTWs. In the case of Rock Island, spare parts replenishment requires 25 to 30 additional man-years of labor per year out of a direct labor workforce of greater than 350.

RAND MR1651-B.1

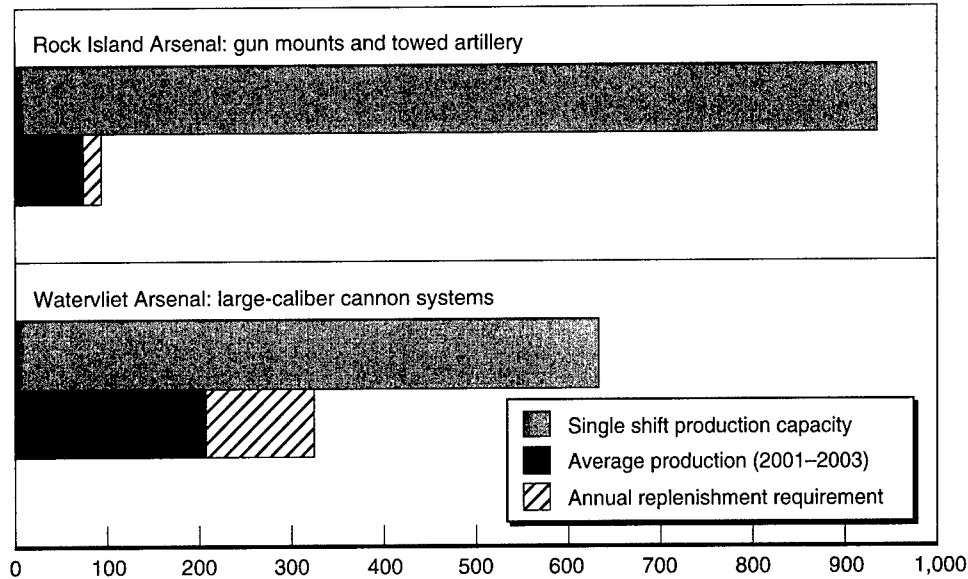


Figure B.1—Arsenal Production, Replenishment Requirements, and Capacity

arsenals.⁴ At WVA, replenishment requirements represent about a 50 percent increase over peacetime production: an increase that could be easily managed within that facility's capacity. Rock Island's annual replenishment requirements are even smaller compared to total capacity and peacetime production (Larsen, e-mail, 2002).

Ammunition replenishment planning is more complex than that required for the arsenals, for a number of reasons.⁵ First, the total number of items involved is greater. In the most recent production base plan for which we have data, the Army tracked 455 ammunition items from all the services' requirements. The Air Force and Navy provide replenishment requirements for conventional ammunition to the Army. These are combined with the Army's requirements to form the total ammunition replenishment requirements for conventional ammunition. OSC then analyzes the list to identify which items require replenishment planning. This analysis examines factors such as current production capability, economics, and ease of creating or finding a production capability

⁴Annual capacity figures are estimates and are based on discussions with arsenal personnel and on extrapolations from historic production, equipment inventories, and personnel numbers.

⁵The data concerning ammunition replenishment production in this appendix are drawn primarily from the current Ammunition Production Base Plan that was published in 1999. Actual figures at the current time may vary slightly, but since this discussion is about replenishment *planning*, planning data were used.

when one is not currently identified. The most recent analysis identified ammunition end items and components⁶ that OSC believes would be at risk of not being produced in the replenishment period without additional government management. The final list is then assembled into a Production Base Plan (PBP). The current PBP dates to 1999 and contains 171 ammunition end items and 302 ammunition components. Data associated with each item, such as producer name and production capacities, are compiled into the PBP, potential problems are identified, and the PBP becomes a management tool for planning ammunition replenishment production.

The current ammunition replenishment production strategy is based on using a mix of government and commercial facilities. A total of fourteen Army ammunition facilities and two other government-owned facilities use 57 production lines to share responsibility for the replenishment production of approximately 300 ammunition items.⁷ Over 50 commercial producers use about 125 production lines to share responsibility for the replenishment production of about 250 items in commercially owned or leased facilities.⁸ Decisions about where the replenishment capability for a specific item will reside are based on a combination of historical circumstance, considerations of total capacity, factors of unique capability, and whether there is peacetime production of the item or similar items.

Of the nearly 550 item-line combinations of ammunition components and end items listed in the PBP,⁹ replenishment production of three-quarters of these is planned on lines that had some production anticipated for 2002. Production of the other quarter is planned for lines that are currently laid away or are otherwise inactive.¹⁰ Figure B.2 presents the breakout between government-owned facilities and commercial facilities. Production lines on government facilities are more likely than commercial lines to be currently active. This is because, on average, replenishment production of more than five ammunition items is

⁶There is not much of a distinction between end items and components for replenishment production planning purposes. Denoting an item as an end item usually just means that the production process planned is final load, assembly, and pack (LAP). Component production processes are those associated with a particular component, for example forging and machining for artillery projectile metal parts.

⁷In addition to the fourteen Army ammunition plants, the Naval Surface Warfare Center at Dahlgren, Virginia, is responsible for replenishment production of two items, as is Watervliet Arsenal.

⁸Since the current PBP was published, a number of consolidations have occurred within the ammunition business. The number of commercial ammunition producers responsible for replenishment production at commercially owned facilities is now fewer than 50.

⁹An item-line combination is a unique combination of a specific ammunition end item or component and a specific production line. This combination is used because there are some items that are produced on multiple lines and some production lines that produce multiple items.

¹⁰Twelve items do not have a producer identified in the PBP.

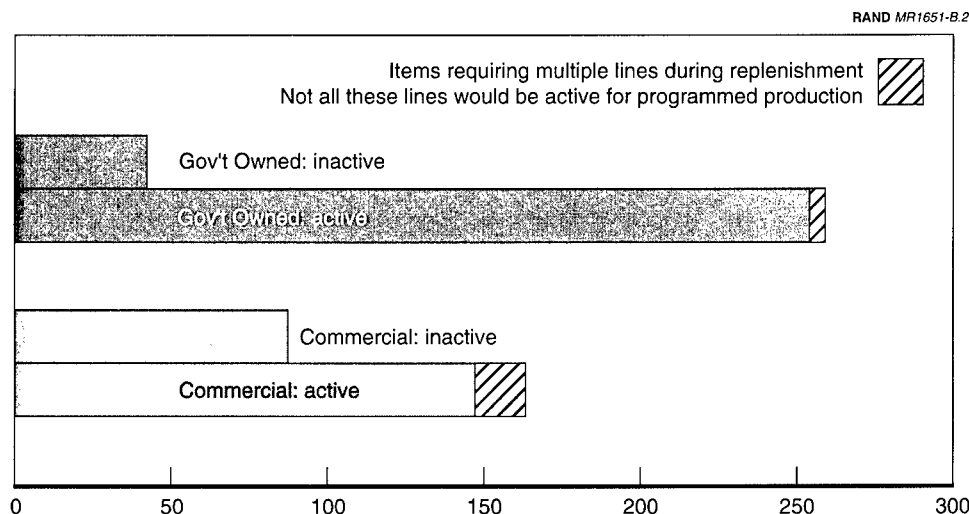


Figure B.2—Mix of Item-Lines on Active and Inactive Commercial and Government Lines

planned for each government line, while fewer than two items are planned for each commercial line. As a result, the probability that a line will be active producing something during any particular year is greater for the government lines. It is also probable that bookkeeping accounts for some of the differences. For government-owned facilities, production lines are more likely to be identified geographically, e.g., by building number or by actual line number. For commercial facilities, lines are often identified by product, e.g., KILGORE—MJU-32-38, though in reality a number of product-named production lines may be co-located, sharing personnel and equipment.

Regardless, it is clear that planned replenishment production of the majority of ammunition items on both government and commercial lines will occur on lines that are producing some ammunition during peacetime. Importantly, for the vast majority of items produced on shared lines, the other items produced on that same line are similar.¹¹ This means that skills are often transferable between items and equipment can often be shared. Presumably, this will ease the start of replenishment production for items that were not in production at the start of the replenishment period.

¹¹For example, the PBP lists nine items for production on Line A at the Action Manufacturing Company. Among the nine items are fuzes, safe and arm mechanisms, and a burster canister. Assembly of these three types of item requires many of the same skills and equipment. Likewise, Line 3 at Lake City Army Ammunition Plant has 19 items planned, but they are all small- to medium-caliber ammunition.

A total of eighteen inactive government lines appear in the PBP. These are, or were anticipated to be, in a laid-away status.¹² This means that the equipment on these lines is preserved but that only a minimum amount of maintenance is performed on them.¹³ In a few cases (15 items on 6 lines), additional work beyond reactivating the old line or new equipment is required to meet replenishment requirements. The status of the commercial lines appears similar. Twelve items do not have a producer identified. Some 21 items on 18 lines will require additional work or new equipment to meet replenishment requirements. There are also examples in which the commercial vendor is identified but there is no existing line. What makes the inactive lines of commercial vendors most different, however, is that absent a contract, the commercial vendors may decide to withdraw support for the line from the replenishment mission without government permission.¹⁴

Although the U.S. military strategy is currently in flux, the 1999 Production Base Plan (the most current replenishment plan available for this analysis) was based on the assumption that two MTWs could be fought and won without relying on increased industrial production of ordnance materiel. When the plan was built, the assumptions required that capacity should be available to replace the materiel damaged, destroyed, or consumed by one MTW within three years after the completion of the two MTWs. Although no longer directed by DoD, the Army continues to use the three-year replenishment assumption.

JUSTIFICATIONS FOR MAINTAINING GOVERNMENT-OWNED REPLENISHMENT CAPABILITY

Several lines of reasoning based on replenishment requirements are advanced as justifications for government ownership of segments of the ammunition industrial base. Arguments for government ownership include the following:

- It is needed because of the large replenishment requirement.

¹²Since the PBP was published, eight lines that were anticipated to be inactive are currently active, six lines that were anticipated to be active are now inactive, and two lines that were anticipated to be active are now in disposal status.

¹³Laid-away equipment is rarely activated, and maintenance consists of actions such as occasionally turning over rotating parts to keep bearings round.

¹⁴For example, the M903 .50-caliber Saboted, Light Armor Piercing (SLAP) round is an important war round that Olin-Winchester in East Alton, Illinois, produces for the Army. Production ceased on the M903 in 1998 (a new contract is or will be let as of the writing of this report), but the Army continued to rely on Olin-Winchester for replenishment production capability. Olin-Winchester maintained the facility to produce M903s primarily because it had no other use for the facility, and it was less expensive to keep the facility as it was when M903 production ceased than to empty it. Olin-Winchester's responsibilities to its shareholders would have required the use of the M903 facility for other, more profitable purposes had the opportunities appeared.

- It is needed because the production capabilities are unique.
- It is better because it does not cost that much to maintain extant capabilities, and divesting it would open the government to high cost for environmental cleanup and replacing the capability if needed.
- It is needed to meet surge requirements.

We address each of these arguments below.

Large Replenishment-to-Peacetime-Production Ratios

The first argument is that some items have very large replenishment requirements compared with peacetime production. In fact, the majority of ammunition end items have no current peacetime production and very large replenishment requirements.¹⁵ An oft-stated belief is that private ammunition producers will size capacity to expected production levels, which in peacetime and for ammunition types with no training requirement, eventually goes to zero. Absent compensation, then, the belief is that private ammunition producers will not maintain the production capacity required for replenishment. According to this reasoning, government ownership of replenishment capacity is required to ensure that large-scale production of ammunition in replenishment time frames will be available.

At its essence, though, this explanation is merely a statement that there are costs to maintaining idle or underutilized industrial capacity. The line of reasoning acknowledges that private-sector ammunition producers will allocate resources to earn a return on investment. When production resources are idle and the idle capacity goes uncompensated, the private producer will indeed look for a more productive use of the resources that make up the capacity. This usually entails diverting production assets to new products or selling the assets.

This is all true, but it is at odds with the current replenishment plan that relies to a significant degree on COCO suppliers for many ammunition items, some of which are not in production or have high replenishment-to-peacetime-production ratios. The apparent conflict is resolved by at least partially com-

¹⁵Of the ammunition end items listed in the PBP, only 45 percent had any production anticipated in the time period covered by the PBP (1998–2005), and only 35 percent had production planned for the year 2002. For example, the M864 projectile is a round for the 155mm howitzer. It carries 72 dual-purpose grenades and incorporates base-burn technology for greater range. While this projectile is highly effective and a principal warfighting round, its expense, complexity, and terminal effects make it unsuitable for training. As a result, the round was produced for war reserve stocks but has not been produced for quite a number of years. There is also no planned production in the PBP. The PBP does, however, anticipate very large replenishment production quantities of the M864.

pensating these producers for retaining replenishment capability through product price and assurance of continuing production.¹⁶ The vast majority of COCO facilities identified in the PBP have some peacetime production of ammunition items in facilities identified for replenishment missions. For many of these firms, their position as ammunition producers is protected in several ways. Sometimes, the government restricts competition through the use of “other than full and open competition.”¹⁷ In other cases, the cost of market entry is high and peacetime buys are small enough to discourage new market entrants. In a few instances, commercial production on “replenishment lines” provides compensation for the capability.¹⁸ Finally, government-owned equipment is used by a number of COCO facilities.¹⁹ Regardless, it is safe to say that much, if not most, replenishment capability in COCO ammunition facilities compensates their owners in some manner.

For much of the replenishment capacity retained on government facilities, it is more difficult to pass replenishment costs through to current products. This happens when there is no peacetime production and no other use for the facility, thus resulting in idled capacity.²⁰ It also happens when there is a large replenishment requirement and difficulty in idling partial capability, resulting in extremely inefficient facilities.²¹

Unfortunately, retention of a large but idle government-owned industrial plant can be costly and does not necessarily guarantee effective replenishment capability. On average, the PBP anticipates almost a year to restart cold lines on government-owned facilities.²² The Korean War example offers an illustration. In that case, restarting lines that had been cold for less than a decade still took one to two years (Huston, 1989). Some of the lines currently responsible for large replenishment requirements have been idle for significantly longer periods. For example, the TNT lines at Radford Army Ammunition Plant are

¹⁶During the course of this study, we have heard many comments about the “unprofitability” of the ammunition market. This could occur when a facility has significant overhead because of excess capacity but cannot shed that capacity and is only partially compensated for it in product price.

¹⁷10 USC 2304(c) allows limitations on competition when the product is available from only one or a limited number of sources, the need for the product is of unusual and compelling urgency, or to maintain a supplier for a national emergency or industrial mobilization. Justification and Approval documents that permit other than full and open competition are prevalent for COCO-produced items such as fuzes and pyrotechnics that appear to have a fragile producer base.

¹⁸For example, General Dynamics' St. Marks Propellant facility produces ball propellant for commercial clients. This production capability is earmarked for replenishment production.

¹⁹Eleven COCO facilities currently have government-owned equipment on hand. Alan R. Beuster, e-mail communication to the author on January 10, 2002.

²⁰This is the case with some metal parts facilities.

²¹This is the case with some energetics production.

²²Inactive lines on COCO facilities that are planned as replenishment resources in the PBP have an average 10.5-month restart time.

approaching twenty years of nonproduction. The metal parts lines at Riverbank,²³ Louisiana, and Mississippi AAPs have been idle for more than a decade. As facilities age, the ability to restart idle production lines wanes, and there is evidence that some of these lines have seriously degraded.²⁴ In addition to the general deterioration of equipment and facilities due to age, laying away idle industrial plant also creates problems of obsolescence. Manufacturing technology continues to advance rapidly, and facilities that are a decade old or more are practically guaranteed not to comply with environmental and occupational safety regulations, not to be energy inefficient, and to be labor intensive compared with more modern facilities. Obsolescence is a growing problem. Technological and regulatory advancement moves more rapidly than ever. Maintaining an idle facility now is quite a different matter than doing so in the post-World War II or even the Vietnam era.

Louisiana AAP (LAAAP) serves as an example. LAAAP's replenishment mission is to produce approximately 600,000 artillery shells.²⁵ One production line, with a capacity of 50,000 shells per month, is currently laid away for this purpose (Beuster, briefing, n.d.). Using the five-year period between 1996 and 2001 as illustrative, maintenance of inactive industrial facilities (MIIF) funding to LAAAP has averaged more than \$850,000 per year,²⁶ though annual expenditures for MIIF at LAAAP are planned to decline significantly over the next few years by the application of revenue generated by leasing facilities at LAAAP. The leasing program is not cost-free either, however, and has largely been made possible by the ARMS program that has cost the Army \$3.5 million at LAAAP over the last ten years.²⁷ Since none of the MIIF funding or equivalently applied tenant revenues has been applied to upgrade the artillery shell production facilities, the production line continues to obsolesce and deteriorate from disuse. As a result, personnel at Louisiana AAP estimate that it is only a matter of 5 to 10 years before it would be better to start from scratch in terms of restarting artillery shell production at LAAAP.²⁸ Should the Army decide to reactivate LAAAP, additional funding will be required. The PBP provides an estimate of \$9

²³Line 6 at Riverbank AAP is active and produces cartridge cases. Lines 1 and 8, for mortar and grenade metal parts respectively, are the idle lines.

²⁴The estimate to restart the TNT facilities at Radford AAP, which have not produced TNT since the mid-1980s, is \$28 million and 18 months (McManus, briefing, 2001).

²⁵Total artillery shell replenishment requirements are 3.2 million. Scranton AAP is responsible for producing 80 percent of these, and LAAAP is responsible for the other 20 percent.

²⁶Total MIIF funding for the 14 ammunition facilities considered in this study was \$6.25 million in 2001 (U.S. Department of the Army, Procurement Programs, 1998, 1999, 2000, 2001a).

²⁷The ARMS program is discussed in more detail elsewhere in this report and in Hix et al., 2003.

²⁸Briefing and discussions by LAAAP personnel with RAND personnel, Milton, Louisiana, September 12, 2000.

million to bring it to just 50 percent capability.²⁹ To bring LAAAP to full capacity would therefore probably cost between \$15 and \$20 million. Thus, if one adds the cost of maintaining idle capacity at LAAAP to the cost of restarting shell production, were that decision to be made today, the cumulative total is more than \$25 million, and that cost continues to rise the longer the facility remains idle. By comparison, an OSC study estimates that creating an artillery shell production capacity of 80,000 per month at Rock Island Arsenal would cost either \$52.8 million or \$18.5 million, depending on whether new or used equipment is employed.³⁰ These costs do not include some items because they already exist at Rock Island,³¹ but even if a completely new facility is required, the cost of indefinitely maintaining an idled LAAAP appears difficult to justify.³² This is particularly true when the additional costs associated with operating obsolete facilities, such as higher labor and energy content, are added after restart.

Since warm lines are more likely to have been upgraded and maintained, increasing production rates on them is generally less of a problem than restarting cold lines. This is particularly true when the ratio of replenishment production to peacetime production is relatively small, say 5 to 1 or less. In such a case, it is not difficult to imagine productivity expansion in reasonably well-utilized facilities by such expedients as adding shifts, adding labor, and upgrading production bottlenecks in ways that improve overall line flow. With larger replenishment-to-peacetime-production ratios, though, maintaining enough capability on warm lines for replenishment production is difficult unless facilities and equipment are grossly underutilized during peacetime. Holston AAP (HAAP) provides a good example. HAAP produces mainly HMX/RDX explosives and is the only significant producer of these items in the United States.³³ According to the PBP, the anticipated replenishment-to-peacetime-production ratio for HAAP's products is 24 to 1. A competition to manufacture explosives for five years and run HAAP for 25 years was held in the 1997/1998 timeframe. The competition resulted in three qualified bids. These included a losing proposal from Day & Zimmermann (D&Z) that suggested idling HAAP during peacetime but reactivating it for replenishment production. Under the

²⁹By comparison, the cost to move and restart a different metal parts line was \$15 million.

³⁰Undated and unpublished cost estimate completed by Operations Support Command personnel and provided to RAND on January 7, 2002.

³¹These items include infrastructure, rough turn and finish turn equipment, paint booth, overhead cranes, and forklift trucks.

³²As another point of comparison, the GSA values Scranton AAP, a facility that is active, makes the same products as LAAAP, but has a capacity of 120,000 shells per month at \$22.1 to 56.8 million (Gadd and Tibble, 1999).

³³Expro of Canada has produced these items in the past, but its capability has been laid away for nine years.

D&Z proposal, peacetime production was to be procured from Expro of Canada, which D&Z claimed could provide peacetime quantities of HMX/RDX products at a significant savings compared with HAAP. The winning bid came from Royal Ordnance North America (RONA), which proposed to provide peacetime explosives production from HAAP in order to operate the facility as a going concern from which replenishment requirements could be met. The Army chose the RONA proposal because it believed the risk of idling HAAP and restarting production in a replenishment scenario was too high. The drawback to the RONA proposal was, of course, that the very high replenishment-to-peacetime requirements meant that HAAP would be largely underutilized. The premium the Army paid to maintain warm lines for replenishment at HAAP was significant.³⁴ The RONA bid for five years of production was \$163 million,³⁵ while the D&Z bid was \$111 million: in other words, a product price premium of 50 percent, roughly \$10 million per year.³⁶

Unique Production Capabilities

The second major reason put forward for government ownership of replenishment production capability is that many ammunition items require unique production capabilities in terms of skills and equipment. Certain skills are said to be unique to ammunition production and these skills must be maintained in order to build on them during the startup of replenishment production. But retaining critical skills has little to do with facility ownership. Whether a facility is government-owned or contractor-owned, employment levels generally reflect ongoing production. In the LAAAP example discussed earlier where there is no current production, the contractor retains very few personnel with the skills to run the equipment³⁷ and notes that reacquiring the skills will be a difficult proposition.³⁸ Critical skill retention in the absence of ongoing production requires the maintenance of excess employees and the provision of training programs. Funding for this kind of skill retention is not provided to either COCO or GOCO facilities.³⁹

³⁴Total ARMS funding for HAAP is also significant at \$9 million since the start of the program.

³⁵The RONA proposal did include some modernization and rehabilitation of the facility.

³⁶Comptroller General of the United States (1998). All data and information in this paragraph concerning the HAAP competition were derived from the Comptroller General's decision.

³⁷Seven government and 19 contractor personnel are employed at LAAAP. OSC website, "Government Owned—Contractor Operated Strength, Longhorn/Louisiana Army Ammunition Plant," <http://www.osc.army.mil/rm/oscfact/str-plts.htm>, July 2001.

³⁸Briefing and discussions by LAAAP personnel with RAND personnel, Milton, Louisiana, September 12, 2000.

³⁹There is evidence that government-owned, government-operated facilities delay sizing employment levels to workload and do receive significant funding to augment production dollars. Even on those facilities, though, this appears to be merely a means of managing the difficulties associated

Certain equipment is also said to be highly specialized for ammunition production and is both expensive and time-consuming to acquire.⁴⁰ As with the discussion concerning large replenishment ratios, concerns about unique capabilities recognize that a private producer will not maintain idle or underutilized equipment for replenishment purposes unless the producer is compensated for doing so.⁴¹ Today, no COCO facilities receive direct compensation to maintain unique ammunition production equipment or facilities, although, as noted above, it is likely that COCO producers with unique but idled or underutilized ammunition production capabilities are at least partially compensated through product price during peacetime. On the other hand, the preservation of idle, long-lead-time or expensive equipment in government-owned ammunition facilities does occur to a significant degree but has required significant funding.⁴²

An obvious alternative to government ownership of replenishment production capability is to compensate commercial ammunition producers for maintaining equipment they own but do not use for current production. This alternative elicits an interesting discussion from some advocates of government ownership of those assets. This discussion usually has two parts. The first states that this course is risky because the commercial contractor who owns and maintains the replenishment production capacity may one day decide to exit the business for any number of reasons, regardless of whether he is compensated for maintaining the capability.⁴³ Should this happen, the government would then bear the expense and risk of establishing a new replenishment production capability for

with downsizing government facilities. Since these facilities are all working-capital-funded facilities, they must eventually size workforces to workloads in order to maintain manageable rate structures and product prices. Even facilities that are near-monopolies, such as Watervliet, will encounter competition if their prices get too outrageous.

⁴⁰For example, the long stroke forges used at Scranton AAP are unique to artillery shell production, and acquiring new forges would take a significant amount of time. Very large replenishment capacity is also required for artillery shells. Hence, Scranton AAP maintains a lot of unique capacity to forge these items.

⁴¹Examples abound of private producers divesting capability or exiting the ammunition market, particularly when the market turns down. Army personnel note that in 1993 there were 20 manufacturers involved in various aspects of medium-caliber ammunition production. In 1998 that number was 11 (25/LW30mm Ammunition, Justification and Approval for Other Than Full and Open Competition, Control No. 990005, U.S. Army Industrial Operations Command, Rock Island, Illinois, November 1998). That number is even smaller today, as two producers of links for belting individual cartridges exited the business in 2001. In the 1980s there were eight private manufacturers of grenades for cargo munitions. Today Amron is the only active producer of this product, while additional, inactive capability exists only on two GOCO facilities.

⁴²LIF and MIIF being the most obvious funding sources.

⁴³While there are no specific examples of contractors leaving the ammunition business while they were getting paid to maintain replenishment capability, there are examples of companies exiting the business despite current and anticipated production and presumed profitability. For example, Dyno-Nobel and ICI Americas left the military ammunition business in the mid-1990s under such circumstances.

that item. This assumes that the capability is gone when the private producer leaves the business, but in all likelihood the capability will be available for some other producer to purchase. The government, of course, must be willing to fund the maintenance of the replenishment capability, which leads to the second, and more interesting, part of the discussion. The greater fear seems to be that countervailing budget pressures within the Department of Defense are so strong that funding for replenishment production capability in private facilities will inevitably become a low priority. As a result, the discussion proceeds, the option to fund private replenishment capability is unrealistic because the DoD will eventually decide not to fund it. When that happens, the commercial producer will dismantle the ammunition capability. The converse of this argument says that if the production capability is owned by the government and maintained on government property, it is easier to generate the internal advocacy within the Army that is necessary to prevail in budget negotiations, and the difficulty of divesting government facilities practically forces the Army to provide some level of funding for the facilities.⁴⁴ By this line of reasoning, those responsible for or concerned with replenishment planning would take some of the resource-allocation decisionmaking away from those charged with balancing the Army's needs.

Cost

Another reason posited for maintaining government-owned replenishment capacity is that since that capacity is already in government hands and is inexpensive to maintain, it makes little sense for the government to divest it. This argument has actually gone farther. Concerns about the immediate cost of required environmental remediation at ammunition facilities that are declared excess and concern about the cost of replacing lost capacity augment the case for continued government retention (McManus, briefing, 2001). The assertion holds that not only does it cost little to maintain current government ammunition production facilities, but that significant costs would be incurred by closing these facilities. As noted in this section and others, maintaining the government facilities is not inexpensive and can result in obsolete capability. Further, while the costs associated with environmental remediation of government-owned industrial plants are high, the Army bears the burden of these costs regardless of ownership of the industrial facilities (Howard, 2000). Further, the Army can take some actions to ease the immediate budgetary impact that would result from its remediation responsibilities, and that would accrue

⁴⁴This argument was expressed by a number of government personnel.

should the Army close or divest its government-owned industrial facilities.⁴⁵ Related to these cost concerns is the idea that securing permits for new facilities (environmental and safety primarily) would be extremely difficult and time-consuming, if not impossible. If such were the case, few new industrial concerns would be possible in this country.⁴⁶ The process is normally time-consuming, but the period leading up to a replenishment requirement could hardly be described as ordinary. Presumably the process for permitting new industrial capabilities in such a time period would be expedited. Additionally, government ownership of idle or underutilized facilities is not required. Private facilities can and currently do maintain the requisite permits to conduct production of chemical products, including explosives and propellants.

Surge

A final case for government retention of production facilities occasionally raised is an assertion that because capacity is preexisting on government facilities, the ability to surge production is much more responsive. This argument is most often provided with arsenal examples⁴⁷ but is raised more emphatically with reference to ammunition.⁴⁸

In addressing whether the ability to surge production is a strong argument for retention of government ownership of production assets, the first question is what is the U.S. policy concerning ammunition surge.

10 USC 2535(a) states that

It is the intent of Congress (1) to provide a comprehensive and continuous program for the future safety and for the defense of the United States by providing adequate measures whereby an essential nucleus of Government-owned industrial plants and an industrial reserve of machine tools and other industrial manufacturing equipment may be assured for immediate use to supply the needs of the Armed Forces in time of national emergency or in anticipation thereof; (2) that such Government-owned plants and such reserve shall not

⁴⁵The issues associated with environmental remediation are addressed in more detail elsewhere in this report.

⁴⁶General Dynamics personnel noted that environmental concerns and permitting at its St. Marks propellant facility were similar to any chemical manufacturing facility. Site visit to General Dynamics St. Marks Propellant plant, St. Marks, Florida, August 2, 2001.

⁴⁷The "Success Stories" page on the Rock Island website lists three such examples (Apache Helicopter Coupling Half Shaft, Apache Helicopter Shims and Threaded Pins, Bosnia Armor Kits); *www.ria.army.mil/success.htm*. In conversations with Army personnel, we have been told that in the cases of the Apache Helicopter Coupling Half Shafts and the Bosnia Armor Kits, Rock Island Arsenal was selected to supply these parts because they could not be procured quickly enough from the private sector.

⁴⁸For example, the commander of OSC notes the inability to surge ammunition production, with the implication that that is a dangerous condition (McManus, briefing, 2001).

exceed in number or kind the minimum requirements for immediate use in time of national emergency, and that any such items which shall become excess to such requirements shall be disposed of as expeditiously as possible; (3) that to the maximum extent practicable, reliance will be placed upon private industry for support of defense production; and (4) that machine tools and other industrial manufacturing equipment may be held in plant equipment packages or in a general reserve to maintain a high state of readiness for production of critical items of defense materiel, to provide production capacity not available in private industry for defense materiel, or to assist private industry in time of national disaster.

This statute appears to endorse a national policy of surging production of defense materiel. It also allows for the supporting industrial capability to be owned or maintained by the government when that capability cannot be supported in private facilities. Congressional intent, though, appears to make that an option of last resort. Furthermore, since the statute does not define what is meant by “critical items of defense material,” one must look to DoD guidance to determine the extent to which ammunition production surge capability is a requirement and policy of the United States. Several laws require the President and the DoD to develop and communicate those industrial policies critical to national security.⁴⁹ None appears to prescribe a policy of maintaining surge capacity.

In short, no specific national policy requires the capability to surge production of military items. While it is certainly advantageous to be able to surge production, without a national policy defining the need, allocating resources for the maintenance of industrial surge capability is problematic.

The failure to allocate sufficient resources to war reserve stocks can leave the nation in the position of defaulting during hostilities to a de facto surge policy. Therefore, if the Army institutionally believes that maintenance of an ammunition production surge capability is required, whether government-owned or not, it should request that such a capability be included in DoD policy documents. More important, the Army should request funding for such a capability and place a high priority on these funding requests. However, absent requests to change policy or budget for a surge capability, the Army cannot argue that retention of government-owned industrial facilities is required to support production surge.

⁴⁹50 USC 404a, 10 USC 113(g), 10 USC 113(c)(1), and 10 USC 118(d)(6) provide a patchwork of laws that require some level of policymaking and reporting by the executive branch with respect to, among other things, military sustainment and the industrial base to support the military.

COMPARING REPLENISHMENT PLANS FOR MISSILES AND CONVENTIONAL AMMUNITION

Missiles represent not just another category of munitions, but a category that the Army increasingly depends upon. The replenishment strategy for missiles is thus interesting in contrast to the replenishment strategy for conventional ammunition because the two strategies are so different. For a number of reasons, the justifications discussed above for government ownership of replenishment production capacity have not held the authority in the missile community that they have in commands responsible for conventional ammunition.

Although the Army estimates the number of missiles that would be expended in support of the national security strategy in the same way as for conventional ammunition, it does not plan for their replenishment in the same way. In fact, replenishment planning for missiles appears to be very ad hoc and stops at the point that identifies whether there is capability for replenishment. In other words, once DCSOPS provides the Aviation and Missile Command (AMCOM) the expenditure estimates for missiles, the Industrial Readiness Group at AMCOM may note, if asked, whether a replenishment capability exists. Replenishment planning goes no further.

Production philosophies, whether for replenishment or not, between conventional ammunition and missiles are also notable. Unlike conventional ammunition, the Army neither owns nor maintains missile production facilities.⁵⁰ Nor does the Army maintain equipment on contractor facilities or plan replenishment on those facilities after production of the missiles is complete.⁵¹ Instead, the DoD relies entirely on a stockpile and renewal strategy for missiles. By renewal we mean that the Army assumes any new missile production will be for the next generation of missile. As an example, the Army assumes that it will buy no more TOW2Bs. Instead, replacement production for TOW2B, whether in a replenishment or standard peacetime acquisition scenario, will be of the TOW2B replacement.⁵²

⁵⁰Some pieces of the missile industrial base are included in the government-owned, conventional ammunition industrial base. Warhead LAP, explosive production, and submunition LAP are notable examples.

⁵¹Godwin (1986). DoD banned the use of "No Cost Storage Agreements" by DoD agencies. At the time, it was a practice within the DoD to have contractors maintain idle government-owned production equipment after completion of a production contract for the DoD. The memo recognized that maintaining government-owned equipment on contractor facilities, even with "No Cost Storage Agreements," was costing the government a lot because the contractors were recapturing their storage costs through overhead charges on other government contracts.

⁵²The Army sold the government-owned TOW missile production equipment to the TOW missile prime contractor. On completion of TOW missile production, the contractor is planning to declare the equipment that it cannot otherwise use as excess.

The reasons for the difference in replenishment philosophy appear to be historical and practical. Historically, reliance on contractors for missile development and production has been the norm.⁵³ In contrast and until quite recently, the government intensively managed production of conventional ammunition, broke out production of it by component, and directed much of the workload to the government-owned ammunition industrial base left over from World War II. The history does not explain, however, why the difference in replenishment philosophy has been acceptable to the Army; it appears to have more to do with Army culture and perceptions about conventional ammunition.

The cultural reasons for the differences in handling between missile and conventional ammunition replenishment are difficult to pin down but seem quite real.⁵⁴ The Army culture that desires government ownership of ammunition production assets has its roots in the experiences of World War I, World War II, and the Korean War. In World War I, the United States depended on allies to supply much of its ammunition. In World War II, the United States rushed to build an industrial capability at great expense and barely in time (Kane and Gaither, 1995). In the Korean War, higher-than-expected ammunition consumption rates and a run-down industrial base generated a fear that ammunition supplies would run critically short (Courter et al., 1994). The combined result of these experiences has apparently left a deeply rooted impression in the Army culture that it must maintain positive control of ammunition production. This impression has been fostered by 60 years of actual ownership of much of the ammunition industrial base and the development of a bureaucracy to manage it.

As mentioned earlier, there also appears to be an implicit assumption within the Army that the next-generation missile is always coming. With conventional ammunition, however, there has been much more tolerance of long life cycles.⁵⁵ The perception that basic “dumb” bullets are relatively unchanging and adequate for the job is apparent in discussions with Army ammunition personnel.⁵⁶ There is also the economic problem that would be associated with

⁵³For example, the development and initial fabrication contracts for the first TOW missiles were awarded to Hughes Aircraft Company, Martin Marietta, and McDonnell Aircraft Corporation in 1962. The first major production contracts were awarded to Hughes and Chrysler in 1968 and 1969 respectively. Redstone Arsenal System History website for the TOW missile system, www.redstone.army.mil/history/systems/TOW.html.

⁵⁴During discussions at the Army Materiel Command in December 2001, the Deputy Commanding General, LTG Roy E. Beauchamp, described ammunition as the “soldier’s fundamental commodity.”

⁵⁵For example, the M107 artillery projectile is half a century old.

⁵⁶One interesting conjecture that has been made by a number of Army personnel is that in a worst-case scenario, the Army will run out of missiles and rockets. Once that happens, it is asserted, the Army will be forced to fall back on its “tried and true” conventional ammunition for which it has maintained a government-owned industrial base.

constantly upgrading the large numbers of conventional ammunition items. The PBP includes 171 ammunition end items, and these are just the ones deemed to require detailed management for replenishment purposes. The actual number of ammunition items is actually somewhat larger. In comparison, the total number of missile systems managed by the Army is small.⁵⁷

To a certain extent, significant differences between missiles and conventional ammunition dictated different strategies for managing their production. First, missiles have typically been produced in smaller numbers because of their cost, size, and precision. Second, missiles have relied much more on advanced electronics and exotic technology than has conventional ammunition, so their life cycles have been shorter on average. Finally, missile development and production has been competed and run by system contractors. What is striking, though, is the degree to which conventional ammunition is becoming more like missiles. As the cost, lethality, and precision of newer conventional munitions rise, buys are decreasing.⁵⁸ Newer types of conventional ammunition now use advanced electronics and exotic technologies like composites and advanced energetics, which may cause life cycles to shorten.⁵⁹ Finally, most new ammunition is competed and managed by system contractors who are increasingly moving ammunition production off the government-owned industrial base.⁶⁰ These trends will continue and accelerate. As that happens, the cost of maintaining a replenishment capability on the current model will become increasingly unaffordable. To manage the cost of the future ammunition industrial base, the Army must begin to evolve its replenishment strategies.

REPLENISHMENT RECOMMENDATIONS

The Need for a Replenishment Policy

Before the implementation of any replenishment strategy, the first and most important step is to define the Army's policy for replenishment. The ambiguity and controversy that currently attach to the subject of a replenishment policy have made it impossible to plan overall ammunition industrial policy. Such a

⁵⁷Missile and rocket systems include items such as TOW, Javelin, Hellfire, BDM, SRAW/MIPM, MLRS, ATACMS, Patriot, and Stinger.

⁵⁸Guided munitions like Sense and Destroy Armor (SADARM) will be very expensive. Even newer types of unguided ammunition, for example the M919 25mm and M829E3 120mm cannon ammunition, are very expensive compared to the rounds they are supplementing.

⁵⁹Even some small-arms ammunition is fitted with electronics. 20mm ammunition for the Objective Individual Combat Weapon will have a fuze that receives information from the rifle firing it.

⁶⁰The M829E3 Armor Piercing, Fin Stabilized, Discarding Sabot (APFSDS) 120mm tank round and the SADARM 155mm artillery round are both managed by systems contractors and are LAPed on non-Army facilities.

definition is beyond the scope of this research project but must be a priority of the Army's ammunition community. The recommendations that follow, however, should apply regardless of the final replenishment policy.

An Integrated Replenishment Strategy

By an integrated replenishment strategy we mean a strategy that spans the life cycle of products, views decisions in light of their effect beyond the specific item in question, and considers ammunition production and sourcing with an eye toward future trends and warfighting developments. An integrated, life-cycle approach to conventional ammunition looks for opportunities to minimize cost and maximize performance all the time. Most of the strategies involved, and briefly discussed below, are already practiced to a certain extent, but the lack of a single ammunition manager/advocate and the resulting split of responsibility along life-cycle and ammunition family boundaries have limited the degree to which conventional ammunition can be managed in an integrated fashion. The recent establishment of a Program Executive Officer for Ammunition should greatly facilitate planning and executing an integrated replenishment strategy.

An integrated replenishment strategy also recognizes that there are costs associated with replenishment and makes those costs, as well as decisions about the allocation of resources and attendant risks, explicit in the budgeting process. Today, the only replenishment capability that the government explicitly budgets for is the capability that resides on government-owned facilities. Even then, the costs associated with replenishment capability are only partially borne by those budget lines expressly established for them. Replenishment capability, wherever it is located, is a distinct service and should be recognized as such. Therefore, replenishment capability should be separately budgeted for *all* ammunition items with high replenishment-to-peacetime-production ratios.⁶¹ Budgeting and contracting for peacetime production and replenishment capacity separately provides two distinct advantages. First, it better informs decisions about allocating ammunition resources. In some cases, a robust replenishment capability may not be important, and resources allocated to maintaining it can be small. In other cases, the requirement may be very important and directing resources toward the capability a priority. Being able to direct the appropriate resources through explicit funding is especially important for COCO producers. The second reason that explicit funding for replenishment is so important is that it greatly assists in devising the optimal alterna-

⁶¹A high peacetime-to-replenishment ratio is one in which a switch from peacetime to replenishment production quantities would be difficult to manage economically. This ratio probably starts in the range of 3-to-1 to 5-to-1.

tives for production and production capability development, all of which are part of taking an integrated, life-cycle approach to managing ammunition acquisition.⁶²

Life-cycle management of ammunition generally begins with the research and development (R&D) required to acquire new or improved ammunition. Ammunition research affects replenishment in several ways. More effective ammunition reduces total ammunition requirements, thus easing replenishment burdens.⁶³ Additionally, ammunition R&D can be used to develop ammunition that is easier to produce.⁶⁴ Finally, R&D may focus directly on ammunition production processes (rather than on the ammunition itself) to develop simpler, cheaper methods of producing ammunition.⁶⁵

Beyond R&D, including replenishment planning and capacity options in ammunition production contracts provides for an initial replenishment capability.⁶⁶ If annual production quantities are well managed, replenishment-to-peacetime-production ratios may be kept relatively low and production extended over a longer period on lines that can accommodate significant increases in production in relatively short timeframes.

As production ends, replenishment strategies should vary depending on the characteristics of production and the perceived need for a replenishment capability specific to each type of ammunition. When a replenishment capability is required for the ammunition item (or ammunition family if appropriate), determining the best replenishment strategy should be the subject of a full and open competition. A Request for Information (RFI) (or presolicitation conference) would detail the replenishment requirements and discuss ideas to meet them. A Request for Proposals (RFP) would then be issued and all producers, including GOGO, GOCO, and COCO facilities, would be invited to make proposals. Depending on the item, proposals could include any number of solutions. In some cases, production lines may be relatively simple to replace

⁶²For example, one contractor complained to us that too often, production schedules were not rational from a production sense. He gave the example of a demolition charge solicitation that required production of 10,000 during the first year, then 2,000 per year for three more years.

⁶³As an example, inclusion of SADARM in the Total Army Analysis exercises greatly reduced artillery ammunition replenishment requirements.

⁶⁴For example, the dyes for some smoke rounds are difficult to procure. Research efforts could aim at providing a more easily produced substitute.

⁶⁵For example, the focus of the Totally Integrated Munitions Enterprise (TIME) is to make manufacturing processes and information more portable in order to ease the burden associated with setting up new production.

⁶⁶PM Mortars is the current champion for this approach, and all new contracts for PM-managed mortar ammunition include "stand-alone replenishment options" (Super, briefing, 2000).

should the need arise.⁶⁷ In those instances, the best-value proposal may offer, for a very small fee, merely the drafting and maintenance of a plan to establish a production line when needed. Alternatively, for items that are difficult to produce in quantity, the offeror could suggest that the entire production capability or portions of it be maintained and occasionally exercised. GOGO bidders may proffer to move the capability onto government facilities and maintain it there. One interesting possibility could bring more commercial producers into the defense industrial base. When a production facility for commercial items is capable of meeting some required replenishment capability, an option contract could offer the government first use of the facility during replenishment production. The government would pay a fee or provide some other consideration in return for this option.⁶⁸

The important point of the above paragraph is that all replenishment is competed and contractors (commercial and government) suggest solutions to the replenishment requirements. Contract winners would be selected on a "best-value" basis focused on available resources and acceptable risk. Importantly, no facility should have replenishment missions directed to it under this policy.⁶⁹ This also requires that no funding to maintain a replenishment capability be provided outside of the competitions for replenishment capability. Such funding would only be provided if a best-value replenishment solution is selected that requires it. In cases where the government is currently contractually obligated to buy product for a specified period,⁷⁰ the replenishment competition for those items would be timed to coincide with the end of the contracts for those items.

Finally, to draw sufficient interest, resulting replenishment capability contracts would need to be multiyear or, at the least, contain continuation options for a number of years.

⁶⁷For example, General Dynamics at Camden claims that lines for any of its products, and similar products, could be established in less than 150 days. As an example, General Dynamics noted a line to LAP Patriot warheads was established in a matter of days during Desert Shield/Desert Storm. Presentation by General Dynamics personnel to RAND at Camden, Arkansas, on October 9, 2001.

⁶⁸This is similar to the Air Force's Civil Reserve Air Fleet (CRAF). Under the CRAF program, airlines agree to provide aircraft to the government during national emergencies. In exchange, the airlines receive a portion of the government's peacetime transport business.

⁶⁹The exception to this policy is that all activities conducted by government personnel at Crane AAA and McAlester AAP are required to continue being conducted by government personnel (PL 99-661, Section 317).

⁷⁰For example, small-arms ammunition from Alliant Techsystems at Lake City AAP or explosives from HAAP.

Replenishment in a Privatizing Industrial Base

The integrated replenishment strategy above is one that will work regardless of whether the industrial base remains configured as it is currently (the consolidation and recapitalization options), is converted to an FGC, or is privatized. However, should the current government-owned ammunition industrial base, or parts of it, be privatized before initiating competition for the replenishment capability currently assigned to it, certain adjustments will be required.

Most likely, any privatization of the ammunition industrial base would proceed via an “excess-to-ownership” transfer. Under such a scenario, the required capability that distinguishes an excess-to-ownership transfer from an excess-to-need divestiture could be current production capability, replenishment capability, or both. In any case, some capability will be required, at a minimum, for a transitional period from transfer to the time when the required capability is competed in a full and open manner.⁷¹ Therefore, any agreement to transfer ownership would include conditions that the required capability be maintained for some period of time. For example, if Iowa AAP were to be privatized, a requirement of the sale could be that a capability to LAP tank and artillery ammo at currently planned replenishment rates would be maintained for five years. Alternatively, if the potential buyer of the facility is not interested in the ammunition business but wants the facility for some other reason, the government could sell the property and lease back the laid-away lines. Leased-back lines could be maintained by contractors or by government personnel. To illustrate, if a developer desired to buy and develop Riverbank AAP as an industrial park, the Army could sell it to the developer subject to a lease for a term of years on the shell casing and grenade metal parts lines.

At the end of the transition period, any peacetime production and replenishment capability would be competed in a full and open manner. Typically, if there is peacetime production, both it and a replenishment capability would be competed at the same time. This would allow contractors to make combined bids that capitalize on any efficiencies that may accrue when replenishment capability and current production are combined in the same facility. It may be the case, however, that it is more efficient to separate current production and replenishment capability, as D&Z proposed for explosives. How this would all work is best illustrated through an example.

⁷¹As mentioned, PL 99-661 prohibits contracting out the functions performed at Crane and McAlester AAPs. Therefore, replenishment capability at those two facilities must be maintained. The requirements of OMB Circular A-76 may apply to ammunition items currently produced at Pine Bluff Arsenal as well as to the maintenance of replenishment capability for those items. But this is not a settled question and should be addressed before the initiation of competition concerning items with current and planned production at Pine Bluff.

Continuing the example just cited of Iowa AAP, suppose that at the end of a five-year transition period, current LAP and replenishment LAP capability of 155mm, high-explosive artillery rounds is put out for full and open competition. Bidder 1, with a single facility (either the former GOCO, some other established facility, or a proposed one), submits three bids. Bid one is only for peacetime production and at its simplest would be something like: Y number of rounds at \$X per round. Bid two would be only for maintenance of a replenishment capability. It would be structured in a manner such as: \$Z for a guaranteed capability to produce W rounds at \$V per round over U months. Finally, bid three combines peacetime production and replenishment capability. Its structure is: Y rounds at $[/math> $[X - T]$ $]$ per round and $[/math> $[Z - S]$ $]$ for a guaranteed capability to expand production to produce $[W + Y]$ rounds at $[/math> $[V - R]$ $]$ per round over U months. In the final bid, T, S, and R are efficiency factors that occur when combining peacetime production and replenishment production capability.⁷² Bidder 2 proposes only peacetime production. Bidder 3 bids for peacetime production and, in a separate bid, proposes only a plan for establishing a replenishment capability in the event it is needed.$$$

In this simple example, the government can then select the strategy for 155mm, high-explosive artillery rounds that best balances risks and resources. Bidder 1's combined proposal may offer the lowest risk strategy but at the greatest price. Bidder 1's, Bidder 2's, or Bidder 3's proposal for peacetime production, combined with Bidder 3's plan for the establishment of replenishment may be a higher-risk, lower-cost alternative. The point is that competing both production and replenishment capacity can lead to greater choice and put downward pressure on the price the government has to pay. Even if market conditions are such that no competition arises for the former GOCO facilities, the government is no worse off than it would otherwise have been. In such a case, even the mere threat of competition can spur improvements on the part of the new owners of the former GOCO facilities.

⁷²T, S, and/or R could be negative, indicating that combining peacetime and replenishment missions creates inefficiencies. In such a case, the integrated package could still be better overall than separating peacetime and replenishment missions to different facilities.

MODEL OF GOCO COMPETITION WITH UNCERTAINTY

This appendix provides the underlying mathematical calculations for the model of GOCO competition with uncertainty discussed in Chapter Five. When the operator of Iowa AAP does not know the exact costs of its competitors, it must calculate a bid that trades off higher profits when it wins the production contract against an increased probability that it loses the contract because one of its competitors enters a lower bid. Thus, it calculates a bid that maximizes expected profits. Suppose the operator of Iowa AAP knows that it can LAP 100,000 artillery shells at a cost of \$100 per shell, but it thinks its competitors' costs are uniformly distributed between \$110 and \$130 per shell.

Let b stand for Iowa AAP's bid in the production contract competition and $E[\pi]$ stand for its expected profits. When there is one other competitor, Iowa AAP wins the contract with the probability that its bid is less than its competitor's costs, or $1 - (b - 110)/(130 - 110)$, which can be rewritten as $(130 - b)/20$. Therefore, Iowa AAP chooses b to maximize

$$\begin{aligned} E[\pi] &= \left(\frac{130 - b}{20} \right) (b - 100) 100,000 \\ &= 5,000(-b^2 + 230b - 13,000). \end{aligned}$$

The first-order condition for the profit-maximizing bid is

$$\frac{\partial E[\pi]}{\partial b} = 5,000(-2b + 230) = 0,$$

which has a solution of $b = 115$. If Iowa AAP bids \$115 per shell, it wins the production contract with probability $(130 - 115)/20 = .75$. Thus, expected

annual profits are $.75(\$115 - \$100)100,000 + .25(0) = \$1,125,000$.¹ In a competition to operate Iowa AAP, bidders should therefore be willing to pay up to \$4.2 million for a 5-year contract, \$9.7 million for a 25-year contract, or \$10.5 million to buy the facility, at an interest rate of 10.69 percent.

When there are two competitors (other than Iowa AAP) for the production contract, Iowa's bid must be lower than both of the other competitors' costs. In this case, it wins with probability $[(130 - b)/20]^2$, so Iowa must choose b to maximize

$$\begin{aligned} E[\pi] &= \left(\frac{130 - b}{20}\right)^2 (b - 100)100,000 \\ &= 250(b^3 - 360b^2 + 42,900b - 1,690,000). \end{aligned}$$

The first-order condition for the profit-maximizing bid is

$$\frac{\partial E[\pi]}{\partial b} = 250(3b^2 - 720b + 42,900) = 0,$$

which has two solutions, $b = 130$ and $b = 110$. At a bid of \$130, Iowa wins with probability zero, so expected profits are zero. Therefore, the profit-maximizing bid must be \$110, so Iowa wins with probability 1, and expected annual profits are $(\$110 - \$100)100,000 = \$1,000,000$. In a competition to operate Iowa AAP, bidders should therefore be willing to pay up to \$3.7 million for a 5-year contract, \$8.6 million for a 25-year contract, or \$9.4 million to buy the facility, at an interest rate of 10.69 percent. Since Iowa's probability of winning the production contract at any given bid is declining in the number of additional competitors, its optimal bid will also be \$110 if there are three or more competitors.

¹It can be shown that this solution is Iowa AAP's optimal bid if its competitor also chooses its bid to maximize its expected profits relative to its costs. See, for example, McAfee and McMillan (1987).

BUDGET IMPACTS AND DESCRIPTIONS OF FACILITIES

In this appendix, we provide summary estimations of how privatizing 10 of the 11 GOCO AAPs will affect the Army's budget.¹ We then provide short descriptions of each Army ammunition plant, with data on physical characteristics, production lines, and employment, along with nonproprietary information on ordnance revenues and other government costs of operation. We begin with the four GOCO LAP plants proposed to be privatized in FY04 (Iowa, Kansas, Lone Star, and Milan), followed by the three GOCO metal parts plants proposed to be privatized in FY05 (Louisiana, Riverbank, and Scranton), the energetics and small-caliber LAP plants proposed to be privatized in FY06 (Holston, Radford, and Lake City), and the remaining GOCO metal parts plant (Mississippi). We then present information on the GOGO arsenals (Rock Island and Watervliet) and the GOGO ammunition plants (Crane, McAlester, and Pine Bluff), including estimated effects on the Army and federal government budgets resulting from the creation of an arsenal FGC for Rock Island and Watervliet.

SUMMARY BUDGET EFFECTS OF PRIVATIZATION

Table D.1 shows estimated effects on the DoD budget of privatizing 10 of the Army's 11 GOCO ammunition plants² under a relatively conservative set of base case assumptions. For the status quo, we assumed that ammunition costs (including production costs, production base support, LIF, and MIIF), the Contracting Officer's Representative (COR) budget, and agriculture and forestry revenues would remain the same as in FY01. We used projected environmental remediation costs provided by U.S. Army Operations Support Command (OSC) through 2014 and spread remaining liability in 2015 equally over FY15–FY21.

¹We show only the total values for all 10 plants to avoid revealing proprietary data on individual plants. Budget projections and other proprietary data on individual plants are available to authorized Army personnel in a proprietary appendix.

²We did not consider the impacts of privatizing Mississippi AAP, since it is located on land owned by NASA.

We used the PricewaterhouseCoopers (2001) “most likely” scenario for estimated future ARMS investments and incentives and ARMS savings.

For the privatization option, we assumed in the base case that in the years before privatization, ammunition costs, environmental remediation costs, COR budgets, and agriculture and forestry revenues would remain the same as in the status quo. However, we assumed no further spending on ARMS investments and incentives and no increase in ARMS savings beyond the FY01 level. To allow for the possibility that some ammunition sales could be lost, revenues from the sale of each plant were estimated at 85 percent of the discounted cash flow valuation, or \$777.8 million. Sales revenues were first used to offset remaining environmental remediation costs at the time each plant was privatized (\$308.4 million),³ and the remaining revenues (a total of \$469.3 million) are shown as “residual sale revenue,” which could be used to offset other one-time costs or to reduce ammunition costs under the first five-year production contract, which we assume would be linked to the sale of the plant. After privatization, we assume a 5 percent reduction in ammunition costs relative to the status quo in each of the first two five-year ammunition production contracts at each plant. Ammunition costs are then assumed to remain 10 percent below the status quo in the remainder of the 20-year projection. Since the ammunition plants appear to be undercapitalized, and production contracts will be subjected to greater competition when the plants are no longer protected by the Arsenal Act and other government subsidies, some savings in the total costs of ammunition (including production base support, LIF, and MIIF) should be possible after privatization.

The one-time costs of privatization include termination of the facility use and production contracts if the plants are not sold to the current contractors, separation of government employees in each plant’s COR office, conducting the sale, and reimbursing the current contractors for any unfunded retiree benefits.⁴ Based on information provided by OSC, the cost of terminating the facility use contracts is set at zero⁵ and the cost of conducting a sale is set at \$1

³For plants where the environmental liability exceeded the sales revenue, we assumed that all of the sales revenue would be used to offset as much of the remediation cost as possible, beginning with the year of sale. When funds ran out, the Army would be responsible for the remainder of the liability.

⁴By agreement with the Study Advisory Group, we do not include the costs of environmental characterization studies (estimated at \$1.5 million per plant) as a one-time cost of privatization, since these studies would need to be undertaken regardless of the option chosen. In principle, conducting these environmental characterization studies could result in the discovery of additional environmental liabilities. We did not have a basis to estimate any additional liability or to attribute additional remediation costs across future years. In any case, these costs would be incurred both under the status quo and the privatization option.

⁵Facility use contracts for most of the plants are set to expire in the next few years and could be temporarily extended if necessary pending a sale. (See Table 7.5.) The contracts at Holston and

million.⁶ Government employee separation costs are estimated based on cost factors provided by OSC of \$48,600 per employee for transfers, \$26,000 per employee for RIFs, and \$33,000 per employee for early retirement incentives (VSIPs). In the base case, we assume all military personnel transfer, 25 percent of civilians are subject to RIF, and 75 percent of civilians receive VSIPs (based on recent experience at the arsenals and ammunition plants). The costs of terminating production contracts are based on compensating contractors for work already completed at the time of termination. However, the maximum length of a production contract is five years, and some contracts can be timed to expire before the facilities are sold. In the absence of more detailed information, we estimated termination of production contracts at 10 percent of production costs (ammunition costs minus production base support, LIF, and MIIF).

We were not able to obtain any estimates of the number of personnel at OSC and higher headquarters who might be separated if the Army no longer owned each ammunition plant, or the number of any additional contracting or auditing personnel needed if the plants were privatized. Accounting for these personnel could result in additional one-time separation costs, and recurring savings or costs.

Army commentators on a draft version of this report also suggested a number of additional costs that could be included in the budget projections. One of the most significant was the cost of insurance after the plants were privatized.⁷ However, Army indemnification of insurance risks at GOCO AAPs is not costless, even though it is not currently budgeted. When casualty losses occur, they are typically paid out of the capital budget for AAP investments (telephone conversation with AMC Office of General Counsel, June 4, 2002). Thus, unless private-sector insurance premiums are higher than the actual risk warrants, insurance costs should be approximately the same whether the Army self-insures a GOCO plant or a privatized plant buys insurance. If the Army believes that private-sector insurance premiums are excessive (for example, because of a misperceived increase in risk after the September 11 terrorist attacks), it still has the option of indemnifying COCO plants for unusually hazardous or nuclear risks under PL 85-804 (50 USC 1431–1435). Therefore, insurance costs for the GOCO plants should not differ significantly after privatization.

Lake City have recently been recompeted to extend to 2023 and 2025, respectively, but financial penalties from termination are associated mainly with production contracts.

⁶This estimate is based on projected costs of the LAP competition and recompetition of facility use contracts.

⁷The Army currently indemnifies energetics and LAP operations, but not metal parts production.

A second issue was whether an allowance of 35 percent of the plants' estimated operating margins was sufficient to cover both profit taxes and property taxes. However, further calculations indicated that an estimated property tax of \$100 per acre would be offset by considering the deductibility (against profit taxes) of property taxes, environmental remediation costs, and depreciation of the price paid by the new owner for buildings and equipment as part of the privatization. Therefore, 35 percent of the operating margin should be sufficient to cover both types of taxes.⁸

Finally, it was suggested that up to 75 percent of the current COR staff (120 out of 160 government personnel) would be needed to monitor contracts at the privatized plants. However, some COCO plant operators we contacted indicated that one or fewer full-time government personnel were currently monitoring their plants. In any case, it seems likely that any additional personnel needed to monitor contracts at the privatized plants would be offset by reductions in the number of government personnel needed at OSC and higher headquarters to manage the organic industrial base, although the Army could not provide an estimate of this number.

The final rows of Table D.1 show the estimated net savings and revenues from privatizing the ammunition plants in each year of the projection, and the net present values of these net savings over the FY03–09 budget and POM and the entire 20-year period. Net savings are calculated by subtracting the privatization total costs from the status quo total costs. We calculate net present values using two interest rates specified in OMB Circular A-94. Real discount rates for cost-effectiveness analysis are specified in Appendix C as 3.0 percent for a 7-year time horizon and 3.5 percent for a 20-year time horizon. The real discount rate for public investment is specified on page 7 of Circular A-94 as 7 percent.

To test the sensitivity of the estimated budget projections, we also considered an optimistic case and a pessimistic case. For the optimistic case, we varied the assumptions in ways that were likely to favor privatization. For the status quo, we used the conservative projections of ARMS investments and incentives and ARMS savings. We assumed that the expiration of production contracts could be timed so that there would be no termination costs, that all government civilian employees would be subject to RIF (the least expensive alternative), and that privatization revenue would be based on the multiple of sales valuations. In addition, we assumed that ammunition costs would be reduced by 5 percent relative to the status quo after each recompetition of the 5-year ammunition production contracts at each plant, so that they would be 20 percent below the

⁸As an additional technical note, if one believes that operators of the privatized plants could raise the price of ammunition to cover any additional costs such as insurance or property taxes, estimated valuations should be calculated on the basis of these higher revenues.

Table D.1
Estimated Budget Impacts of Privatization: Base Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ammunition costs	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	
Environmental remediation	27.2	31.5	30.9	33.4	35.6	30.9	29.0	14.8	10.3	11.8	9.2	9.3	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	
COR budget	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	
ARMS investments & incentives	24.2	23.9	22.6	21.5	21.4	21.3	20.2	17.9	15.6	10.8	6.3	6.3	6.0	5.9	5.0	2.8	1.9	1.8	1.7	1.6	
ARMS savings	-25.3	-26.7	-27.8	-29.0	-30.1	-31.3	-32.6	-33.7	-34.6	-35.4	-36.0	-36.5	-37.0	-37.5	-38.0	-38.3	-38.3	-38.2	-38.2	-38.1	
Agriculture & forestry revenues	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	
Total	693.9	696.5	693.4	693.6	694.6	688.6	684.3	666.8	659.0	654.9	647.3	646.8	650.5	649.9	648.5	646.0	645.1	645.1	645.0	645.0	
Privatization																					
Ammunition costs	661.2	651.3	648.0	628.2	628.2	628.2	618.2	614.9	595.1	595.1	595.1	595.1	595.1	595.1	595.1	595.1	595.1	595.1	595.1	595.1	
Environmental remediation	27.2	12.9	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	3.9	3.9	3.9	3.9	4.1	
COR budget	10.7	6.0	4.4																		
ARMS investments & incentives	0.0	0.0	0.0																		
ARMS savings	-25.3	-20.3	-16.4																		
Agriculture & forestry revenues	-4.2	-1.2	-0.1																		
Termination of facility contract		0.0	0.0	0.0																	
Termination of prod'n contracts		18.2	6.2	37.3																	
Gov't employee separation costs		2.3	0.6	2.2																	
Cost of conducting sale		4.0	3.0	3.0																	
Unfunded retiree benefits		0.0	0.0	77.0																	
Residual sale revenue		-76.1	-67.5	-325.7																	
Total	669.7	597.1	588.7	421.9	628.2	628.2	618.2	614.9	595.1	595.1	595.1	595.1	595.1	595.9	599.0	599.0	599.0	599.0	599.2	599.7	
Difference (status quo - privatization)	24.2	99.4	104.7	271.7	66.5	60.4	66.1	51.8	63.9	59.8	52.2	51.7	55.4	54.0	49.5	47.0	46.1	46.1	45.8	45.3	
NPV (FY03-FY09)	634.6	(3.0%)		568.2	(7%)																
NPV (FY03-FY22)	1061.6	(3.5%)		860.9	(7%)																

SOURCES: ARMS investments and savings—PricewaterhouseCoopers (2001); status quo ammunition costs, environmental remediation costs through 2015, COR budget, agriculture and forestry revenues, cost factors for government employee separation costs, cost of conducting sale, and unfunded retiree benefits—U.S. Army Operations Support Command; other values calculated for this study.

status quo at the end of the 20-year projection. Although the overall net savings are higher than in the base case, in some years the optimistic case savings are lower than the base case because of higher spending on ARMS investments and incentives in the base case.⁹

For the pessimistic case, we varied the assumptions in ways that were likely to be unfavorable to privatization. For the status quo, we used the aggressive projections of ARMS investments and incentives and ARMS savings. We increased the cost of terminating production contracts to 15 percent of production costs, and we assumed that all government civilian employees would receive VSIPs (the most expensive alternative). We based privatization sale revenue on the higher of discounted cash flow with a 10 percent annual decline or the land value at each plant,¹⁰ and we increased the cost of conducting each sale to 3.5 percent of the purchase price. In addition, we assumed that ammunition costs would remain the same as the status quo. The variations in the assumptions for the base case, optimistic case, and pessimistic case are summarized in Table D.2. The resulting budget projections are shown in Tables D.3 and D.4.

The negative net present value for privatization at a 3.5 percent interest rate over the FY03–22 period in the pessimistic case occurs primarily because of optimistic assumptions about the growth in ARMS savings in Pricewaterhouse-

Table D.2
Variations in Privatization Assumptions

	Pessimistic	Base Case	Optimistic
Ammunition cost reduction	None	5% in first 2 5-yr contracts (10% cumulative)	5% in each 5-yr contract (20% cumulative)
Revenue from sale	DCF with 10% decline	85% of DCF	Multiple of sales
ARMS program	Aggressive scenario	Most likely scenario	Conservative scenario
Cost to terminate production contracts	15% of FY01 revenues	10% of FY01 revenues	None
Gov't employee separation costs	100% VSIP	25% RIF/75% VSIP	100% RIF
Cost of conducting sale	3.5% of sale price	\$1 million per plant	\$1 million per plant

⁹Although the increases in ARMS program savings eventually exceed spending on investments and incentives at most plants, typically this does not happen until the “out-years” of the projections.

¹⁰We assume that the land value sets a lower bound on privatization revenue.

Table D.3
Estimated Budget Impacts of Privatization: Optimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Status quo																				
Ammunition costs	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2
Environmental remediation	27.2	31.5	30.9	33.4	35.6	30.9	29.0	14.8	10.3	11.8	9.2	9.3	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
COR budget	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7
ARMS investments & incentives	10.7	10.4	10.2	10.1	10.0	9.9	9.8	9.7	8.1	8.0	8.0	7.9	7.6	7.6	7.5	7.0	6.2	6.1	6.0	5.9
ARMS savings	-19.7	-20.1	-20.4	-20.8	-21.2	-21.6	-22.0	-22.4	-22.8	-23.1	-23.4	-23.8	-24.1	-24.4	-24.8	-25.1	-25.4	-25.6	-25.9	-26.2
Agriculture & forestry revenues	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2
Total	686.0	689.5	688.5	690.4	692.2	686.9	684.6	669.8	663.4	664.5	661.5	661.2	665.0	664.6	664.2	663.4	662.3	662.0	661.6	661.3
Inflation factor	1.061	1.093	1.126	1.159	1.194	1.230	1.267	1.305	1.344	1.384	1.426	1.469	1.513	1.558	1.605	1.653	1.702	1.754	1.806	1.860
ARMS FY01 savings	0.0																			
Privatization																				
Ammunition costs	661.2	651.3	648.0	628.2	628.2	628.2	618.2	614.9	595.1	595.1	595.1	585.1	581.9	562.0	562.0	562.0	552.1	548.8	529.0	529.0
Environmental remediation	27.2	12.9	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
COR budget	10.7	6.0	4.4																	
ARMS investments & incentives	0.0	0.0	0.0																	
ARMS savings	-19.7	-15.1	-12.2																	
Agriculture & forestry revenues	-4.2	-1.2	-0.1																	
Termination of facility contract	0.0	0.0	0.0																	
Termination of prod'n contracts	0.0	0.0	0.0																	
Gov't employee separation costs	2.0	0.5	1.9																	
Cost of conducting sale	4.0	3.0	3.0																	
Unfunded retiree benefits	0.0	0.0	0.0	77.0																
Remaining sale revenue	-115.0	-89.0	-467.1																	
Total	675.3	544.8	565.0	242.9	628.2	628.2	618.2	614.9	595.1	595.1	595.1	585.1	581.9	562.0	562.0	562.0	552.1	548.8	529.0	532.1
Difference	10.7	144.7	123.5	447.5	64.0	58.8	66.4	54.9	68.3	69.4	66.4	76.1	83.2	102.6	102.2	101.3	110.2	113.2	132.6	129.2
NPV (FY03-FY09)	840.3	(3.0%)	754.1	(7%)																
NPV (FY03-FY22)	1,583.3	(3.5%)	1,239.7	(7%)																

SOURCES: ARMS investments and savings—PricewaterhouseCoopers (2001); status quo ammunition costs, environmental remediation costs through 2015, COR budget, agriculture and forestry revenues, cost factors for government employee separation costs, cost of conducting sale, and unfunded retiree benefits—U.S. Army Operations Support Command; other values calculated for this study.

Table D.4
Estimated Budget Impacts of Privatization: Pessimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ammunition costs	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	
Environmental remediation	27.2	31.5	30.9	33.4	35.6	30.9	29.0	14.8	10.3	11.8	9.2	9.3	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	
COR budget	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	
ARMS investments & incentives	39.1	37.1	33.2	30.7	28.2	21.7	4.6	4.5	3.5	3.4	3.3	3.2	2.8	2.4	2.2	2.1	2.0	2.0	2.0	1.7	
ARMS savings	-34.0	-36.7	-38.9	-41.1	-43.1	-44.8	-45.5	-45.4	-45.2	-45.3	-45.2	-45.2	-45.1	-45.0	-45.0	-44.9	-44.8	-44.7	-44.7	-44.6	
Agriculture & forestry revenues	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	-4.2	
Total	700.0	699.8	692.9	690.7	688.5	675.6	655.9	641.6	636.3	637.6	635.1	635.1	639.1	638.9	638.7	638.7	638.7	638.7	638.5	638.5	
Inflation factor	1.061	1.093	1.126	1.159	1.194	1.230	1.267	1.305	1.344	1.384	1.426	1.469	1.513	1.558	1.605	1.653	1.702	1.754	1.806	1.860	
ARMS FY01 savings	0.0																				
Privatization																					
Ammunition costs	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	661.2	
Environmental remediation	27.2	12.9	10.5	0.0	0.0	2.6	6.8	8.2	4.4	4.9	5.1	5.4	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	
COR budget	10.7	6.0	4.4																		
ARMS investments & incentives	0.0	0.0	0.0																		
ARMS savings	-34.0	-27.1	-21.4																		
Agriculture & forestry revenues	-4.2	-1.2	-0.1																		
Termination of facility contract	0.0	0.0	0.0																		
Termination of prod'n contracts	27.3	9.4	55.9																		
Gov't employee separation costs	2.5	0.6	2.3																		
Cost of conducting sale	4.4	2.2	9.1																		
Unfunded retiree benefits	0.0	0.0	77.0																		
Remaining sale revenue	-26.2	-44.1	-121.3																		
Total	660.9	659.8	622.6	694.2	661.2	663.8	668.0	669.4	665.6	666.1	666.4	666.6	666.1	666.1	666.1	666.1	666.1	666.1	666.1	666.1	
Difference	39.1	40.0	70.3	6.5	27.3	11.8	-12.1	-27.8	-29.3	-28.5	-31.3	-31.5	-26.9	-27.2	-27.4	-27.4	-27.3	-27.3	-27.5	-27.5	
NPV (FY03-FY09)	174.3	(3.0%)		164.3	(7%)																
NPV (FY03-FY22)	-64.3	(3.5%)		6.1	(7%)																

SOURCES: ARMS investments and savings—PricewaterhouseCoopers (2001); status quo ammunition costs, environmental remediation costs through 2015, COR budget, agriculture and forestry revenues, cost factors for government employee separation costs, cost of conducting sale, and unfunded retiree benefits—U.S. Army Operations Support Command; other values calculated for this study.

Coopers (2001), particularly in the out-years of the budget projections.¹¹ Although we would argue that the Army should not accept a bid that has a negative NPV, such decisions should be based on the sale revenue from privatization and projected ammunition costs, not assumptions about the growth in ARMS revenues that may not be realized.

IOWA ARMY AMMUNITION PLANT

Iowa AAP (Des Moines County), located in southeast Iowa near Burlington, specializes in large-caliber load, assemble, and pack and high-explosive melt/pour operations. It was built in 1941 to load 75–155mm shells and produce bombs, fuzes, boosters, detonators, artillery primers, percussion elements, mines, grenades, and ammonium nitrate, and was initially operated by Day & Zimmerman (Kane and Gaither, 1995, Appendix A).¹² It is currently operated by American Ordnance, a joint venture of Day & Zimmerman and General Dynamics Ordnance and Tactical Systems (GD-OTS), whose facility use contract expires in FY03. Current production lines include 120mm tank ammunition, 105mm and 155mm artillery shells, Javelin and Sidewinder warheads, and the Modular Artillery Charge System (MACS). Iowa AAP's replenishment missions also include 81mm artillery shells, Longbow Hellfire and Patriot warheads, and demolition charges.

The physical characteristics of Iowa AAP are given in Tables D.5 (land), D.6 (building space), and D.7 (other improvements). Table D.8 shows budgeted FY01 production and planned replenishment on each of Iowa AAP's production lines. Iowa AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.9.¹³

¹¹PricewaterhouseCoopers (2001) assumes that over 2001–2025, up to 90 percent of available square footage at the ammunition plants could be rented at the same average renovation costs and rental rates as in the 1993–2000 period, adjusted for inflation. This assumption could be considered optimistic if the most desirable space was renovated and rented first, for example.

¹²The contract was awarded in November 1940. Construction began in January 1941 and was completed in September 1941.

¹³When ammunition producers have direct contracts with the Army or other services to produce ammunition end items or subcomponents, prices and planned production quantities are reported in annual ammunition and missile procurement budgets. However, if an AAP is a subcontractor to another ammunition producer holding a prime contract for an ammunition end item, subcontract prices are not reported, but planned production quantities can sometimes be attributed.

Table D.5
Iowa AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	700
Tenants	20
Agriculture	
Leased	7,500
Unleased	0
Forestry	
Leased	0
Unleased	7,766
Vacant	3,025
Total	19,011

SOURCE: U.S. Army Operations Support Command.

NOTE: Some agricultural acreage also serves as a safety buffer to meet quantity-distance requirements.

Table D.6
Iowa AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	1,669,503	361,541	830,088	932,973
Standby	296,797	0	0	0
Caretaker	228,781	0	0	0
Total (4,319,593)*	2,195,081	361,541	830,088	932,973
Occupied by				
Ammunition operations	2,189,701	0	830,088	932,973
Government tenants	0	5,900	0	0
Nongovernment tenants	0	111,188	2,120	0

SOURCE: U.S. Army Operations Support Command.

* The total building space at each facility (reported by OSC) will be shown in parentheses after "Total" in each AAP building space table in this appendix. For some plants, this total figure is different from the sum of all categories reported by OSC; for other categories of space accounting, the sum of various subcategories is also inconsistent with other subtotals; OSC was not able to resolve these discrepancies.

Table D.7
Iowa AAP Other Improvements

Type	Amount
Buildings	1,053
Roads	141 miles
Railroads	102 miles
Steam lines	30 miles
Steam production capacity	540,000 lb/hr
Electricity generation capacity	0
Water production capacity	3,000,000 gal/day
Wastewater treatment capacity	800,000 gal/day
Number of employees as of April 2001	
Contractor	870
Government	21

SOURCE: U.S. Army Operations Support Command.

Table D.8
Iowa AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
Line 1	Tank 120mm M830A1 HEAT-MP-T	2,000	38,200
	Javelin AAWS-M Warhead	4,936	23,210
	Patriot M248 Warhead	**	3,510
	M21 AT Hvy HE Metallic Mine	**	1,040
Line 2	Tank 120mm M829A2 APFSDS-T	7,000	85,560
	Tank 120mm M831A1 TP-T	90,000	274,168
	Tank 120mm M865 TPCSDS-T	237,000	634,939
Line 3	Arty 105mm M395 Blank	88,000	N/A
	Arty 105mm M913 HERA	**	51,940
	Arty 105mm M1 HE Comp B w/o Fuze	**	19,040
	Arty 105mm M760 HE Hi Frag	**	10,390
	Arty 105mm M1 HE Hi Frag	**	8,000
	Demo M228 40 lb Cratering Charge	**	26,570
	Demo M180 Cratering Kit	**	13,670
Demo MK36-1 4 lb Block	**	3,780	
Line 3A	Arty 155mm M107 HE Comp B w/o Fuze	208,000	1,270,470
	Arty 155mm M795 HE TNT w/o Fuze	75,000	167,050
	Arty 155mm M549A1 HE RAP TNT Ldd	**	317,170
	Arty 81mm M821A1 HE Melt Pour	**	55,460
	Arty 81mm M889A1 HE Melt Pour	**	55,160
Line 4B	Sidewinder warhead	185	N/A
	Longbow Hellfire Missile Warhead	**	14,470
Unknown	Modular Artillery Charge System	288	N/A
Line 5A	Demo TNT 1 lb Block	**	73,940
	Demo TNT 1/2 lb Block	**	42,740
	Demo TNT 1/4 lb Block	**	2,360

Table D.8—continued

Line	Products	FY01 Production	Replenishment Plan
Line 9	Mine Pressing (Inactive)		
Line 4A	Detonators (Disposal)		
Area 800	Blanks (Disposal)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

NOTE: The use of ** indicates that the production quantity for FY01 is either zero or unknown. OSC could not completely account for production at each facility, in part because many facilities are subcontractors for other facilities and manufacturers.

Table D.9
Iowa AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
Arty 155mm M107 HE	208,000	\$ 70.91	\$14,749,280
Arty 155mm M795 HE	75,000	116.00	8,700,000
Arty 105mm M395 Blank	88,000	51.36	4,519,680
MACS	288	16.00	4,608
Subcontracts			
Tank 120mm M865 TPCSDS-T	237,000	(unknown)	(unknown)
Tank 120mm M831A1 TP-T	90,000		
Tank 120mm M829A2 APFSDS-T	7,000		
Tank 120mm M830A1 HEAT-MP-T	2,000		
Javelin AAWS-M warhead	4,936		
Sidewinder warhead	185		
Other ammunition revenues			
Industrial facilities			7,686,000
LIF			746,000
MIF			428,000
Nonammunition revenues			
Agriculture			1,105,537
Forestry			10,414
Other government costs			
Environmental remediation			4,800,000
COR (gov't staff) budget			1,375,015
FY01 liabilities			
Environmental remediation			54,856,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs, (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

KANSAS AAP

Kansas AAP (Labette County), located in Parsons, Kansas, specializes in small-caliber and specialty LAP production. It was built in 1942 as a multipurpose LAP facility producing shells, bombs, detonators, artillery primers, fuzes, boosters, and ammonium nitrate (Kane and Gaither, 1995, Appendix A).¹⁴ Day & Zimmerman currently operates Kansas AAP. The facility-use contract expired on December 31, 2002. Current production lines include bomb disposal and production. The physical characteristics of Kansas AAP are given in Tables D.10 (land), D.11 (building space), and D.12 (other improvements). Table D.13 shows budgeted FY01 production and planned replenishment on each of Kansas AAP's production lines. Kansas AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.14.

Table D.10
Kansas AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	11,181
Tenants	29
Agriculture	
Leased	9,971
Unleased	129
Forestry	
Leased	0
Unleased	950
Vacant	231
Total	13,727

SOURCE: U.S. Army Operations Support Command.

¹⁴The contract was awarded in August 1941. Construction began in September 1941 and was completed in April 1942. J-M Service Inc. (a subsidiary of the Johns-Manville Corporation) was the Army's initial plant operator.

Table D.11
Kansas AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	797,291	61,560	512,000	380,000
Standby	0	6,676	0	0
Caretaker	407,413	7,600	0	0
Total (2,200,000)	1,204,704	75,836	512,000	380,000
Occupied by				
Ammunition operations	1,204,704	75,836	512,000	380,000
Government tenants	0	0	0	0
Nongovernment tenants	0	1,271	94,640	0

SOURCE: U.S. Army Operations Support Command.

Table D.12
Kansas AAP Other Improvements

Type	Amount
Number of buildings	555
Roads (miles)	106
Railroads (miles)	33
Steam lines (miles)	14
Steam production capacity	3,638 hp
Electricity generation capacity	0
Water production capacity	1,000,000 gal/day
Wastewater treatment capacity	500,000 gal/day
Number of employees as of April 2001	
Contractor	132
Government	8

SOURCE: U.S. Army Operations Support Command.

Table D.13
Kansas AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
1100	Disp & Bomb CBU-97/B SFW	300	1,890

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

Table D.14
Kansas AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
None visible in Army budget			
Subcontracts			
Disp & Bomb CBU-97/B SFW	300	(unknown)	(unknown)
Other ammunition revenues			
Industrial facilities			\$456,000
LIF			0
MIIF			0
Nonammunition revenues			
Agriculture			344,434
Other government costs			
Environmental remediation			2,190,000
COR (gov't staff) budget			632,700
FY01 liabilities			
Environmental remediation			25,191,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

LONE STAR AAP

Lone Star AAP (Bowie County), located in Texarkana, Texas, specializes in small-caliber and specialty LAP production. It was built in 1942 as a multi-purpose LAP facility working with 36 different munitions, including artillery, shells, bombs, fuzes, boosters, grenades, bursters, shot, ammonium nitrate, and amatol (Kane and Gaither, 1995, Appendix A).¹⁵ Day & Zimmerman currently operates Lone Star AAP. The facility use contract expires on December 31, 2003. Current production lines include tracer striping, and a variety of detonators, fuzes, and 60mm, 105mm, and 155mm projectiles/casings.

The physical characteristics of Lone Star AAP are given in Tables D.15 (land), D.16 (building space), and D.17 (other improvements). Table D.18 shows budgeted FY01 production and planned replenishment on each of Lone Star AAP's production lines. Lone Star AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.19.

Table D.15
Lone Star AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	9,363
Tenants	7
Agriculture	
Leased	0
Unleased	0
Forestry	
Leased	0
Unleased	6,218
Vacant	112
Total	15,700

SOURCE: U.S. Army Operations Support Command.

¹⁵The contract was awarded in July 1941. Construction began in September 1941 and was completed in May 1942. Lone Star Defense Company (a subsidiary of B.F. Goodrich) was the Army's initial plant operator.

Table D.16
Lone Star AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	828,169	92,174	771,045	447,388
Standby	182,280	0	0	0
Caretaker	822,324	0	0	0
Total (3,143,380)	1,832,773	92,174	771,045	447,388
Occupied by				
Ammunition operations	1,832,773	92,174	771,045	447,388
Government tenants	0	0	0	375,344
Nongovernment tenants	30,631	1,700	0	1,110

SOURCE: U.S. Army Operations Support Command.

Table D.17
Lone Star AAP Other Improvements

Type	Amount
Number of buildings	991
Roads (miles)	144
Railroads (miles)	37.7
Steam lines (miles)	24
Steam production capacity	534,000 lb/hr
Electricity generation capacity	0
Water production capacity	0
Wastewater treatment capacity	200,000 gal/day
Number of employees as of April 2001	
Contractor	394
Government	18

SOURCE: U.S. Army Operations Support Command.

Table D.18
Lone Star AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
B	CTG 105mm HEDP (ICM) XM915	**	152,350
B	Gren GP M77 (HE-TAC) F/MLRS	**	57,824,340
B	Proj 155mm HEDP (ICM) M483A1	**	278,030
B13	Proj 155mm HE XM 864 DP ICM	**	717,640
F	Chg Supplementary	**	1,844,736
F	Disp & Bomb ACFT CBU-78a/b Gator	**	2,010
F	Mine Canister M87 W/6AT&no AP Mines	**	126,430
F	Mine Canister M87 W/mines Blu-91&92B (Volcano)	1,000	126,430

Table D.18—continued

Line	Products	FY01 Production	Replenishment Plan
G	Chg Expel F/105mm M314 Illum	**	7,059
G	Chg Expel F/105mm M825 WP SMK	**	40,365
G	Chg Expel Prim F/M485 Illum	**	9,720
G	Chg Expel Sec F/M485	**	9,720
G	Chg Expul F/105mm ICM XM915	**	156,921
G	Chg Expul F/155mm M483A1	**	283,591
G	Chg Expul F/155mm M864	**	750,652
G	Proj 155mm RADAM-L	**	70,790
G	Proj 155mm RADAM-S	**	507,930
G	Tracer M13	**	437,722
G18	Primer Perc M82	**	2,053,800
K	Primer Perc M36A2	**	18,258,912
K	Primer Perc M54	**	9,746,977
K	Primer Perc M61	**	74,787
O	Burster M85 (F/60mm M722)	**	147,455
O	Casing Brstr M1	**	25,664
O	Chg Brstr XM86 F/120mm MRTR	**	128,929
O	Chg Brstr M54A1	**	25,664
O	Gren Hand Frag M67	**	607,440
P/Q	Chg Expel F/105mm M84 BE	**	10,598
P/Q	Delay Assy F/M549	**	348,887
P/Q	Delay Det (PA506)	**	1,438,261
P/Q	Delay Det F/155mm M825	**	40,560
P/Q	Delay Elem M53	**	618,166
P/Q	Detonator Elec M84	**	35,643
P/Q	Detonator F/30mm M789	**	1,116,093
P/Q	Detonator F/FZ M206A2	**	37,143
P/Q	Detonator F/FZ M213	**	643,887
P/Q	Detonator F/FZ M758	**	3,868,532
P/Q	Detonator F/FZ M759	**	1,085,655
P/Q	Detonator Flash WOX 80a	**	6,948
P/Q	Detonator M46	**	1,092
P/Q	Detonator M55	3,670,000	153,808,564
P/Q	Detonator M57	**	5,747,131
P/Q	Detonator M61E2	**	990,587
P/Q	Detonator M85	**	313,864
P/Q	Detonator M99	**	626,361
P/Q	Detonator MK18-0	**	763,200
P/Q	Detonator MK23-1	**	14,486
P/Q	Detonator MK25-1	**	2,071
P/Q	Detonator MK44-1	**	6,948
P/Q	Detonator Slide F/FZ M732	**	56,914
P/Q	Detonator Stab M59	**	11,344,293
P/Q	Detonator Stab M76	**	621,446
P/Q	Detonator Stab M94	**	7,059
P/Q	Detonator Stab M98	**	560,769
P/Q	Detonator WOX-87a	**	6,948

Table D.18—continued

Line	Products	FY01 Production	Replenishment Plan
P/Q	Lead Assy PA508	**	667,311
P/Q	Lead Cup Assy F/Gren M42/46/77	**	148,975,570
P/Q	Primer M104	**	111,395
P/Q	Primer M42	**	6,995,324
P/Q	Primer MK154-0	**	6,771
P/Q	Primer PA505	**	48,557
P/Q	Primer PA515	**	428
P/Q	Primer Perc M115	**	21,998,271
P/Q	Primer Perc M28B2	**	280,087
R	Primer Elec M125 F/120MM	**	1,045,474
R	Primer Elec M129 F/120mm Tank	**	128,711
C	Melt Pour (Disposal)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999). **Zero or unknown; see note on Table D.8.

Table D.19

Lone Star AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
Detonator M55 (for 40mm HEDP M430)	3,250,000	\$ 0.71	\$2,307,500
Detonator M55 (for 40mm TP M 918)	420,000	1.22	512,400
Mine AT M87 (Volcano)	1,000	786.00	786,000
Subcontracts			
None visible in Army budget			
Other ammunition revenues			
Industrial facilities			2,628,000
LIF			0
MIIF			153,000
Nonammunition revenues			
Forestry			430,400
Other government costs			
Environmental remediation			1,295,000
COR (gov't staff) budget			1,200,274
FY01 liabilities			
Environmental remediation			3,519,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

MILAN ARMY AMMUNITION PLANT

Milan AAP (Gibson County), located in Milan (in the center of western Tennessee), specializes in medium-caliber LAP production. It was built in 1941 to load ammunition, bombs, rockets, primers, fuzes (also applied tracer striping to munitions and produced ammonium nitrate), and was initially operated by Procter and Gamble Inc. (Kane and Gaither, 1995, Appendix A).¹⁶ It is currently operated by American Ordnance, a joint venture of Day & Zimmerman and General Dynamics Ordnance and Tactical Systems, whose facility use contract expires in 2003. Current production lines include LAP of 40mm, 60mm, and 81mm mortar shells, as well as assembly of a variety of fuze and mine munitions.

The physical characteristics of Milan AAP are given in Tables D.20 (land), D.21 (building space), and D.22 (other improvements). Table D.23 shows budgeted FY01 production and planned replenishment on each of Milan AAP's production lines. Milan AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.24.

Table D.20
Milan AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	6,758
Tenants	8
Agriculture	
Leased	8,490
Unleased	54
Forestry	
Leased	0
Unleased	6,859
Vacant	188
Total	22,357

SOURCE: U.S. Army Operations Support Command.

¹⁶The contract was awarded to build Wolf Creek Ordnance Plant (OP), later renamed Milan AAP, in December 1940. Construction began in March 1941 and was completed in September 1941. The Army's initial plant operating contractor was Procter and Gamble Defense Corporation, a subsidiary of Procter and Gamble Inc.

Table D.21
Milan AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	1,010,000	86,335	2,240,000	302,546
Standby	0	0	0	0
Caretaker	117,059	10,995	67,261	42,070
Total (4,280,288)	1,127,059	97,330	2,307,261	344,616
Occupied by				
Ammunition operations	1,127,059	97,330	2,307,261	344,616
Government tenants	0	0	0	0
Nongovernment tenants	0	300	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.22
Milan AAP Other Improvements

Type	Amount
Number of buildings	1,504
Roads (miles)	215
Railroads (miles)	85.7
Steam lines (miles)	976
Steam production capacity	202 (units not specified)
Electricity generation capacity	Negligible
Water production capacity	4,120,000 gal/day
Wastewater treatment capacity	700,000 gal/day
Number of employees as of April 2001	
Contractor	789
Government	26

SOURCE: U.S. Army Operations Support Command.

Table D.23
Milan AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
B	Case Ctg 40mm M118 LDD	**	1,133,641
B	Case Ctg 40mm M195 LDD	**	2,301,042
B?	CTG 40mm TP M918 (training)	3,250,000	N/A
B	Chg Assy Demo M183	**	147,360
B	Chg Demo Blk M112 1.25 Lb Comp C4	159,000	1,095,820
B	Chg Demo Flex Linear M58A3	**	11,070
B	Chg Linear HE (C4) M59	**	1,320
B	Ctg 40mm HEDP M430 W/FZ PIBD M549 W/LK M16A2	420,000	10,804,150

Table D.23—continued

Line	Products	FY01 Production	Replenishment Plan
B	CTG 40mm HEDP M433 W/FZ PIBD M550	**	973,780
B	Mine AP M18A1 Claymore W/Access	**	105,870
D	Ctg 60mm HE M720 W/FZ M734	**	274,770
D	CTG 60mm HE M889A1 W/FZ M935	391,000	509,790
D	CTG 81mm HE M821A1 W/FZ M734	**	55,460
D	CTG 81mm HE M889A1 W/FZ M935	**	55,160
D	Fuze LAP PD M745	**	275,135
D	Gren M74 LDD F/ATACMS	**	1,750,000
H	Chg Incr Assy 60mm M204	1,564,000	4,261,455
H	Chg Incr Assy 81mm M218	**	462,398
H	Chg Incr Assy 81mm M219	**	507,006
H	Chg Incr Assy 81mm M220	**	453,542
H	Fuze LAP PD M935/M936	120,000	581,899
H	Fuze PD M739A1 LAP	**	593,350
H	Fuze Proj ET M767 LAP	**	527,830
H	Fuze Proj Prox RF M732A2 LAP	**	107,450
H	IGN M752 F/81mm	**	245,899
H	Ignition CTG 60mm M702	391,000	1,086,302
H	Ignition CTG 81mm M299	**	115,046
I	C4 Extrusion (Active)		
A	40mm (Disposal)		
C	Mortars (Disposal)		
E	Fuzes (Disposal)		
F	Ign Ctg (Disposal)		
X	Melt Pour (Disposal)		
Z	120mm comp (Disposal)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

**Zero or unknown; see note on Table D.8.

Table D.24
Milan AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
CTG 40mm TP M918	3,250,000	\$8.41	\$27,332,000
CTG 40mm HEDP M430	420,568	11.15	4,689,333
CTG Mortar 60mm HE M888	391,000	27.30	10,674,300
M702 Ignition Cartridge	391,000	11.71	4,579,000
Fz Mpts M935	120,000	10.00	1,200,000
LAP Chg Prop M204	1,564,000	0.85	1,329,000
Chg Demo Blk Comp C-4 1.25lb M112	159,000	4.44	706,000
Subcontracts			
None visible in Army budget			
Other ammunition revenues			
Industrial facilities			5,132,000
LIF			0
MIIF			186,000
Nonammunition revenues			
Agriculture			1,070,216
Forestry			13,784
Other government costs			
Environmental remediation			10,000,000
COR (gov't staff) budget			1,513,623
FY01 liabilities			
Environmental remediation			128,002,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

LOUISIANA AAP

Louisiana AAP (Webster County), located in Shreveport, Louisiana, specializes in metal parts production. It was built in 1942 as a multi-purpose LAP facility working with 36 different munitions, including bombs, mines, projectiles, grenades, boosters, fuzes, and tracer striping (Kane and Gaither, 1995, Appendix A).¹⁷ Valentec Inc. currently operates Louisiana AAP. The facility use contract expired on December 31, 2002. Current production lines include multiple types of 155mm shells.

The physical characteristics of Louisiana AAP are given in Tables D.25 (land), D.26 (building space), and D.27 (other improvements). Table D.28 shows budgeted FY01 production and planned replenishment on each of Louisiana AAP's production lines. Louisiana AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.29.

Table D.25
Louisiana AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	110
Tenants	1,034
Agriculture	
Leased	0
Unleased	0
Forestry	
Leased	0
Unleased	13,665
Vacant	140
Total	14,949

SOURCE: U.S. Army Operations Support Command.

¹⁷The contract was awarded in July 1941. Construction began in September 1941 and was completed in March 1942. Silas Mason Company was the Army's initial plant operator.

Table D.26
Louisiana AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	262,253	25,533	135,819	0
Standby	434,180	17,704	161,746	80,690
Caretaker	1,072,537	0	0	637,871
Total (2,828,333)	1,768,970	43,237	297,565	718,561
Occupied by				
Ammunition operations	1,768,970	11,000	297,565	718,561
Government tenants	0	83,317	0	173,654
Nongovernment tenants	262,253	14,533	135,819	0

SOURCE: U.S. Army Operations Support Command.

Table D.27
Louisiana AAP Other Improvements

Type	Amount
Number of buildings	652
Roads (miles)	209
Railroads (miles)	61
Steam lines (miles)	8.2
Steam production capacity	0
Electricity generation capacity	0
Water production capacity	3,300,000 gal/day
Wastewater treatment capacity	2,000,000 gal/day
Number of employees as of April 2001	
Contractor	19
Government	7

SOURCE: U.S. Army Operations Support Command.

Table D.28
Louisiana AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
Y	SHELL 155mm HE M107	**	1,295,880
Y	SHELL 155mm HE M483	**	283,591
Y	SHELL 155mm ICM M864	**	735,581
G/H	Black Powder (rented to tenant)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

**Zero or unknown; see note on Table D.8.

Table D.29
Louisiana AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
No contracts visible in Army budget			
Other ammunition revenues			
Industrial facilities			0
LIF			\$ 50,000
MIF			798,000
Nonammunition revenues			
Forestry			1,049,591
Other government costs			
Environmental remediation			390,000
COR (gov't staff) budget			686,200
FY01 liabilities			
Environmental remediation			10,928,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

RIVERBANK ARMY AMMUNITION PLANT

Riverbank AAP (Stanislaus County), located in Riverbank (in the center of California near Modesto), specializes in metal parts production. Riverbank AAP was an existing industrial plant acquired by the U.S. Army during the Korean War and converted into a GOCO metal parts plant. It is currently operated by Norris Industries (NI) and the facility-use contract expires on December 31, 2005. Current production lines include production of a shell casing for MLRS grenades, and a variety of shell calibers (76mm, 105mm, and 5/54 caliber).

The physical characteristics of Riverbank AAP are in Tables D.30 (land), D.31 (building space), and D.32 (other improvements). Table D.33 shows budgeted FY01 production and planned replenishment on each of Riverbank AAP's production lines. Riverbank AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.34.

Table D.30
Riverbank AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	146
Tenants	10
Agriculture	
Leased	34
Unleased	0
Forestry	
Leased	0
Unleased	0
Vacant	16
Total	172

SOURCE: U.S. Army Operations Support Command.

NOTE: Some agricultural acreage also serves as a safety buffer to meet quantity-distance requirements.

Table D.31
Riverbank AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	66,500	16,800	0	17,000
Standby	47,300	0	0	0
Caretaker	128,600	0	0	0
Total (768,519)	242,400	16,800	0	17,000
Occupied by				
Ammunition operations	242,400	16,800	0	17,000
Government tenants	0	0	0	0
Nongovernment tenants	185,000	9,000	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.32
Riverbank AAP Other Improvements

Type	Amount
Number of buildings	129
Roads (miles)	5
Railroads (miles)	5
Steam lines (miles)	1.5
Steam production capacity	350 hp
Electricity generation capacity	20 MW/hr
Water production capacity	6,000 gal/hr
Wastewater treatment capacity	180 gal/min
Number of employees as of April 2001	
Contractor	67
Government	3

SOURCE: U.S. Army Operations Support Command.

Table D.33
Riverbank AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
6	Case CTG 105mm XM 217	**	155,397
6	Case CTG 5/54 Cal MK9 All Mods	**	54,722
6	Case CTG 76mm (Steel)	**	9,801
8	Gren Mpts XM80 F/ICM XM 915	**	6,703,400
8	Gren Mpts F/Gren M42/M46	**	80,008,189
8	Gren Mpts F/Gren M77 (MLRS)	**	57,824,340
1	Mortars (Inactive)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

**Zero or unknown; see note on Table D.8.

Table D.34
Riverbank AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
No contracts visible in Army budget			
Other ammunition revenues			
Industrial facilities			0
LIF			0
MIIF			\$ 923,000
Nonammunition revenues			
Agriculture			6,593
Other government costs			
Environmental remediation			1,620,000
COR (gov't staff) budget			238,200
FY01 liabilities			
Environmental remediation			16,903,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

SCRANTON ARMY AMMUNITION PLANT

Scranton AAP (Lackawanna County), located in Scranton, Pennsylvania, in the heart of the industrial northeastern United States, specializes in metal parts production. Scranton AAP was an existing industrial plant acquired by the U.S. Army during the Korean War and converted into a GOCO metal parts plant. Chamberlain Inc. currently operates Scranton AAP. The facility use contract expires on December 31, 2002. Current production lines include mortar and artillery shell casings in 105mm, 120mm, and 155mm caliber.

The physical characteristics of Scranton AAP are given in Tables D.35 (land), D.36 (building space), and D.37 (other improvements). Table D.38 shows budgeted FY01 production and planned replenishment on each of Scranton AAP's production lines. Scranton AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.39.

Table D.35
Scranton AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	15
Tenants	0
Agriculture	
Leased	0
Unleased	0
Forestry	
Leased	0
Unleased	0
Vacant	0
Total	15

SOURCE: U.S. Army Operations Support Command.

Table D.36
Scranton AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	457,400	43,500	0	8,100
Standby	0	0	0	0
Caretaker	0	0	0	0
Total (500,900)	457,400	43,500	0	0
Occupied by				
Ammunition operations	457,400	43,500	0	8,100
Government tenants	0	300	0	0
Nongovernment tenants	0	0	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.37
Scranton AAP Other Improvements

Type	Amount
Number of buildings	8
Roads (miles)	1
Railroads (miles)	1
Steam lines (miles)	1
Steam production capacity	56,000 lb/hr
Electricity generation capacity	0
Water production capacity	0
Wastewater treatment capacity	500,000 gal/day
Number of employees as of April 2001	
Contractor	380
Government	8

SOURCE: U.S. Army Operations Support Command.

Table D.38
Scranton AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
120mm	Shell 120mm HE	78,000	355,296
120mm	Shell Smk XM929 f/120mm Mrtr	66,000	128,929
120mm	Shell 120mm Illum XM930	3,640	N/A
5" LN	Proj Body 5/54 Cal MK48-1	**	4,641
5/54	Proj Body 5/54 Cal MK64	**	113,395
M314	Shell 105mm Illum M314A3	**	7,059
Shell	MTR Body f/Proj 155mm M549 HERA	**	320,341
Shell	Shell 105mm 915/916 & Metal PartAssembly	**	155,397
Shell	Shell 105mm BE M84E1	**	10,598
Shell	Shell 105mm HE M1	**	19,421
Shell	Shell 105mm Hi-Frag M760	**	18,758
Shell	Shell 105mm M913 HERA	**	52,979
Shell	Shell 105mm Smk WP M60	**	9,099
Shell	Shell 155mm HE M107	139,000	1,295,880
Shell	Shell 155mm HE M549 w/o Mtr Body	**	323,514
Shell	Shell 155mm HE M795	75,000	170,391
Shell	Shell 155mm ICM M864	**	735,581
Shell	Shell 155mm Illum M485	**	9,915
Shell	Shell 155mm Smk M110	**	25,664
Shell	Shell 155mm Smk M825 BE	**	39,780
Shell	Shell 155mm XM898 SADARM	364	329,857

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

**Zero or unknown; see note on Table D.8.

Table D.39
Scranton AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
Shell 120mm HE	78,000	\$138.97	\$10,840,000
Shell Smk XM929 f/120mm Mrtr	66,000	206.00	13,596,000
Shell 120mm Illum XM930	3,640	298.00	1,084,720
Shell 155mm HE M107	139,000	121.05	16,825,950
Shell 155mm HE M795	75,000	207.00	15,525,000
Subcontracts			
Shell 155mm XM898 SADARM	364	(unknown)	(unknown)
Other ammunition revenues			
Industrial facilities			0
LIF			1,300,000
MIIF			0
Nonammunition revenues			
Agriculture/forestry			0
Other government costs			
Environmental remediation			0
COR (gov't staff) budget			626,000
FY01 liabilities			
Environmental remediation			0
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

HOLSTON AAP

Holston AAP (Hawkins County), located in Kingsport, Tennessee, specializes in propellants and explosives production. It was built in 1943 to produce energetics such as RDX, Composition B, Acetic Anhydride, Nitric Acid, and Ammonium Nitrate (Kane and Gaither, 1995, Appendix A).¹⁸ Royal Ordnance North America currently operates Holston AAP. The facility use contract expires on December 31, 2023. Current production lines include PBX, HMX, RDX, Compositions A, B, and C, and other explosives.

The physical characteristics of Holston AAP are given in Tables D.40 (land), D.41 (building space), and D.42 (other improvements). Table D.43 shows budgeted FY01 production and planned replenishment on each of Holston AAP's production lines. Holston AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.44.

Table D.40
Holston AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	1,514
Tenants	2
Agriculture	
Leased	435
Unleased	543
Forestry	
Leased	0
Unleased	3,530
Vacant	0
Total	6,024

SOURCE: U.S. Army Operations Support Command.

¹⁸The contract was awarded in June 1942. Construction began in August 1942 and was completed in April 1943. Eastman Kodak Company was the Army's initial plant operator.

Table D.41
Holston AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	827,800	233,143	220,420	355,153
Standby	406,822	20,472	0	6,424
Caretaker	232,443	19,850	0	90
Total (2,322,677)	1,467,065	273,465	220,420	361,667
Occupied by				
Ammunition operations	1,467,125	273,465	220,420	361,667
Government tenants	0	1,000	0	0
Nongovernment tenants	31,894	46,695	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.42
Holston AAP Other Improvements

Type	Amount
Number of buildings	446
Roads (miles)	107
Railroads (miles)	31
Steam lines (miles)	Unknown
Steam production capacity	1,850,000 lb/hr
Electricity generation capacity	0
Water production capacity	520,992 gal/day
Wastewater treatment capacity	7,080,000 gal/day
Number of employees as of April 2001	
Contractor	173
Government	19

SOURCE: U.S. Army Operations Support Command.

Table D.43
Holston AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
3	Composition A-3	**	750,048
3	Composition A-4	**	423,721
3	Composition A-5	**	11,474,318
3	Composition B	**	54,093,389
3	Composition CH-6	**	238,679
3	CXM-6	**	398,727
3	CXM-7	**	33,932,899
3	Cyclotol 70/30	**	14,207
3	PBX O-280	**	1,881,745
3	PBX TY I	**	11
3	RDX Bulk (Not Used in Comp)	**	112,432
4	Composition D-2	**	1,750,813

Table D.43—continued

Line	Products	FY01 Production	Replenishment Plan
5	Composition C-4 (for Chg Demo Blk 1-1/4 lb M112)	198,750	28,176,101
5	CXM-3	**	357,756
5	HMX (Not Used in Comps)	**	36,639
5	LX-14	**	394,078
5	Octol 75/25	**	245,700
5	PBXN-5	**	965,619
5	PBXN-8	**	38,073
5	PBXN-9 TYPE II	**	825,867
6	Octol 70/30	**	616,092
6	PBX 9407	**	760
7	HMX Products (Active)		
8	Composition C-4 (Disposal)		
1	Composition B (Disposal)		
2	Composition B (Disposal)		
9	Composition A-4 (Disposal)		
10	Composition A-5 (Disposal)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999). **Zero or unknown; see note on Table D.8.

Table D.44

Holston AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
Composition C-4 Class 3 (for Chg Demo Blk 1-1/4 lb M112)	198,750	\$7.55	\$1,500,563
Subcontracts			
None visible in Army budget			
Other ammunition revenues			
Industrial facilities			14,069,000
LIF			0
MIIF			1,705,000
Nonammunition revenues			
Agriculture			51,397
Other government costs			
Environmental remediation			695,000
COR (gov't staff) budget			1,171,843
FY01 liabilities			
Environmental remediation			10,104,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

RADFORD ARMY AMMUNITION PLANT

Radford AAP (Montgomery County), located near Radford, Virginia, in the heart of the state's western panhandle (New River Valley), specializes in propellants and explosives production. It was built in 1941 to produce energetics such as Nitrocellulose Powder, Pentolite, and TNT (Kane and Gaither, 1995, Appendix A).¹⁹ Alliant Techsystems Inc. (ATK) currently operates Radford AAP. The facility use contract expired on December 31, 2002. The Army held a competition in 2002 to award a new long-term contract for both facility use and multiyear energetics production.²⁰ Current production lines include single-base and double-base propellants, nitrocellulose, and (inactive) TNT production capability.

The physical characteristics of Radford AAP are given in Tables D.45 (land), D.46 (building space), and D.47 (other improvements). Table D.48 shows budgeted FY01 production and planned replenishment on each of Radford AAP's production lines. Radford AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.49.

Table D.45
Radford AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	4,080
Tenants	250
Agriculture	
Leased	483
Unleased	0
Forestry	
Leased	0
Unleased	1,263
Vacant	825
Total	6,901

SOURCE: U.S. Army Operations Support Command.

¹⁹The contract was awarded in August 1940. Construction began in October 1940 and was completed in April 1941. The Army's initial plant operating contractor was the Hercules Powder Company.

²⁰The Army received only one bid, and eventually decided to terminate the competition. The Army plans to extend ATK's contract for one year while it determines a long-run strategy for the plant.

Table D.46
Radford AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	977,658	183,420	127,823	322,914
Standby	893,505	4,158	56,602	29,864
Caretaker	380,489	27,654	96,516	82,135
Total (3,735,694)	2,251,652	215,232	280,941	434,913
Occupied by				
Ammunition operations	1,698,696	184,100	253,505	397,651
Government tenants	41,475	0	0	0
Nongovernment tenants	415,651	31,132	27,436	37,262

SOURCE: U.S. Army Operations Support Command.

Table D.47
Radford AAP Other Improvements

Type	Amount
Number of buildings	1,154
Roads (miles)	162
Railroads (miles)	28
Steam lines (miles)	372,951
Steam production capacity	850,000 lb/hr
Electricity generation capacity	580,000 KWH/day
Water production capacity	83,000,000 gal/day
Wastewater treatment capacity	Sanitary: 1,000,000 gal/day; Acidic: 8,000,000 gal/day; Bio: 3,000,000 gal/day
Number of employees as of April 2001	
Contractor	1,465
Government	29

SOURCE: U.S. Army Operations Support Command.

Table D.48
Radford AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
A	Prop SB IMR 4895	**	26,735
A	Powder Clean Burning Ign (CBI)	**	46,483
A	Benite	**	112,080
A	Prop SB M1 SP	**	153,066
A	Prop SB IMR 5010	**	311,546
A	Prop SB M10	**	316,913
B	Prop SB M6+2	**	53,940
B	Prop SB M6	**	786,900
B	Prop SB Naco (Navy)	**	1,098,009
B	Prop SB M14	**	14,906,483
C	Prop DB M9	**	25,688
C	Prop SLVT DB Rkt M7 (Mod)	**	135,055
C	Prop DB M2	**	302,163
C	Prop SLVT SB/DB XM45 f/120mm Mrtr	**	672,660
C	PAP 7993	252,000	1,052,030
C	Prop SB M1 MP	**	1,978,734
C	Prop Stick M31A1E1 .080 Web	**	2,821,410
C	Prop TB M30A1	**	52,167,250
RM	Prop Gr Aft F/155mm M549	**	329,857
RM	Prop Gr Fwd F/155mm M549	**	329,857
RM	Rkt Gr MK90	**	1,051,218
RM	Prop SLVTLS DB JA-2	**	2,194,060
RP4	Prop SLVTLS DB XM44 f/120mm Mrtr	**	81,536
RP4	Prop SLVTLS DB NOSIH AA6	**	117,300
RP4	Prop SLVTLS DB Rkt N5	**	975,928
RP4	Prop SLVTLS DB M37	**	2,873,053
RP4	Prop SLVTLS DB NOSIH AA2	**	8,384,560
TNT B	Trinitrotoluene (TNT), Line B	**	97,160,642
TNT C	Trinitrotoluene (TNT), Line C	**	97,160,642
NG 1	Nitroglycerin (Active)		
NG 2	Nitrate Esthers (Active)		
AOP	Acid (Active)		
NAC/SAC 2	Acid (Active)		
NAC/SAC 3	Acid (Active)		
NC C	Nitrocellulose (Active)		
NC B	Nitrocellulose (Inactive)		
CASBL	SB Propellant (Disposal)		
CAMBL	MB Propellant (Disposal)		
NAC/SAC 1	Acid (Disposal)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

**Zero or unknown; see note on Table D.8.

Table D.49
Radford AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
PAP 7993	252,000	\$4.00	\$1,008,000
Subcontracts			
None visible in Army budget			
Other ammunition revenues			
Industrial facilities			2,700,000
LIF			0
MIIF			938,000
Nonammunition revenues			
Agriculture			11,924
Forestry			56,359
Other government costs			
Environmental remediation			3,043,000
COR (gov't staff) budget			2,044,414
FY01 liabilities			
Environmental remediation			92,835,000
Unfunded retiree benefits			77,000,000

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

LAKE CITY ARMY AMMUNITION PLANT

Lake City AAP (Jackson County), located in Independence, Missouri, specializes in small-caliber LAP production. It was built in 1941 to produce small-arms ammunition and was initially operated by Remington Arms Company (Kane and Gaither, 1995, Appendix A).²¹ It is currently operated by Alliant Techsystems (ATK) and the facility use contract expires on December 31, 2025. Current production lines include LAP and tracer striping for a variety of small-caliber munitions, including 5.56mm, 7.62mm, .50 caliber, and 20mm rounds.

The physical characteristics of Lake City AAP are given in Tables D.50 (land), D.51 (building space), and D.52 (other improvements). Table D.53 shows budgeted FY01 production and planned replenishment on each of Lake City AAP's production lines. Lake City AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.54.

Table D.50
Lake City AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	2,483.5
Tenants	51.5
Agriculture	
Leased	0
Unleased	850
Forestry	
Leased	0
Unleased	565
Vacant	0
Total	3,950

SOURCE: U.S. Army Operations Support Command.

²¹The contract was awarded to build Lake City OP, later renamed Lake City AAP, in November 1940. Construction began in January 1941 and was completed in September 1941. The Army's initial plant operating contractor was the Remington Arms Company. Prior to ATK, Lake City was operated by Olin Inc.

Table D.51
Lake City AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	1,711,938	132,966	85,458	614,489
Standby	0	0	0	0
Caretaker	217,898	0	20,800	0
Total (3,285,650)	1,929,836	132,966	106,258	614,489
Occupied by				
Ammunition operations	1,711,938	132,966	85,458	614,489
Government tenants	0	680	0	7,920
Nongovernment tenants	0	10,291	0	2,834

SOURCE: U.S. Army Operations Support Command.

Table D.52
Lake City AAP Other Improvements

Type	Amount
Number of buildings	442
Roads (miles)	60
Railroads (miles)	3.5
Steam lines (miles)	17
Steam production capacity	9,830 hp
Electricity generation capacity	6,067 KW
Water production capacity	3,500,000 gal/day
Wastewater treatment capacity	1,537,500 gal/day
Number of employees as of April 2001	
Contractor	887
Government	21

SOURCE: U.S. Army Operations Support Command.

Table D.53
Lake City AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
1	CTG 5.56mm (SAW) M855	130,700,000	721,026,430
1	CTG 5.56mm 4 Ball M855 1 TR M856 LKD	97,500,000	190,719,640
1	CTG 5.56mm M193	48,600,000	105,603,720
1	CTG 5.56mm M193 10 RD Clip	**	81,082,330
1	CTG 5.56mm M855 Linked F-Saw	22,040,000	53,427,780
1	CTG 5.56mm TR (SAW) M856	**	35,577,400
1	Primer Elec M52A3B1	**	19,775,026
1	CTG 5.56mm Tracer M196	**	1,650,870
1	CTG 5.56mm Grenade M195	**	36,310
1?	CTG 5.56mm Blank M200	31,800,000	N/A
1?	CTG 5.56mm Blank M200 Linked F/SAW	48,200,000	N/A
3	CTG 20mm 4 HEI M210 1 AP-T M95 W/M10	**	96,750
3	CTG 7.62mm 4 Ball M80 5 RD Clip	**	5,529,450
3	CTG 7.62mm Ball M80 5 RD Clip	**	1,901,070
3	CTG 7.62mm Ball M80 9-1	**	1,546,000
3	CTG 7.62mm Ball M80 W/LK M13	6,400,000	47,685,820
3	CTG 7.62mm DIM Trace M80/M276	**	5,331,150
3	CTG 7.62mm DIM Trace M80/M276 4:1	**	5,217,990
3	CTG 7.62mm LKD 4 Ball M80 1TR M62	**	120,758,160
3	CTG 7.62mm LKD 4 Ball M80 1TR M62 (GAU-2B/A)	**	22,489,030
3	CTG 7.62mm M118 Long Range	**	4,292,4800
3	CTG 7.62mm Match M852	**	26,670
3	CTG 7.62mm Rifle M64 Gren Ctn	**	92,560
3	CTG 7.62mm Spec Ball M118 Ctm	**	4,050,750
3	CTG 7.62mm TR M62 Ctn	**	200,220
3?	CTG 7.62mm Blank M82 linked/M13	1,200,000	N/A
3	CTG CAL .50 4 API 1 API-T W/M9	**	14,722,950
3	CTG CAL .50 4 API M8 1TR M27 W/LK M15	**	52,280
3	CTG CAL .50 4 Ball 1 TR W/M9	10,600,000	31,723,930
3	CTG CAL .50 Ball M33 W/M9 Link	1,740,000	10,419,320
3	CTG CAL .50 MK211	**	1,701,590
6	CTG 20mm AP HEI PGU-28/B	**	7,319,000
6	Fuze PD M505A3 LAP	**	4,498,947
Bldg 35	Intermediate (Active)		
Bldg 139/142	Intermediate (Active)		

Table D.53—continued

Line	Products	FY01 Production	Replenishment Plan
2	7.62mm (Disposal)		
3A	20mm case (Disposal)		
4	5.56mm (Disposal)		

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

**Zero or unknown; see note on Table D.8.

Table D.54

Lake City AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
Direct contracts			
CTG 5.56mm Ball M855 f/M16A2	130,700,000	\$0.19	\$24,833,000
CTG 5.56mm Ball M855 linked f/SAW	22,040,000	0.27	5,950,800
CTG 5.56mm 4 Ball M855 1 Tracer M856 f/SAW	97,500,000	0.29	28,275,000
CTG 5.56mm Ball M193	48,600,000	0.14	6,804,000
CTG 5.56mm Blank M200	31,800,000	0.11	3,498,000
CTG 5.56mm Blank M200 linked f/SAW	48,200,000	0.25	12,050,000
CTG 7.62mm Ball M80 linked/M13	6,400,000	0.40	6,400,000
CTG 7.62mm Blank M82 linked/M13	1,200,000	0.33	396,000
CTG .50 cal Ball w/M9 link	1,740,000	1.73	3,010,200
CTG .50 cal Ball/1 Tracer w/M9 link	10,600,000	1.71	18,126,000
Subcontracts			
None visible in Army budget			
Other ammunition revenues			
Industrial facilities			4,480,000
LIF			0
MIIF			0
Nonammunition revenues			
Agriculture/forestry			0
Other government costs			
Environmental remediation			5,165,000
COR (gov't staff) budget			1,198,703
FY01 liabilities			
Environmental remediation			71,098,000
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

MISSISSIPPI AAP

Mississippi AAP (Hancock County), located on NASA's Stennis Space Center, specializes in metal parts production. This is the last AAP built by the Army, and it was completed in the early 1980s. Currently operated by Mason Technologies (MTI), it is situated in a Federal Foreign Trade Zone that gives tenants advantageous import-export trade and tariff status. Production lines include artillery grenade components.

The physical characteristics of Mississippi AAP are given in Tables D.55 (land), D.56 (building space), and D.57 (other improvements). Table D.58 shows budgeted FY01 production and planned replenishment on each of Mississippi AAP's production lines. Mississippi AAP revenues visible in the ammunition budget and other nonproprietary government costs and revenues are shown in Table D.59.

Table D.55
Mississippi AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	0
Tenants	310
Agriculture	
Leased	0
Unleased	0
Forestry	
Leased	0
Unleased	3,628
Vacant	399
Total	4,337

SOURCE: U.S. Army Operations Support Command.

Table D.56
Mississippi AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	0	217,852	0	1,217,515
Standby	202,069	0	6,343	0
Caretaker	0	0	0	0
Total (1,708,711)	202,069	217,852	6,343	1,217,515
Occupied by				
Ammunition operations	202,069	217,852	0	1,217,515
Government tenants	0	204,586	6,343	156,646
Nongovernment tenants	104,213	135,240	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.57
Mississippi AAP Other Improvements

Type	Amount
Number of buildings	123
Roads (miles)	25
Railroads (miles)	10
Steam lines (miles)	0
Steam production capacity	0
Electricity generation capacity	0
Water production capacity	0
Wastewater treatment capacity	477,000 gal/day
Number of employees as of April 2001	
Contractor	71
Government	3

SOURCE: U.S. Army Operations Support Command.

Table D.58
Mississippi AAP Production Lines

Line	Products	FY01 Production	Replenishment Plan
Bldg 9100	Gren Mpts F/Gren M42/M46	**	80,008,189
Bldg 9100	Gren Mpts F/Gren M77 (MLRS)	**	57,824,340

SOURCES: Status of lines—U.S. Army Operations Support Command; planned FY01 production—U.S. Department of the Army, Procurement Programs (2001a); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

Table D.59
Mississippi AAP Revenues and Other Government Costs

Revenues and Costs	Planned FY01 Production	Unit Price	Estimated FY01 Revenues
Production revenues			
No contracts visible in Army budget			
Other ammunition revenues			
Industrial facilities			0
LIF			0
MIIF			0
Nonammunition revenues			
Forestry			\$39,382
Other government costs			
Environmental remediation			0
COR (gov't staff) budget			181,800
FY01 liabilities			
Environmental remediation			0
Unfunded retiree benefits			0

SOURCES: Direct contracts, subcontracts, and other ammunition revenues—U.S. Department of the Army, Procurement Programs (2001a); nonammunition revenues, other government costs, and FY01 liabilities—U.S. Army Operations Support Command.

ROCK ISLAND ARSENAL

Rock Island Arsenal (Rock Island County), located near Moline, Illinois, specializes in production of large-caliber gun mounts and recoil mechanisms. Originally acquired by the federal government under an Indian treaty in 1804, the Army used it intermittently as a garrison and depot until the Civil War, when Congress established Rock Island Arsenal in 1862.²² Production at the arsenal peaked during World War II, when it employed 18,467 personnel.

The physical characteristics of Rock Island Arsenal are given in Tables D.60 (land), D.61 (building space), and D.62 (other improvements). Table D.63 shows budgeted FY01 production, revenues, and other government costs. Estimated valuations of Rock Island Arsenal based on pro-forma business cash flows as an FGC or privately owned corporation are found in Table D.64. Valuation methodologies are discussed in more detail in Appendix E.

Table D.60
Rock Island Arsenal Land

Land Usage	Acres
Occupied by	
Arsenal operations	697
Tenants	249
Agriculture	
Leased	0
Unleased	0
Forestry	
Leased	0
Unleased	0
Vacant/unusable	50
Total	997

SOURCE: U.S. Army Operations Support Command.

²²During construction of the arsenal, the Army also operated a Confederate prisoner of war camp on the island.

Table D.61
Rock Island Arsenal Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	2,045,000	1,737,000	3,346	2,019,000
Standby	102,000	268,000	0	206,000
Caretaker	0	0	0	0
Total (6,560,000)	2,147,000	2,005,000	3,346	2,225,000
Occupied by				
Arsenal operations	1,942,000	421,000	3,346	1,240,000
Government tenants	103,000	1,316,000	0	779,000
Nongovernment tenants	0	2,700	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.62
Rock Island Arsenal Other Improvements

Type	Amount
Number of buildings	197
Family housing units (2-4 bdrm)	58
Golf Course	18 holes
Roads (miles)	24
Railroads (miles)	3
Steam lines (miles)	52,542
Steam production capacity	Yes
Electricity generation capacity	approx. 14% of need
Water production capacity	Yes
Wastewater treatment capacity	No

SOURCE: U.S. Army Operations Support Command.

Table D.63
Rock Island Arsenal Revenues and Other Government Costs

Revenues and Costs	FY01 New Orders	Direct Labor Hours	Estimated FY01 Revenues
Core products			
M109 SP Howitzer (M178)		600	\$ 97,000
M119		21,800	4,072,000
M198 Spares		40,000	7,573,000
Other production			
Basic issue items		8,900	2,216,000
Mobile shop sets	-425	122,700	25,268,000
Prototypes		21,400	2,541,000
Shelter/shop set		26,000	4,664,000
TACOM tool sets		27,900	12,665,000
Target vehicles	-85	44,600	7,817,000
Misc. workload		29,800	3,973,000
Misc. other		6,200	869,000
Other services			
M1A2 co-prod. tech spt	-30	12,800	2,599,000
Forward repair system (FRS)	-25	29,500	7,977,000
Supply depot operations		79,100	8,808,000
Tech support			770,000
Tech data			65,000
Production revenues			91,974,000
Other arsenal revenues			
Support costs (base ops, MWR, utilities, schools, etc.)			13,792,000
IMC, IPO, bill adjustment			15,999,000
LIF			772,000
MIIF		15,700	1,790,000
Total arsenal revenues			124,327,000
Tenant revenues			
Army tenants			24,897,000
Non-Army tenants			3,090,000
Agriculture/forestry			0
Other government costs			
Environmental remediation			3,800,000

SOURCES: Arsenal Revenues—U.S. Department of the Army, AWCF (2001), Exhibit 29; environmental remediation—U.S. Army Operations Support Command.

Table D.64
Rock Island Arsenal Estimated Valuations

Category	Value
FY01 revenues	
Arsenal operations	\$124,327,000
Leases	27,987,000
Valuations*	
Multiple of sales	270,870,000
Discounted cash flow (DCF)	200,080,000
Land value	1,888,000
Other appraisals	N/A
FY01 liabilities	
Environmental remediation	7,792,000
Accumulated operating result (AOR)	11,807,000
Number of employees as of April 2001	
Government	1,179

SOURCE: FY01 revenues, AOR, and number of employees—U.S. Department of the Army, AWCF (2001), Exhibits 29, 14, and 24a; environmental remediation liability—U.S. Army Operations Support Command; other values calculated as part of this study.

*Valuations are based upon pro-forma business plans for Rock Island Arsenal managed as an FGC or privately owned corporation.

Since ownership of the arsenals would transfer from the Army to the federal government under the FGC option, we estimated the potential effects of creation of an arsenal FGC on both the Army budget and the federal government budget as a whole over the FY03–09 budget and POM period and over a 20-year period from FY03 to FY22. As in the privatization analysis, we chose a relatively conservative set of assumptions for the base case, and varied some of these assumptions in optimistic and pessimistic cases to test the sensitivity of the results. Estimated impacts on the government budget for Rock Island are shown in Tables D.65 (base case), D.66 (optimistic case), and D.67 (pessimistic case). Estimated impacts on the Army budget are shown in Tables D.68 (base and optimistic cases) and D.69 (pessimistic case), because the changes in assumptions from the base case to the optimistic case only affect the government budget.

For the status quo base case government budget impacts, ordnance costs include all AWCF funding except foreign military sales (FMS),²³ government tenant assessments and upkeep of Army housing, and IMC and other supple-

²³We excluded FMS from government and Army budget and savings estimates because these costs and savings accrue to foreign governments. FMS represents less than \$100,000 of FY01 revenues at Rock Island, but approximately 75 percent of FY01 revenues at Watervliet.

mental funds added to the AWCF. The latter two items are listed separately. Projected IMC funding for FY03–07 was provided by OSC; we extended the FY07 level to future years. Projected environmental remediation spending through 2015 was provided by OSC. For the FGC base case government budget impacts, the costs of ordnance, government tenants, and IMC are based on the business plans discussed in Chapter Six. Ordnance costs are assumed to transition immediately to market levels; additional funding needed to cover the costs of retaining temporarily excess capacity and paying workers who have not yet transitioned to commercial work are shifted to IMC. Government tenant costs are assumed to stay the same as the status quo, but funding for Army housing is eliminated, since maintenance of the housing is assumed to be funded by the FGC. The Army is assumed to retain the liability for environmental remediation.²⁴

During the year before the creation of the FGC, the federal government is assumed to hire a transition manager to develop a business plan and draft a charter for the FGC.²⁵ When the FGC is created, the federal government must provide working capital to launch the business. For the base case, we estimate working capital requirements at 30 percent of FY01 revenues, based on similar industries in the 1997 Economic Census. The Army is responsible for each of the arsenals' AWCF Accumulated Operating Results (AOR), which we based on the FY01 recoverable AOR in U.S. Department of the Army, AWCF (2001), Exhibit 14. We also assume that the FGC incurs training costs of \$5,000 per worker transitioned from indirect to direct work. Finally, as the owner of 100 percent of the FGC's equity, the federal government is assumed to be entitled to the profit stream of the FGC, net of state and local taxes. (Federal income taxes paid by the FGC would also accrue to the federal government.) To estimate annual profits, we applied the average industry operating margin of 13.57 percent (Ibbotson Associates, 2001) to ordnance revenues from government customers and FMS and to commercial revenues, less an estimated tax rate of 10 percent.²⁶

The Army budget effects shown in Tables D.68 and D.69 vary from the government effects in several respects. Revenues from non-Army ordnance customers

²⁴Since environmental liabilities at the two arsenals are low, this assumption does not have much impact on the overall results.

²⁵By agreement with the Study Advisory Group, we do not include the costs of environmental characterization studies (estimated at \$1.5 million per arsenal) as a one-time cost of creating an arsenal FGC, since these studies would need to be undertaken regardless of the option chosen. In principle, conducting these environmental characterization studies could result in the discovery of additional environmental liabilities. We did not have a basis to estimate any additional liability or to attribute additional remediation costs across future years. In any case, these costs would be incurred both under the status quo and the FGC option.

²⁶The state corporate tax rates for New York and Illinois are 7.5 percent and 7.3 percent, respectively. The remainder is an allowance for property taxes.

and non-Army tenants are excluded from both the status quo and FGC budget impacts. In the FGC budget impacts, IMC funding is prorated to reflect higher-than-market prices charged to non-Army customers during the transition to commercial workload.²⁷ Funding for environmental remediation and the AWCF AOR is assumed to remain with the Army. However, the federal government is assumed to pay FGC transition costs, provide initial working capital for the FGC, and receive FGC profits. Employee retraining costs are assumed to be deducted from the FGC's operating margin.

For the optimistic case, we varied the assumptions in ways that were likely to be favorable to the creation of an arsenal FGC. We reduced employee retraining costs to \$3,000 per employee, FGC transition costs to \$5 million, and working capital requirements to 28 percent of FY01 revenues. We also assumed that the arsenal FGC would be able to bring in additional commercial workload beyond Year 5 of the business plans in Chapter Six, so that total ordnance and commercial revenues would increase at 3 percent per year. Profits were calculated based on the industry average operating margin for large firms, 14.56 percent (Ibbotson Associates, 2001). These changes affected the estimated government budget effects, but not those for the Army budget.

For the pessimistic case, we varied the assumptions in ways that were likely to be unfavorable to creation of an arsenal FGC. We increased employee retraining costs to \$10,000 per employee, FGC transition costs to \$10 million, and working capital requirements to 36 percent of FY01 revenues. We also assumed that the arsenals would not be able to complete the transition to commercial work. We fixed total ordnance and IMC cost reductions at Year 2 of the business plans in Chapter Six, representing a 47 percent cost reduction at Rock Island and a 55 percent cost reduction at Watervliet. Prices charged to government and FMS customers did not fully fall to commercial levels, but the FGC had to set market prices for commercial work in order to attract business. As a result, the Army had to continue to provide IMC funding for underutilized capacity. We also froze commercial work at Year 2 of the business plans and reduced the operating margin to the industry median of 10.27 percent (Ibbotson Associates, 2001). The variations in the assumptions for the base case, optimistic case, and pessimistic case are summarized in Table 8.10 in the main text.

²⁷Since FMS represents a large share of revenues at Watervliet, it seemed appropriate to assume that other customers would continue to bear some of the costs of excess capacity during the transition period.

Table D.65
Rock Island Arsenal Estimated Government Budget Impacts of FGC Creation: Base Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ordnance costs (excl. FMS)	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	
Government tenants	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	
IMC	27.4	27.8	28.5	29.3	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	164.1	164.5	165.2	166.0	166.7	166.7	166.7	166.7	166.7	166.7	166.7	166.7	166.6	166.6	166.6	166.6	166.6	166.6	166.6	166.6	
FGC																					
Ordnance costs (excl. FMS)	108.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
Government tenants	28.0	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	
IMC	27.4	70.1	35.9	25.0	9.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Env. characterization study																					
Employee retraining		1.1	0.8	0.1	0.2	0.0															
Cost of creating FGC (transition)	8.0																				
Working capital infusion					45.7																
Payoff of AWCFAOR					11.8																
Unfunded retiree benefits					0.0																
Profit accruing to government		-6.2	-10.3	-11.7	-14.2	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	-15.5	
Total	172.1	180.8	84.7	71.7	54.0	42.8	42.8	42.8	42.8	42.8	42.8	42.8	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	
Difference (Status quo - FGC)	-8.0	-16.3	80.5	94.3	112.7	123.9	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	124.0	
NPV (FY03-FY09)	449.2	(3.0%)		381.0	(7%)																
NPV (FY03-FY22)	1478.8	(3.5%)		1071.3	(7%)																

SOURCES: Ordnance costs, government tenants, and AWCFAOR—U.S. Department of the Army, AWCFA (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.66
Rock Island Arsenal Estimated Government Budget Impacts of FGC Creation: Optimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Status quo																				
Ordnance costs (excl. FMS)	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5
Government tenants	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0
IMC	27.4	27.8	28.5	29.3	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	164.1	164.5	165.2	166.0	166.7	166.7	166.7	166.7	166.7	166.7	166.7	166.7	166.6	166.6	166.6	166.6	166.6	166.6	166.6	166.6
FGC																				
Ordnance costs (excl. FMS)	108.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
Government tenants	28.0	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5
IMC	27.4	70.1	35.9	25.0	9.8	0.0	0.0													
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture & forestry revenues	0.0																			
Env. characterization study																				
Employee retraining		0.7	0.5	0.0	0.1	0.0														
Cost of creating FGC (transition)	5.0																			
Working capital infusion		42.6																		
Payoff of AWC/AOR		11.8																		
Unfunded retiree benefits		0.0																		
Profit accruing to government		-6.6	-11.1	-12.6	-15.3	-16.7	-17.2	-17.7	-18.2	-18.8	-19.3	-19.9	-20.5	-21.1	-21.8	-22.4	-23.1	-23.8	-24.5	-25.2
Total	169.1	176.9	83.7	70.8	52.9	41.7	41.1	40.6	40.1	39.6	39.0	38.4	37.7	37.1	36.4	35.8	35.1	34.4	33.7	33.0
Difference (Status quo - FGC)	-5.0	-12.4	81.5	95.2	113.8	125.1	125.6	126.1	126.6	127.2	127.8	128.3	128.9	129.5	130.2	130.8	131.5	132.2	132.9	133.6
NPV (FY03-FY09)	461.1	(3.0%)	392.0	(7%)																
NPV (FY03-FY22)	1536.0	(3.5%)	1111.0	(7%)																

SOURCES: Ordnance costs, government tenants, and AWC/AOR—U.S. Department of the Army, AWC/F (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.67
 Rock Island Arsenal Estimated Government Budget Impacts of FGC Creation: Pessimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status Quo																					
Ordnance costs (excl. FMS)	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	
Government tenants	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	
IMC	27.4	27.8	28.5	29.3	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	164.1	164.5	165.2	166.0	166.7	166.7	166.7	166.7	166.7	166.7	166.7	166.7	166.6	166.6	166.6	166.6	166.6	166.6	166.6	166.6	
FGC																					
Ordnance costs (excl. FMS)	108.5	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	
Government tenants	28.0	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	
IMC	27.4	42.6	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Agriculture & forestry revenues	0.0																				
Env. characterization study																					
Employee retraining		2.2	1.5																		
Cost of creating FGC (transition)	10.0																				
Working capital infusion		54.8																			
Payoff of AWCf AOR		11.8																			
Unfunded retiree benefits		0.0																			
Profit accruing to government		-4.7	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	
Total	174.1	192.6	88.0	86.5	86.5	86.5	86.5	86.5	86.5	86.5	86.5	86.5	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	
Difference (Status quo - FGC)	-10.0	-28.1	77.2	79.5	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	
NPV (FY03-FY09)	316.1	(3.0%)	268.1	(7%)																	
NPV (FY03-FY22)	982.3	(3.5%)	715.1	(7%)																	

SOURCES: Ordnance costs, government tenants, and AWCf AOR: U.S. Department of the Army, AWCf (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.68
Rock Island Arsenal Estimated Army Budget Impacts of FGC Creation: Base and Optimistic Cases

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ordnance costs (excl. FMS)	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	
Army tenants	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	
IMC	27.4	27.8	28.5	29.3	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	159.3	159.7	160.5	161.2	162.0	162.0	162.0	162.0	162.0	162.0	162.0	162.0	161.9	161.9	161.9	161.9	161.9	161.9	161.9	161.9	
FGC																					
Ordnance costs (excl. FMS)	106.8	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	
Government tenants	24.9	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	
IMC	27.4	69.0	35.4	24.6	9.6	0.0	0.0														
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Agriculture & forestry revenues	0.0																				
Env. characterization study																					
Employee retraining																					
Cost of creating FGC (transition)																					
Working capital infusion																					
Payoff of AWCFAOR		11.8																			
Unfunded retiree benefits		0.0																			
Profit accruing to government																					
Total	159.3	135.6	90.2	79.4	64.4	54.8	54.8	54.8	54.8	54.8	54.8	54.8	54.6	54.6	54.6	54.6	54.6	54.6	54.6	54.6	
Difference (status quo - FGC)	0.0	24.2	70.3	81.8	97.6	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	
NPV (FY03-FY09)	433.7	(3.0%)	373.2	(7%)																	
NPV (FY03-FY22)	1324.2	(3.5%)	970.4	(7%)																	

SOURCES: Ordnance costs, government tenants, and AWCFAOR—U.S. Department of the Army, AWCF (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.69
 Rock Island Arsenal Estimated Army Budget Impacts of FGC Creation: Pessimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ordnance costs (excl. FMS)	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8
Government tenants	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9
IMC	27.4	27.8	28.5	29.3	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	159.3	159.7	160.5	161.2	162.0	162.0	162.0	162.0	162.0	162.0	162.0	162.0	161.9	161.9	161.9	161.9	161.9	161.9	161.9	161.9	161.9
FGC																					
Ordnance costs (excl. FMS)	106.8	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1	57.1
Government tenants	24.9	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
IMC	27.4	42.1	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Environmental remediation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture & forestry revenues	0.0																				
Env. characterization study																					
Employee retraining																					
Cost of creating FGC (transition)																					
Working capital infusion																					
Payoff of AWCf AOR																					
Unfunded retiree benefits																					
Profit accruing to government																					
Total	159.3	135.8	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2
Difference (status quo - FGC)	0.0	24.0	70.2	70.9	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7	71.7
NPV (FY03-FY09)	340.0	(3.0%)		295.2	(7%)																
NPV (FY03-FY22)	934.9	(3.5%)		694.6	(7%)																

SOURCES: Ordnance costs, government tenants, and AWCf AOR—U.S. Department of the Army, AWCf (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

WATERVLIET ARSENAL

Watervliet Arsenal (Albany County), located on the Hudson River near Albany, New York, specializes in production of large-caliber cannon. Congress established Watervliet Arsenal in 1813 during the War of 1812. The Army's Benet Weapons Laboratory is co-located on Watervliet Arsenal. Current production includes tank and mortar cannon for the U.S. Army, U.S. Marine Corps, and other customers.

The physical characteristics of Watervliet Arsenal are given in Tables D.70 (land), D.71 (building space), and D.72 (other improvements). Table D.73 shows budgeted FY01 production, revenues, and other government costs. Estimated valuations of Watervliet Arsenal based on pro forma business cash flows as an FGC or privately owned corporation are found in Table D.74.

Table D.70
Watervliet Arsenal Land

Land Usage	Acres
Occupied by	
Arsenal operations	140
Tenants	0
Agriculture	
Leased	0
Unleased	0
Forestry	
Leased	0
Unleased	0
Vacant/Unusable	0
Total	140

SOURCE: U.S. Army Operations Support Command.

Table D.71
Watervliet Arsenal Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	867,000	75,000	0	233,000
Standby	423,000	10,000	0	0
Caretaker	0	0	0	0
Total (2,100,000)*	1,290,000	85,000	0	233,000
Occupied by				
Arsenal operations	867,000	55,000	0	138,000
Government tenants	13,000	2,000	0	95,000
Nongovernment tenants	0	0	0	0

*Includes 212,000 square feet of residential housing.

SOURCE: U.S. Army Operations Support Command.

Table D.72
Watervliet Arsenal Other Improvements

Type	Amount
Number of buildings	70
Family housing units (2–4 bdrm)	71
Golf course	N/A
Roads (miles)	7
Railroads (miles)	2.9
Steam lines (miles)	33,963
Steam production capacity	Yes
Electricity generation capacity	No
Water production capacity	No
Wastewater treatment capacity	No; except for chrome plating facility

SOURCE: U.S. Army Operations Support Command.

Table D.73
Watervliet Arsenal Revenues and Other Government Costs

Revenues and Costs	FY01 New Orders	Direct Labor Hours	Estimated FY01 Revenues
Core products (U.S. gov't customers)			
120mm M256 Tube	100	12,100	\$ 3,034,000
120mm Mortar Barrel Assembly	40	1,500	676,000
60mm Mortar Barrel Assembly	76	1,500	266,000
81mm Mortar Barrel Assembly	25	2,400	976,000
Gun Books		700	200,000
Core products (other customers)			
105mm M68 Cannon	12	4,900	3,991,000
120mm M256 Cannon	240	115,700	39,270,000
155mm/62 Caliber AGS	2	3,000	722,000
155mm M284 Breech Kits	96	4,700	1,696,000
Other production			
Miscellaneous spares		9,000	2,054,000
UH1 Helicopter, T53 Carrier	120	6,000	1,063,000
Other services			
RDT&E		13,100	2,720,000
Production revenues			56,668,000
Other arsenal revenues			
Base operations			559,000
IMC, IPO, bill adjustment			25,807,000
LIF			1,520,000
MIIF		5,300	1,115,000
Total arsenal revenues			85,669,000

Table D.73—continued

Revenues and Costs	FY01 New Orders	Direct Labor Hours	Estimated FY01 Revenues
Tenant revenues			
Army tenants			3,431,000
Non-Army tenants			119,000
Agriculture/forestry			0
Other government costs			
Environmental remediation			1,955,000

SOURCES: Arsenal revenues—U.S. Department of the Army, AWCF (2001), Exhibit 29; environmental remediation—U.S. Army Operations Support Command.

Table D.74

Watervliet Arsenal Estimated Valuations

Category	Value
FY01 revenues	
Arsenal operations	\$ 85,669,000
Leases	3,550,000
Valuations*	
Multiple of sales	138,506,000
Discounted cash flow (DCF)	104,674,000
Land value	292,000
Other appraisals	N/A
FY01 liabilities	
Environmental remediation	5,845,000
Accumulated operating result (AOR)	14,839,000
Number of employees as of April 2001	
Government	549

SOURCE: FY01 revenues, AOR, and number of employees—U.S. Department of the Army, AWCF (2001), Exhibits 29, 14, and 24a; environmental remediation liability—U.S. Army Operations Support Command; other values calculated as part of this study.

*Valuations are based upon pro forma business plans for Rock Island Arsenal managed as an FGC or privately owned corporation.

Creation of an arsenal FGC is expected to have different impacts on the budgets of the Army and the government as a whole, since ownership of the arsenals will transfer from the Army to the Treasury. Estimated impacts on the government budget for Watervliet are shown in Tables D.75 (base case), D.76 (optimistic case), and D.77 (pessimistic case). Estimated impacts on the Army budget are shown in Tables D.78 (base and optimistic cases) and D.79 (pessimistic case), because the changes in assumptions from the base case to the optimistic case only affect the government budget. A detailed description of the assumptions underlying each of the three cases is given in Chapter Eight and in the section above on Rock Island Arsenal.

Table D.75
Watervliet Arsenal Estimated Government Budget Impacts of FGC Creation: Base Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ordnance costs (excl. FMS)	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
Government tenants	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
IMC	20.3	20.8	21.4	21.9	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture & forestry rev's	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	40.0	39.5	39.9	40.4	41.0	41.0	41.8	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
FGC																					
Ordnance costs (excl. FMS)	14.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Government tenants	3.6	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
IMC	20.3	27.7	15.1	7.9	6.8	0.0	0.0														
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture & forestry rev's	0.0																				
Env. characterization study																					
Employee retraining		0.3	0.6	0.3	0.0	0.1															
Cost of creating FGC (transition)	8.0																				
Working capital infusion		26.8																			
Payoff of AWCFAOR		14.8																			
Unfunded retiree benefits		0.0																			
Profit accruing to gov't		-2.4	-5.2	-7.6	-7.9	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2
Total	48.0	73.5	16.6	6.7	4.9	-3.1	-2.4	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3
Difference (status quo - FGC)	-8.0	-33.9	23.3	33.7	36.1	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2
NPV (FY03-FY09)	119.1	(3.0%)		96.7	(7%)																
NPV (FY03-FY22)	486.6	(3.5%)		342.9	(7%)																

SOURCES: Ordnance costs, government tenants, and AWCFAOR—U.S. Department of the Army, AWCFA (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.76
Watervliet Arsenal Estimated Government Budget Impacts of FGC Creation: Optimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ordnance costs (excl. FMS)	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	
Government tenants	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	
IMC	20.3	20.8	21.4	21.9	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	40.0	39.5	39.9	40.4	41.0	41.0	41.8	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	
FGC																					
Ordnance costs (excl. FMS)	14.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	
Government tenants	3.6	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	
IMC (other government work)	20.3	27.7	15.1	7.9	6.8	0.0	0.0														
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agriculture & forestry revenues	0.0																				
Env. characterization study																					
Employee retraining		0.2	0.4	0.2	0.0	0.0															
Cost of creating FGC (transition)	5.0																				
Working capital infusion		25.0																			
Payoff of AWCF AOR		14.8																			
Unfunded retiree benefits		0.0																			
Profit accruing to government		-2.6	-5.6	-8.1	-8.5	-9.9	-10.2	-10.5	-10.8	-11.2	-11.5	-11.8	-12.2	-12.6	-12.9	-13.3	-13.7	-14.1	-14.6	-15.0	
Total	45.0	71.4	16.0	6.0	4.3	-3.8	-3.4	-4.6	-4.9	-5.3	-5.6	-5.9	-6.3	-6.7	-7.0	-7.4	-7.8	-8.2	-8.7	-9.1	
Difference (status quo - FGC)	-5.0	-31.8	23.9	34.4	36.7	44.9	45.2	45.5	45.8	46.1	46.5	46.8	47.2	47.5	47.9	48.3	48.7	49.1	49.5	50.0	
NPV (FY03-FY09)	127.3	(3.0%)	104.3	(7%)																	
NPV (FY03-FY22)	521.6	(3.5%)	367.5	(7%)																	

SOURCES: Ordnance costs, government tenants, and AWCF AOR—U.S. Department of the Army, AWCF (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.77
Watervliet Arsenal Estimated Government Budget Impacts of FGC Creation: Pessimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ordnance costs (excl. FMS)	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	
Government tenants	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	
IMC	20.3	20.8	21.4	21.9	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	40.0	39.5	39.9	40.4	41.0	41.0	41.8	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	
FGC																					
Ordnance costs (excl. FMS)	14.8	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	
Government tenants	3.6	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	
IMC	20.3	23.9	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agriculture & forestry revenues	0.0																				
Env. characterization study		0.6	1.2																		
Employee retraining																					
Cost of creating FGC (transition)	10.0																				
Working capital infusion		32.1																			
Payoff of AWCFAOR		14.8																			
Unfunded retiree benefits		0.0																			
Profit accruing to government		-1.8	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	
Total	50.0	79.7	18.4	17.2	17.2	17.2	18.0	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	
Difference (status quo - FGC)	-10.0	-40.2	21.5	23.2	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	
NPV (FY03-FY09)	54.1	(3.0%)	41.1	(7%)																	
NPV (FY03-FY22)	251.7	(3.5%)	173.7	(7%)																	

SOURCES: Ordnance costs, government tenants, and AWCFAOR—U.S. Department of the Army, AWCFA (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.78
Watervliet Arsenal Estimated Army Budget Impacts of FGC Creation: Base and Optimistic Cases

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	
Status quo																					
Ordnance costs (excl. FMS)	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	
Army tenants	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	
IMC	20.3	20.8	21.4	21.9	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	39.9	39.4	39.8	40.3	40.9	40.9	41.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	
FGC																					
Ordnance costs (excl. FMS)	14.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	
Army tenants	3.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
IMC	20.3	27.7	15.1	7.9	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Environmental remediation	1.4	0.4	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agriculture & forestry revenues	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	40.8	39.9	31.1	13.8	12.7	5.9	6.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	
Difference (status quo - FGC)	0.0	-9.3	18.7	26.5	28.2	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	
NPV (FY03-FY09)	117.4	(3.0%)	99.1	(7%)																	
NPV (FY03-FY22)	408.0	(3.5%)	293.8	(7%)																	

SOURCES: Ordnance costs, government tenants, and AWCf AOR—U.S. Department of the Army, AWCf (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

Table D.79
Watervliet Arsenal Estimated Army Budget Impacts of FGC Creation: Pessimistic Case

Cost Category (FY01 \$ million)	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Status quo (pessimistic)	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
Ordnance costs (excl. FMS)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Government tenants	20.3	20.8	21.4	21.9	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
IMC	1.4	0.4	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental remediation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture & forestry revenues	39.9	39.4	39.8	40.3	40.9	40.9	41.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7
Total	0.24	0.55	0.73	0.76	0.87															
Reduction in ordnance costs + IMC	0.24																			
Army share of ordnance costs																				
FGC (pessimistic)	14.8	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Ordnance costs (excl. FMS)	3.4	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Army tenants	20.3	23.9	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
IMC	1.4	0.4	0.2	0.2	0.2	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Environmental remediation	0.0																			
Agriculture & forestry revenues	0.0																			
Env. characterization study																				
Employee retraining																				
Cost of creating FGC (transition)																				
Working capital infusion																				
Payoff of AWCFAOR		14.8																		
Unfunded retiree benefits		0.0																		
Profit accruing to government																				
Total	39.9	48.7	21.1	21.0	21.0	21.0	21.8	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9
Difference (status quo - FGC)	0.0	-9.3	18.7	19.3	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
NPV (FY03-FY09)	77.7	(3.0%)		66.0	(7%)															
NPV (FY03-FY22)	242.5	(3.5%)		176.6	(7%)															

SOURCES: Ordnance costs, government tenants, and AWCFAOR—U.S. Department of the Army, AWCFA (2001), Exhibits 29 and 14; IMC (FY03-07), environmental remediation costs through 2015, and agriculture and forestry revenues—U.S. Army Operations Support Command; other values calculated for this study.

CRANE AAA

Crane Army Ammunition Activity (AAA) (Martin County), located in Crane, Indiana, specializes in demilitarization and LAP production. It was commissioned in 1941 as a naval ammunition depot. In 1975, DoD designated the Army as the single manager of conventional ammunition, and Crane AAA became a tenant of Crane Division, Naval Surface Warfare Center. Crane AAA is also a Tier I depot, and current ammunition production lines include demilitarization and LAP of bombs, projectiles, and pyrotechnics. The limited available information on the physical characteristics of Crane AAA is given in Table D.80 (land and improvements). Table D.81 shows planned replenishment on each of Crane AAP's production lines. We have not done a detailed analysis of Crane AAA's FY01 production, revenues, and potential valuation in a sale, since it is located on a Navy-owned facility and its workload is protected by legislation.

Table D.80
Crane AAA Land and Improvements

Type	Amount
Land (acres)	64,000
Building space (square feet)	
Manufacturing	877,245
Office	48,733
Explosive storage	4,722,947
Other storage	1,894,020
Total	7,542,945
Number of buildings	937
Roads (miles)	375
Railroads (miles)	164
Steam lines (miles)	20
Steam production capacity	465,598 mbtu/hr
Electricity generation capacity	0
Water production capacity	2,300,000 gal/day
Wastewater treatment capacity	2,100,000 gal/day

SOURCE: U.S. Army Operations Support Command.

Table D.81
Crane AAA Production Lines

Line	Products	Replenishment Plan
PLANT 1	Cutter Pwd Act HE MK24-0	67,720
PLANT 1	Cutter Pwd Act HE MK23-0	67,590
PLANT 1	Chg Assy Demo MK133-2	300
PLANT 3	Sig Smk & Illum Mar MK99-3 Yel	660
PLANT 3	Sig Flare Mar MK132-0 Org	6,510
PLANT 3	Sig Smk Mar MK131-0 Red	6,510
PLANT 3	Marker Location Mar MK25-4	290
PLANT 3	Marker Location Mar MK25-3 (AF)	12,090
PLANT 3	Illum Candle F/155mm M485	10,206
PLANT 3	Illum Candle F/120mm XM930	19,793
PLANT 3	Illum Candle F/60mm M721	122,651
PLANT 3	Illum Candle F/81mm M853	90,164
PLANT 3	Illum Candle IR F/120mm IR XM983	26,397
PLANT 3	Illum Candle IR F/81mm M816	39,680
PLANT 4	Chg Explosive Sheet MK56-0	1,170
PLANT 4	Proj 5/54 Cal WP MK89-0 W/FZ MK415-0	700
PLANT 4	Proj 5/54 Cal Illum MK91-0	3,850
PLANT 7	Ctg 76mm HE-IR MK199-1 W/FZ MK404-0	4,130
PLANT 7	Proj 5/54 HC HE-PD/D	3,910
PLANT 7	Ctg 76mm HE-VT MK208-0 W/FZ MK417-0	3,060
PLANT 7	Ctg 76mm HE-PD MK200-1 W/FZ MK407-1	1,800
PLANT 8	Proj 5/54 VT MK 86-0	750
PLANT 8	Proj 5/54 Cal HE-CVT Insens Munition MK64 W/FZ	51,740
PLANT 8	Proj 5/54 HE-IR MK 84/ MK186	3,850
PLANT 8	Proj 5/54 HE-MF MK174 Mod-1 (MFFP)	13,430
PLANT 8	Proj 5/54 Cal HE-MT/PD Insens Munition MK82 W/FZ	1,490

SOURCES: Status of lines—U.S. Army Operations Support Command (2001); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

McALESTER AAP

McAlester AAP (Pittsburgh County), located in McAlester, Oklahoma, specializes in LAP production of bombs and medium-caliber cartridges. McAlester AAP is also a Tier II depot, and current ammunition production lines include demilitarization and LAP of MK-82 bombs, and cartridges for 20mm and 40mm munitions. The physical characteristics of McAlester AAP are given in Tables D.82 (land), D.83 (building space), and D.84 (other improvements). Table D.85 shows planned replenishment on each of McAlester AAP's production lines. We have not done a detailed analysis of McAlester AAP's FY01 production, revenues, and potential valuation in a sale, since its workload is protected by legislation.

Table D.82
McAlester AAP Land

Land Usage	Acres
Occupied by	
Ammunition operations	40,061
Tenants	270
Agriculture	
Leased	3,000
Unleased	0
Forestry	
Leased	0
Unleased	0
Vacant	0
Unknown	1,633
Total	44,964

SOURCE: U.S. Army Operations Support Command.

Table D.83
McAlester AAP Building Space (Square Feet)

Status	Manufacturing	Office	Explosive Storage	Other Storage
Active	1,245,999	230,492	7,824,290	471,677
Standby	60,014	0	0	0
Caretaker	12,007	0	0	0
Total (9,844,479)	1,318,020	230,492	7,824,290	471,677
Occupied by				
Ammunition operations	1,198,495	147,330	7,793,609	397,165
Government tenants	119,525	81,872	30,681	74,512
Nongovernment tenants	0	1,290	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.84
McAlester AAP Other Improvements

Type	Amount
Number of buildings	N/A
Roads (miles)	408
Railroads (miles)	212
Steam lines (miles)	16.2
Steam production capacity	80,700 lb/hr
Electricity generation capacity	2,363.6 KW/hr
Water production capacity	1,100,000 gal/day
Wastewater treatment capacity	300,000 gal/day

SOURCE: U.S. Army Operations Support Command.

Table D.85
McAlester AAP Production Lines

Line	Products	Replenishment Plan
Bldg 102	Ctg 40mm HEI-P PGU-9A/B W/Zirconium Liner	720,000
Bldg 140	Chg Prop 5/54 Cal MK67-3 W/Case Full	50,230
Bldg 140	Chg Prop 5/54 Cal Reduced MK68-2 W/Steel	1,770
Bldg 221	Mtr Rkt 5in MK71 W/GR MK88	390
A EAST	Bomb GP 1000lb BLU-110A/B PBX	71,800
A EAST	Bomb GP 500lb BLU-111/B PBX	52,880
A EAST	Bomb Pene 2000lb BLU-109A/B PBX	4,390
A EAST	Bomb Pene 5000lb BLU-113A/B TRIT	1,540
B EAST	Bomb GP 500lb MK82-1 TRIT	87,940
B EAST	Bomb GP 2000lb MK84-4 TRIT	57,990
B EAST	Bomb GP 2000lb MK84-6 H-6	31,150
B EAST	Bomb GP 1000lb MK83-4 H6 W/LUG	3,470
B EAST	Bomb Pene 2000lb BLU-109/B TRIT	17,380
454	Practice Bomb (Active)	
455	Practice Bomb (Active)	
Bldg 107	Prop Chg (Disposal)	
Bldg 109	16"/50 (Disposal)	
Bldg 126	5/38 and 54 (Disposal)	
Bldg 142	5/54 Prop Chg (Disposal)	
Bldg 162	20mm (Disposal)	
Bldg 220	2.75" Rocket (Disposal)	
Bldg 224	2.75" Rocket (Disposal)	

SOURCES: Status of lines—U.S. Army Operations Support Command (2001); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

PINE BLUFF AAP

Pine Bluff Arsenal (Jefferson County), located in Pine Bluff, Arkansas, specializes in smoke- and phosphorus-related LAP production. Pine Bluff is also a Tier II depot, and current ammunition production lines include LAP of white and red phosphorus munitions, smoke munitions, and demilitarization. The physical characteristics of Pine Bluff Arsenal are given in Tables D.86 (land), D.87 (building space), and D.88 (other improvements). Table D.89 shows planned replenishment on each of Pine Bluff's production lines. We have not done a detailed analysis of Pine Bluff Arsenal's FY01 production, revenues, and potential valuation in a sale, since its variety of missions and status as a GOGO operation make it difficult to privatize or convert to an FGC.

Table D.86
Pine Bluff Arsenal Land

Land Usage	Acres
Occupied by	
Ammunition operations	1,000
Tenants	50
Agriculture	
Leased	0
Unleased	0
Forestry	
Leased	0
Unleased	8,196
Vacant	4,247
Total	13,493

SOURCE: U.S. Army Operations Support Command.

Table D.87
Pine Bluff Arsenal Building Space (Square Feet)

Status	Manufac- turing	Office	Depot Ops + Other	Explosive Storage	Other Storage
Active	752,782	186,707	168,721	1,841,716	19,396
Standby	82,643	0	147,551	0	0
Caretaker	0	0	0	0	0
Total (3,199,516)	835,425	186,707	316,272	1,841,716	19,396
Occupied by					
Ammunition operations	729,828	136,139	212,002	1,575,491	0
CB defense	96,113	31,079	59,074	230,854	0
Government tenants	9,484	19,489	45,196	35,371	19,396
Nongovernment tenants	0	0	0	0	0

SOURCE: U.S. Army Operations Support Command.

Table D.88
Pine Bluff Arsenal Other Improvements

Type	Amount
Number of buildings	964
Roads (miles)	97.1 paved, 37.5 unpaved
Railroads (miles)	34 active, 9 inactive
Steam lines (miles)	23
Steam production capacity	147,290 mbtu
Electricity generation capacity	5192 KVA
Water production capacity	1,250,000 gal/day (raw) 1,250,000 gal/day (treated)
Wastewater treatment capacity	3,000,000 gal/day (sanitary) 1,000,000 gal/day (industrial)

SOURCE: U.S. Army Operations Support Command.

Table D.89
Pine Bluff AAP Production Lines

Line	Products	Replenishment Plan
31-530	Gren Smk RP Screen L8A3	46,570
31-630	Ctg 40mm Grn Smk M715	42,280
31-630	Ctg 40mm Red Smk M713 F/Lnchr M79	42,280
31-630	Ctg 40mm Yel Smk M716	42,280
33-530	Gren Hand Smk Trng M83	700,542
33-530	Gren Hand Smk Grn M18	595,360
33-530	Gren Hand Smk Yel M18	572,180
33-530	Gren Hand Smk Hc AN-M8	51,650
33-530	Gren Hand Smk Vio M18	384,470
33-530	Gren Hand RC CS M7A3	25,090
33-530	Gren Hand Smk Red M18	228,480
33-530	Gren Hand RC CS M47E3	2,070
33-530	Gren Smk Scrn LVOSS XM90	104,860
33-630	Ctg 40mm TAC CS M651 W/FZ M581E1	37,280
33-630	Smoke Pot Floating HC M4A2	21,110
33-630	Smoke Pot Trng M8	16,241
33-630	Ctg 105mm Smk HCBE M84A1 W/O FZ	10,390
34-110	Proj 155mm Smk WP M825 W/O FZ	39,000
34-110	Proj 155mm Smk WP M110A2 W/O FZ	25,160
44-110	Proj 155mm Illum M485A2 W/O FZ F/How	9,720
44-110	Ctg 81mm Illum M853A1	85,870
44-110	Ctg 105mm Illum M314A3	6,920
44-110	Ctg 81mm Illum Infrared XM816	37,790
44-110	Ctg 120mm Mrtr IR Illum M983	25,140
44-110	Ctg 120mm Illum Mrtr XM930	18,850
44-110	Ctg 60mm Wp M722 W/FZ M745	143,150
44-110	Ctg 120mm Smk Mrtr XM929	123,970
44-110	Ctg 60mm Illum M721 W/FZ M766	116,810
44-110	Ctg 81mm Smk Screen RP M819	112,780
32-640	Grenade CS (Inactive)	

SOURCES: Status of lines—U.S. Army Operations Support Command (2001); replenishment plan—U.S. Department of the Army, Single Manager for Conventional Ammunition (1999).

VALUATION OF PARCELS

INTRODUCTION

The purpose of conducting a valuation of the Army's organic industrial base prior to privatization is to establish a range of value for analysis and to create the conditions for subsequent negotiation (McKinsey, 2001, p. 3). In the case of a sale of these parcels under an Army determination of "excess to ownership but not excess to need," the target market for the sales of the assets is, by definition, current or potential producers of ordnance materiel.¹

Valuation methodologies are open to biases, so it is typical to use multiple methods and assumptions to create an informed picture of the range of potential value for an asset. Corporate asset sales and mergers often take place at prices that differ significantly from what valuations would predict. This variance reflects the private information held by buyers and sellers at the time of actual sale. This private information is not always revealed in valuation methodologies, and it may only be revealed in a fully competitive sale. Army ordnance parcels are real assets with potential to produce income from manufacturing and leasing operations. Like all risky assets, value is determined by three factors:

- Magnitude of expected net cash flows.
- Timing of expected net cash flows.
- Risk associated with these cash flows.²

This appendix outlines the techniques used in this study to create a range of possible values for Army ordnance parcels, which are then used in estimates of

¹Under ETO, the new (qualified) owner must agree to material contractual obligations to continue to manage the assets to satisfy ongoing national defense needs for a reasonable period of time.

²Risk is a function of the volatility of expected cash flows that is correlated to overall returns in the market for risky securities. This issue will be explained in detail in this appendix.

the budgetary impacts of privatization. We utilize valuation techniques that are common in corporate finance (McKinsey, 2001; Brigham and Ehrhardt, 2002). There are many other valuation methods, approaches, and assumptions that might also be used to create a range of values for these parcels. This appendix will conclude with a summary of the findings and offer some insights on the interpretation of these valuations.

VALUING RISKY ASSETS

In this section, we discuss in more detail the process of determining the value of risky assets, including estimating the magnitude and timing of expected future cash flows, analyzing the risk associated with these cash flows, identifying the appropriate cost of capital, and using this information to create a discounted cash flow valuation. We also discuss some alternative methods of estimating valuations, and potential additional sources of value.

Net Cash Flows

Determining an unbiased expectation of the magnitude and timing of future net cash flow, or free cash flow (FCF), is not easy. FCF is the flow of cash made available to the owners of the assets through continued operation or sale of the assets. Financial analysts often start their analysis by looking at earnings before interest and taxes (EBIT) found in recent financial statements issued by the firm under generally accepted accounting principles (GAAP). If analysts believe that the accounting statements are reliable *and* that recent trends in EBIT appear indicative of future trends in FCF, then EBIT, and trends in EBIT, might be used as one possible estimate of future magnitude and timing of cash flows.

Potential buyers of risky assets often have ideas to improve the management and performance of the assets under their ownership. Therefore, assumptions about improvements in free cash flow are often incorporated in the estimation of future FCF. Alternatively, skepticism over the reliability of the current owner's financial reports, or pessimistic economic or market-specific forecasts may also be incorporated into FCF estimation. These sorts of factors make valuation prone to bias, and as much an art as it is a science.

The timing of expected FCF is important because the value of these future cash flows must be converted to their present value (PV) to reflect the time value of money. Discounting future expected cash flows at a risk-free (r_f) rate of interest converts future sure payments into their present value.³ Since future corporate

³ r_f is normally modeled by U.S. Treasury Bill returns.

cash flows are uncertain, however, a valuation methodology must also incorporate a method to handle the risk of these future cash flows.

Risk

The theory and practice of modern corporate finance rest substantially on the notion that in a securitized world, equity holders can diversify away all risk, except the systemic risk inherent in "the market." This market risk cannot be diversified away, it can only be lowered by reducing holdings of risky securities in favor of risk-free securities. The mathematics stem from the fact that the correlation of one security to all others is less than 1, thus *ex ante* portfolio variance must fall as one adds more securities to a portfolio. A random draw of only 15–20 securities from the S&P 500 will produce a portfolio variance of returns that will not significantly differ from the entire S&P 500 (Brealey and Myers, 1996, pp. 153–156).⁴

The important result of a securitized world in which all investors can hold diversified portfolios is that nonsystemic risk is *not* a relevant factor for corporate management in capital budgeting. The only risk that is relevant is the systemic or market risk inherent in the asset to be acquired. The relevant opportunity cost of capital for a capital project is thus the return that an investor might expect from an equivalently risky security, where only market risk is a concern.

The implication for valuing Army ordnance production parcels is that the *ex ante* total variance in expected cash flows is mostly irrelevant because the shareholders care only about market risk. The Army's ordnance production parcels do not lose value simply because the total volatility of expected future cash flows might be high.⁵ Management that gives up an opportunity to make a positive-NPV capital budgeting decision because of nonsystemic risk loses an opportunity to add to shareholder value.⁶

⁴A corollary result is that regardless of personal risk preference, investors should always hold diversified portfolios of risky securities and then adjust for risk through risk-free lending or borrowing. For example, a risk-averse investor should hold relatively more of her wealth in risk-free bonds. Conversely, a risk-loving investor should do the opposite, perhaps even borrowing cash on margin to plow into additional risky securities.

⁵Sophisticated investors and fund managers may actually have an appetite for this volatility so as to diversify their portfolios with the expectation that future defense-related assets may in fact have low or even negative correlations to the rest of their portfolio.

⁶Privately held firms may be operated by risk-averse owner-managers who have not fully diversified their wealth. Aversion to positive NPV acquisitions does not hedge competition from other firms to obtain capital assets, and therefore it should not affect the value of the assets in competitive sales negotiations. Empirical studies of mergers and acquisitions have generally found that the stock prices of acquired firms rise by 20 to 30 percent on average, whereas the stock prices of the buying firms remain constant on average. These results suggest that buying firms do not usually underpay to acquire assets, possibly due to managerial incentive problems or to competition from other potential buyers. See, for example, Brigham and Ehrhardt (2002), pp. 998–999.

Cost of Capital

The purpose of the valuation of the Army ammunition plants and arsenals is to determine their *market* value to potential private owners. To ensure consistency with this purpose, valuations of future cash flows should be discounted by a measure consistent with *corporate* finance, not *government* finance. Therefore, discount rates for valuations are derived from the Capital Asset Pricing Model (CAPM) and not OMB Circular A-94.⁷

CAPM offers a method to obtain an appropriate cost of capital for risky assets that accounts for both the time value of money and market risk. The model has several variants, but it generally holds that

$$r_s = r_f + \beta_s (r_m - r_f), \text{ where}$$

r_s = return of security "s";

r_f = risk-free interest rate;

β_s = coefficient of regression; and

$(r_m - r_f)$ = the market premium.

CAPM estimates the correlation of a given security with the return on the market portfolio with the parameter β .⁸ In other words, a security with $\beta = 1$ is expected to move with the market, a security with $\beta < 0.5$ should underperform market gains or losses, and a security with $\beta > 1$ indicates that the stock will yield some multiple of market returns or losses in any period. Analysts can find continuously updated accounting and financial performance statistics about publicly held firms aggregated by Standard Industrial Classification (SIC) code.⁹

This aggregation of data allows firms to use CAPM to determine an appropriate cost of capital for a given acquisition opportunity. The technique is to match the target acquisition with a security or group of securities that holds assets very similar in nature, and use the cost of capital to discount expected future cash flows. To adjust for the PV of tax shields when a firm has debt financing, analysts would normally discount future cash flows by a weighted average cost of

⁷OMB Circular A-94 is used as a source of a consistent and independent estimate of future inflation throughout this study, and to determine discount rates for analyzing gross long-term budget impacts of privatization. See Appendix D.

⁸Typically, security returns are regressed against market portfolio returns using the S&P 500 index as a proxy for "the market."

⁹This study relies on Ibbotson Associates (2001).

capital (WACC) based upon the financial structure of their firm.¹⁰ WACCs are calculated as follows:

$$\text{WACC} = (E/V) r_e + [(1 - t)D/V]r_d, \text{ where}$$

E = market value of outstanding equity;

D = market value of outstanding debt;

r_e = expected return on equity (from CAPM);

r_d = return on debt;

V = market capitalization of the firm = D + E; and

t = marginal corporate tax rate.

DCF Calculations

Discounted cash flow (DCF) analysis can then be used to calculate the PV of expected future FCF using a WACC. Analysts sometimes model projects or acquisitions as perpetuities:

$$PV_0 = FCF_1 / (\text{WACC} - g), \text{ where}$$

PV_0 = PV at time 0;

FCF_1 = FCF at the end of period 1; and

g = expected rate of change (if any) in FCF each period.

Alternative Methods

Other valuation methods can be used in addition to DCF. In this study, we also looked at valuing parcels based on average land values by county and selected real estate appraisals. Another common valuation technique is to look at financial multiple metrics. The practice of relating the value of a potential project or acquisition to an observed multiple of firm value to accounting metrics is common and easy to apply. Common "multiples" include market value to gross sales, value to EBIT, and value to book assets. These multiples can be

¹⁰Higher debt financing and higher tax rates yield a lower WACC and, hence, higher PVs of future projected cash flows. Finance theory holds that debt financing can increase the value of a firm by taking advantage of tax effects and by placing the firm's managers under stress to perform better. However, these effects on firm value may be mitigated by the present value of financial distress that may occur if debt loads rise so high that financial markets may balk at the financing of even very positive future NPV projects.

based on industry averages by SIC code, comparable individual firms, or recent acquisitions of similar firms.

Additional Sources of Value

When conducting detailed valuations with sufficient information or inference, analysts can sometimes find additional value in such areas as depreciation tax shields, trademarks, and intellectual property. An emerging area of corporate finance is the use of intuition from derivative security pricing models to value contingent projects as “option values.” Contingent projects are projects that a firm might decide to execute in the future if conditions were right. These opportunities are analogous to call options, whose values increase with higher expected future volatility of the price of the underlying security. In ordnance markets, the potential for wartime surge and replenishment orders yields an option value to holding laid-away or low-rate production lines.

Keys to Valuation

The keys to conducting unbiased valuations using DCF are

- Exercise care in estimating the expected value (EV) and trends of FCF; don't confuse risk of the cash flows with their expected value.
- Choose an appropriate cost of capital from CAPM.
- Use multiple methods.
- Consider the sensitivity of your results to possible variations in FCF and financial metrics.

VALUING ARMY AMMUNITION PLANTS

A challenge in valuing Army Ammunition Plants (AAPs) is the general lack of data on the value of the economic activity currently transacted on these parcels. Army accounting methods did not allow us to create a perfectly reliable estimation of the FCF currently attributable to each plant. The Army does not use GAAP, nor can it consistently characterize the type and magnitude of cash flows attributable to each plant for current, past, or future periods. The accounting methods used by the Army Working Capital Fund (AWCF) make it difficult to determine the value of economic activity at the three government-owned, government-operated (GOGO) ammunition plants and the two GOGO arse-

nals.¹¹ The GOCO AAPs are typically operated as divisions of larger corporations, some of which are privately held, so corporate accounting data on individual plants are not publicly available.

GOGO AAPs

We chose to avoid attempting valuations of the GOGO ammunition plants (Crane AAA, McAlester AAP, and Pine Bluff Arsenal) because of the difficulty in interpreting AWCF data, as well as the complexities of other operational management realities. Crane AAA is on a Navy-owned parcel. Congress has directed in PL 99-661 that Army ordnance lines in production as of 1986 at Crane AAA and McAlester AAP continue to be operated by civil service employees. Furthermore, all three installations have missions as Tier I or Tier II ammunition supply depots in addition to their ammunition production missions. It appears highly likely that the Army would first divest its GOCO AAPs before addressing alternative management options for the three GOGO AAPs.¹²

GOCO AAPs

Based on estimates of 2001 ordnance revenues and agriculture and forestry revenues from the U.S. Army Operations Support Command and ARMS tenant revenues from PricewaterhouseCoopers (2001), we arrived at an estimate of gross cash flows attributable to the GOCO AAPs for FY01. We applied separate economic and financial parameters to ordnance revenues and lease revenues to value each plant as a package of the two distinct cash flows.¹³ These packages of cash flows could then be modeled as a going concern and valued using applicable financial metrics. See Table E.1.¹⁴

¹¹For example, AWCF prices are set to recover costs from customers who typically are not allowed to buy from other sources, so it is unclear what the market prices for the GOGOs' output would be.

¹²A related issue arises at Mississippi AAP, where the Army facility-use contractor operates on a NASA-owned parcel of land. Although we therefore omit Mississippi AAP from our analysis of the budgetary impact of privatization, the Army could approach NASA about selling this parcel under ETO in a manner that respects the ongoing ordnance production and mission needs of both NASA and the Army. Interestingly, NASA is currently considering plans to privatize operation of the U.S. Space Shuttle program as well as restructuring other programs (Peckenpaugh, 2001).

¹³In estimating recurring revenues for ordnance production, we tried to include what could be characterized as recurring resource flows to obtain ordnance materiel (including cash flows for Layaway of Industrial Facilities (LIF), Maintenance of Inactive Industrial Facilities (MIIF), and Industrial Facilities (IF) while excluding one-time capital investment flows such as military construction (MILCON) or ARMS appropriations from Congress. One of the major benefits of divestiture of the AAPs is that the Army should achieve a significant increase in the transparency of ordnance materiel procurement costs.

¹⁴For ammunition metal parts production and arsenals, we applied metrics from SIC 349. LAP and energetics production were valued using metrics from SIC 289.

Table E.1
GOCO AAP Financial Summary

Financial Statistics		Value/Sales Multiple
Misc. chem and explosives		1.2733
SIC code	289	
Operating margin	0.1598	
Industry WACC	0.1069	
Misc. metal fabrication		1.0911
SIC code	349	
Operating margin	0.141	
Industry WACC	0.1102	
Real estate industry		4.1975
SIC code	6512	
Operating margin	0.2411	
Industry WACC	0.0887	
Estimated sales growth (inflation)	0.021	
Corporate marginal tax rate	0.35	

SOURCE: Ibbotson Associates (2001), pp. 2-44, 3-22, and 6-36.

After significant discussion and analysis of the future prospects for military ammunition and related commercial markets, we felt that in the short term (3–5 years), DoD procurement of ammunition is likely to remain stable in real terms or even rise slightly in the DoD six-year Program Objective Memorandum (POM). Since five-year production contracts would be competed in conjunction with privatization, the new owners of AAP parcels would also have a good chance of maintaining or increasing ongoing production contracts with the Army and the other armed services in the short term. In the middle to long term (4–10 years), we felt that DoD transformation initiatives will probably shift ammunition procurement away from legacy (and mainly cannon) ordnance and toward smarter (and missile) munitions currently produced in the COCO ordnance sector. Additionally, owners of the privatized AAPs are likely to face increasingly effective competition to maintain their share of legacy procurement, and their current share of this market may decline. On the other hand, aggressive reengineering and capital investment at the privatized AAPs may allow them to maintain their share of legacy munition production and capture a share of the large and growing nonlegacy ammunition market from current COCO facilities.

An important assumption of this study's valuation methodology is that the Army makes a *credible* decision to divest itself of *all* of the GOCO ammunition plants. Bidders can only be expected to pay full market value for these plants if in fact the Army is truly committed to divestiture and the liberalization of the

legacy ammunition market.¹⁵ Therefore, GOCO AAP valuations should not be used as estimates for AAPs that would be sold under any limited or noncredible privatization plan.

To establish a range of value for GOCO AAPs, we decided to calculate values for each plant based upon

- A multiple of current ordnance sales and leasing revenue.
- A DCF of FCFs modeled from the operation as a perpetual going concern at stable real revenues.
- A DCF of FCFs modeled from the operation of a perpetual going concern with revenues declining at a 10 percent nominal rate.¹⁶
- Average farmland value in the county where the plant is located.
- Real estate appraisals (available for Scranton and Radford AAPs).

All prior-year values were converted to year 2001 dollars using the U.S. Bureau of Labor Statistics (BLS) inflation calculator. Future inflation was projected in accordance with OMB Circular A-94 (Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs).

Army commentators on a draft version of this report suggested a number of possible alternative techniques for valuation, including the use of lower sales revenues, lower operating margins, higher capital costs, and higher tax rates. In particular, they suggested an alternative source of industry financial statistics, Integra Industry Reports. Although Integra provides industry statistics at the 4-digit SIC level for the ordnance and explosives industries, there are a number of weaknesses in the Integra data that caused us to prefer the Ibbotson Associates data. First, Integra data do not include multiple-of-sales ratios or industry WACCs, or sufficient data to calculate them, so Ibbotson or another alternative source would still be needed for these variables. Second, Ibbotson's selection criteria require that firms have sales greater than \$100,000, market value greater than \$10,000, and at least 75 percent of sales in the reported SIC code. At least five companies must meet these criteria for Ibbotson to calculate values for a SIC code. Therefore, if Integra is able to calculate statistics for a SIC code but Ibbotson is not, the firms in its sample must violate one or more of these crite-

¹⁵This assumption is not unreasonable given the Army's track record favoring GOCO over COCO bidders on ammunition contracts. If potential buyers believe that the Army will retain some GOCO facilities and continue to award production contracts to them on this basis, they are not likely to be willing to pay as much for the privatized plants.

¹⁶Which equates to a higher real rate of revenue decline.

ria.¹⁷ As a result, we believe the Ibbotson statistics are more likely to be representative of the Army's ordnance facilities in terms of size and industry classification. In any case, using the EBITDA-to-sales ratios from Integra (which are lower than the operating margins reported in Ibbotson)¹⁸ produce valuations that fall within the range of valuations resulting from the five approaches listed above.

A second issue was whether an allowance of 35 percent of the plants' estimated operation margins was sufficient to cover both profit taxes and property taxes. However, further calculations indicated that an estimated property tax of \$100 per acre would be offset by considering the deductibility (against profit taxes) of property taxes, environmental remediation costs, and depreciation of the price paid by the new owner for buildings and equipment as part of the privatization. Therefore, 35 percent of the operating margin should be sufficient to cover both types of taxes.

We also investigated value-to-sales ratios for comparable firms and comparable recent acquisitions as a check on the valuations calculated by the five approaches listed above. Publicly traded firms with significant ammunition sales include General Dynamics, with an average price-to-sales ratio of 1.24 over the 12 months ending in July 2002; ATK, with a ratio of 1.10; and Olin Corporation, with a ratio of 0.68. The average price-to-sales ratio for the entire aerospace and defense industry is 0.90 over the same period.¹⁹ Some comparable recent acquisitions include ATK's purchase of Thiokol Propulsion from Alcoa in December 2001, with a value-to-sales ratio of 1.20; General Dynamics' purchase of Primex in early 2001, with a ratio of 0.97; and ATK's acquisition of Blount Ammunition company in November 2001, with a ratio of 0.23. Most of these value-to-sales ratios are comparable to the multiple-of-sales ratios from Ibbotson (1.2733 for miscellaneous chemicals and explosives and 1.0911 for miscellaneous metal fabrication). The lower ratios of 0.68 and 0.23 are comparable to the DCF valuation based on an annual 10 percent nominal decrease in revenues and to farmland value.

¹⁷For example, Integra reports 96 businesses in SIC code 2892 (Manufacturing-Explosives), of which 78 have sales less than \$1,000,000. Ibbotson reports that only 10 firms in SIC code 289 (Miscellaneous Chemical Products, of which 2892 is a subset) meet its criteria.

¹⁸The EBITDA-to-sales ratios reported for the year 2000 in Integra are 9.5 percent for SIC code 2892 (Manufacturing-Explosives), 8.1 percent for SIC code 3482 (Manufacturing-Small-arms ammunition), 8.7 percent for SIC code 3483 (Manufacturing-Ammunition, except for small arms), and 10.4 percent for SIC code 3489 (Manufacturing-Ordnance and accessories).

¹⁹Downloaded from <http://yahoo.marketguide.com/MGI> on July 26, 2002, and July 29, 2002.

VALUING ARSENALS

The GOGO arsenals also present a challenge to estimating value. Rock Island Arsenal (RIA) and Watervliet Arsenal (WVA) appear to vastly underemploy the capital and labor available at these facilities. The Army supports these operations through very large Industrial Mobilization Capacity (IMC) subsidies and cash infusions into the AWCF ordnance activity group, and by overcharging itself and other customers for the dwindling output of ordnance products produced at RIA and WVA.

Since AWCF accounting data do not measure the market value of the arsenals' output, we used U.S. economic census data to extrapolate the potential revenues from their assets and workforces if they were operated at productivity levels similar to those in comparable private-sector industries. Unlike some of the AAPs, much of the plant and equipment at RIA and WVA are relatively modern and in good working order. Based on historical production at these two arsenals, the current labor force should be endowed with sufficient skills, capital, and plant floor space to significantly increase output if they had orders to produce ordnance and related products such as machine shop services, industrial oil and gas valves, and structural steel products.

We assume that under private management, the current workforce could be transformed to meet private-sector norms for ratios of indirect labor to direct labor, and execute a business plan to enter the large and growing markets that are closely related to the traditional ordnance materiel market expertise. Using the business plan pro-forma cash flows for RIA and WVA outlined in Chapter Six, we estimate expected FCF, assuming that the FGC reaches a steady state after a five-year period of restructuring.²⁰ This FCF is then used to derive DCF valuations using the same methodology as indicated for the GOCO AAPs above.

Table E.2 summarizes the results of the valuation estimates for the Army's ammunition plants and arsenals.²¹ It also indicates the known environmental remediation liability remaining at each plant as of the end of 2001. These costs could potentially be assumed by the buyers of the plants in lieu of cash payments for the facilities.

²⁰If one believes that the FGC business plan is realistic, then it must be realistic for a private firm as well. Additionally, real estate development potential at both arsenals is likely to be significant.

²¹We present only the total valuations of the 10 GOCO ammunition plants (excluding Mississippi AAP) to avoid revealing proprietary information on individual plants, except for land value, which is based on publicly available information.

Table E.2
Army Ordnance Production Parcel Valuations
(in \$ millions)

Parcel	Environmental Liability	Multiple of Sales Value	DCF Value	DCF with 10% Decline Value	Land Value
GOCO ammunition plants					
Holston AAP	10.1				13.4
Iowa AAP	54.8				32.1
Kansas AAP	25.2				9.6
Lake City AAP	71.1				9.3
Lone Star AAP	3.5				25.7
Louisiana AAP	10.9				23.8
Milan AAP	128.0				31.3
Radford AAP	92.8				13.5
Riverbank AAP	16.9				.9
Scranton AAP	0				22.1*
GOCO AAP subtotal	413.3	987.3	892.7	423.1	181.7
Arsenals					
Watervliet	5.8	138.5	104.7	**	0.3
Rock Island	7.8	270.9	200.1	**	1.9
Arsenal subtotal	13.6	409.4	304.8	**	2.2
Ordnance portfolio subtotal	426.9	1,396.7	1,197.5	**	183.9
Ordnance portfolio net worth (value – liability)		969.8	770.6	**	(243.0)

*This figure is based on lower GSA appraisal value of Scranton AAP in lieu of "land value."

**DCF with 10% decline values not calculated for arsenals.

ILLUSTRATIVE VALUATION OF A HYPOTHETICAL AAP

In this section, we illustrate each of the valuation methodologies using as an example a hypothetical AAP with \$65 million in ordnance revenues (LAP or energetics), \$3 million in ARMS tenant revenues, and \$400,000 in agriculture and forestry revenues. As indicated above, ordnance revenues and lease revenues are valued separately using financial metrics from the appropriate SIC code.

Multiple of Sales

The general formula is $V = R * M$, where V is the value of the enterprise, R is estimated annual sales, and M is the average firm market capitalization as a multiple of its sales.

- Ordnance revenue multiple: $\$65,000,000 * 1.2733 = \82.8 million.
- Lease revenue multiple: $\$3,400,000 * 4.1975 = \14.3 million.

Sum of ordnance and lease revenue multiples: \$82.8 million + \$14.3 million = \$97.0 million.

DCF Value

The general formula is $V = (1 - T_c)(1 + g)(OM)(R)/(WACC - g)$, where

V = value of enterprise

T_c = marginal corporate tax rate

= .35 (current maximum federal tax rate)

g = expected nominal revenue growth

= .021 (current OMB Circular A-94 future annual inflation estimate, used as an independent source to estimate future inflation)

OM = expected operating margin²²

R = expected total real annual revenues, broken down into ordnance and lease revenues.

Free cash flow (FCF) for Year 1 is defined as $(1 + g)(OM)(R)$.

a. Ordnance DCF: $(1 - .35)(1 + .021)(.1598)(\$65,000,000)/(.1069 - .021) = \mathbf{\$80.2}$ million

b. Lease DCF: $(1 - .35)(1 + .021)(.2411)(\$3,400,000)/(.0887 - .021) = \mathbf{\$8.0}$ million

Sum of ammo DCF and real estate DCF = **\$88.3 million.**

DCF Value with 10 Percent Perpetual Annual Nominal Decline in Estimated Future Revenues after 2002

The general formula is the same as for DCF value $[(1 - T_c)(1 + g)(OM)(R)/(WACC - g)]$, except that $g = -10\%$; this equates to an assumption of a 12.31 percent decline per year in real terms.

a. Ordnance DCF (with 10 percent revenue decline): $(1 - .35)(1 + .021)(.1598)(\$65,000,000)/(.1069 - (-.10)) = \mathbf{\$33.3}$ million.

²²See Table E.1 for summary of statistics used from Ibbotson Associates (2001). SIC code 289 (Miscellaneous Chemicals and Explosives) was used to value energetics and LAP business operations; SIC code 349 (Miscellaneous Fabricated Metal Products) was used for metal parts and arsenal business operations; SIC code 6512 (Operators of Nonresidential Buildings) was used for lease revenues.

b. Lease DCF (assumed not to decline) from above = \$8.0 million.

Sum of ordnance DCF (with 10 percent revenue decline) and (nondeclining) lease DCF = \$33.3 million + 8.0 million = \$41.4 million.

Land Value

We calculate land value using the average value of farmland in the local area and total acreage at each plant as provided by OSC. The value of Iowa AAP is based on the value of farmland in its region of Iowa as estimated by the University of Iowa. All other facility land valuations use the 1997 USDA farm census data by county. All values are inflated to 2001 dollars using the BLS inflation calculator, most likely underestimating farm (and industrial) land value appreciation since 1997. Research indicates that significant improvements on farmland increase its value, often to as high as \$5,000/acre. For a hypothetical AAP with 10,000 acres of land and a local farmland value of \$2,000 per acre,

Land value = 10,000 acres * \$2,000/acre = \$20 million.

CONCLUSION

The valuations of Army ordnance parcels indicate that these parcels have significant value that generally outweighs their known environmental liabilities. While any valuations are subject to possible bias, these valuations are based upon reasonable assumptions that leasing and ammunition procurement revenues will continue either at current levels or show a declining trend.

There are many conservative assumptions embedded in these valuations. The value range itself is bounded by use of an *average* multiple-of-sales value at the high end, and *average* (and largely unimproved) farmland value at the low end. Additionally, the valuations make no allowance for improvements or investments on these parcels, even though there appears to be great potential for positive-NPV capital expenditures. We also chose not to consider opportunities for bringing in additional ammunition or other manufacturing, the PV of depreciation tax shields, the PV of Qualified Environmental Remediation (QER) tax shields,²³ the option value of contingent projects such as replenishment or surge production, trademark potential, intellectual property, and opportunities

²³Under IRS Code Section 198, QER expenses are deductible without triggering corporate alternative minimum tax (AMT). In an ETO divestiture, the Army offers firms the opportunity to buy industrial real estate in exchange for conducting environmental remediation later, and then expensing the costs when executed. The QER and depreciation tax shields associated with these transactions could be very valuable, perhaps in the neighborhood of \$89 and \$30 million, respectively, for the "base case" (85 percent of DCF).

to develop real estate holdings or to sell excess land and facilities to generate additional FCF in future periods. Finally, we applied an industry average operating margin for nonresidential buildings to real estate cash flows, even though these flows include forestry sales and agricultural leasing income streams that are most likely already "free cash flow."

The Army has an opportunity to achieve more than divestiture of these assets. It can improve transparency of ordnance materiel procurement decisions. Leveraging sales under excess to ownership, it may be able to finance environmental liabilities of over \$400 million, while generating additional cash for the Army budget and stimulating a more competitive ordnance market. While one cannot know exactly what an asset is worth until it is sold in an arm's-length transaction, the valuation of the Army's holdings of ordnance production parcels indicates that it is well worth the time and effort to aggressively market and competitively sell these assets as excess to ownership.

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