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Special Tooling and Special Test Equipment: A Case Study Analysis

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PREFACE

This document was prepared by the Institute for Defense Analyses (IDA) for the Director of Industrial Capabilities and Assessments, Office of the Deputy Under Secretary for Industrial Affairs. The work was performed under the task order Integrated Diagnostics and Improved Affordability for Weapons and Support Systems. It addresses an objective of this task, to provide analytic support for Department of Defense automatic test systems policy (special test equipment includes automatic test equipment).

This document was reviewed by IDA staff members Dr. Richard J. Ivanetich and Dr. J. Richard Nelson.

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EXECUTIVE SUMMARY

Background. The Department of Defense weapon system program offices sometimes permit contractors to acquire Special Tooling/Special Test Equipment (ST/STE) as government-furnished property in the course of developing or manufacturing a product. A study team from the Institute for Defense Analyses evaluated the potential effects on contractor target profits, using a case study analysis to evaluate five alternatives for obtaining additional tooling or test equipment to meet contractual requirements. All five required the use of automatic test equipment with an original cost of $100,000, to meet a special contractual need.

- Case 1: The contractor uses existing government-owned STE. The contractor may have used the equipment on a previous contract or it may be newly furnished by the government.
- Case 2: The contractor acquires new STE on behalf of the government. The cost is reimbursed by the government as a direct materials expense under the contract.
- Case 3: The contractor acquires new test equipment and capitalizes it as a contractor-owned asset. The contractor recovers depreciation on the equipment as an indirect cost on this and other defense contracts.
- Case 4: The contractor uses existing, contractor-owned equipment. We assume this used equipment has been partially depreciated and has a book value of $60,000 at the beginning of the contract.
- Case 5: The contractor acquires new test equipment but treats it as an expense item rather than a capital asset. The cost is reimbursed by the government as a direct materials expense under the contract.

Approach. As part of our approach, we examined (1) the potential profitability for each alternative; (2) the cash flow changes to the base case, using two types of contracts (*negotiated fixed price* and *reimbursable cost plus fixed fee*); and (3) the size of the contract relative to the size of the contractor.

We also analyzed the sensitivity of the case study analysis to assumptions concerning the type of contract, length of contract, and discount rate. While these assumptions affect the profitability of the five alternatives, they do not change the relative standing of the alternatives themselves in the analysis.

Conclusions. It can be much more profitable for a company to acquire test equipment as ST/STE on behalf of the government, when prices covering no more than (roughly) 70% of a company's business adjust to reflect the acquisition.

Acquiring ST/STE appears more profitable from the perspective of a particular contract, i.e., ignoring price adjustments on other contracts, than it is to the company as a whole.

Acquiring contractor-owned assets tends to be profitable when prices covering more than (roughly) 85% of a company's business adjust. In this case, however, profitability may require that the equipment be worth at least its book value to the company at the end of the contract. If a potential exists for the equipment to be worth less than its book value, this case may pose a substantial risk.

INTRODUCTION

Background. In 1994, the Office of the Deputy Under Secretary for Industrial Affairs asked the Institute for Defense Analyses (IDA) to assemble a study team to study the commercial and defense electronics manufacturing industries. One objective was to evaluate how Special Tooling (ST) and Special Test Equipment (STE) policies affects target profits. An example of a defense contract was constructed, with the price determined in accordance with DOD's rules for establishing negotiating targets. Case study assumptions were varied to cover a range of contract amounts, lengths, and types.

The IDA team observed that the Department of Defense (DOD) program offices, as acquiring agents, sometimes permitted contractors to acquire ST/STE as government-furnished property in the course of developing or manufacturing a product. The Federal Acquisition Regulation[1] defines ST/STE in this narrow context as tooling and test equipment that belongs to the government and may be used by the contractor. By this definition, the items that are designated as ST/STE are exclusive of all other tooling and test equipment that is owned by the contractor, even when other tooling or test equipment is unique and/or special for some application.

Approach. The team analyzed the potential effects on contractor profit associated with the practice of permitting contractors to acquire tooling and test equipment as government property (i.e., ST/STE). The case study analysis reported in this document was conducted in conjunction with ongoing evaluations of both commercial and defense electronics manufacturing and automatic test equipment (ATE) applications for defense electronics.

The IDA team's approach borrowed heavily from Kent Osband's draft RAND report, *Target Profitability Under DOD Profit Policy* [1989]. Roughly the same typical contract as Osband's was used in this report. Details were developed based on findings supporting a DOD report, *Defense Financial and Investment Review* [1985], and a Myron G. Myers et al. paper, *Facilities Capital as a Factor in Contract Pricing* [1985]. Financial parameters that have changed were updated. The model for this case study is somewhat simpler than Osband's, omitting such nuances as payment delays, continuous discounting, and unallowed costs. The results nevertheless appeared consistent with his.

Organization of this document. Chapter 2 describes the study methodology. Chapter 3 describes findings while Chapter 4 presents conclusions. Appendix A presents additional detail on the methodology described in Chapter 2, including an example and assumptions. References, a glossary, and a list of acronyms follow.

[1] Part 45, Government Property.

METHODOLOGY

This study examines five nominally different alternatives. The base case is a three-year contract that does not require the use of special equipment. The five alternatives, all of which require the use of special automatic test equipment with an original cost of $100,000, are defined as follows:

Case 1: The contractor uses existing government-owned STE. The contractor may have used the equipment on a previous contract or it may be newly furnished by the government.

Case 2: The contractor acquires new STE on behalf of the government. The cost is reimbursed by the government as a direct materials expense under the contract.

Case 3: The contractor acquires new test equipment and capitalizes it as a contractor-owned asset. The contractor recovers depreciation on the equipment as an indirect cost on this and other defense contracts.

Case 4: The contractor uses existing, contractor-owned equipment. We assume this used equipment has been partially depreciated and has a book value of $60,000 at the beginning of the contract.

Case 5: The contractor acquires new test equipment but treats it as an expense item rather than a capital asset. The cost is reimbursed by the government as a direct materials expense under the contract.

Analysis Model. The IDA study team used the weighted guidelines approach, specified in the Defense Federal Acquisition Regulation Supplement, was used as the analytical model for purposes of this study. This approach is used by DOD contracting officers to calculate target prices for contract negotiation.

For each unique contractual negotiation, the actual price of the negotiated contract may vary from the target price used by the contracting officer at the start of negotiation. However, these weighted guidelines provide an analytical model of the DOD policy and practice for establishing fair and reasonable price bounds for negotiated contracts.

Potential profitability. We evaluate the potential profitability for each case alternative by examining its effect on the net present value of the contractor's cash flow. That is, cash outflows and inflows are tracked period by period, and the cash flows that occur after the start of the contract are discounted, using an annualized discount rate of 10%. The present values of cash flows that occur later in the contract are thus reduced below their nominal values. Under this approach, the contractor breaks even only if the contract provides an after-tax return of 10% per year. While the discount rates assigned by the Office of Management and Budget are different, the intent here is to recognize that contractors have other potential profit-making opportunities for their funds. Later in the analysis we vary some assumptions, including the discount rate, to gain an indication of analysis sensitivity to assumptions.

Cash flow changes. For each of the five cases, we evaluate cash flow changes relative to the base case. The principal cash flows considered were:

- Increased outflows at the beginning of the contract if the contractor purchases new equipment or assigns existing assets to the contract.

- Changes in the level and timing of government payments to the contractor during and at the end of the contract.
- Changes in the level and timing of income taxes paid by the contractor.
- The residual book value of contractor-owned equipment, which is considered a cash inflow at the end of the contract.

Contract types. For each case, we examine two types of contracts: negotiated fixed price and reimbursable cost plus fixed fee. Under both types, the government establishes a target price for negotiating purposes, including a target profit fee based on expected costs.[2] In the context of this evaluation, the contract type has two major cash flow effects:

- Under a fixed price contract, the contractor may receive periodic progress payments amounting to 75% of period costs. The remaining 25%, plus profit fees, are paid upon completion of the contract. In contrast, under a reimbursable contract, the contractor may be periodically reimbursed for 100% of period costs plus related profit.
- The allowable percentage markup over costs is lower under a reimbursable contract, in light of the lower risk to the contractor.

Contract size. Finally, for each case, we consider the size of the contract relative to the size of the contractor. This is important because of the Defense Federal Acquisition Regulations Supplement rules for assigning indirect costs (i.e., overhead) to contracts. Indirect costs are assigned as a percentage markup to direct contract costs (i.e., direct labor or materials). The percentage rate is established based on company-wide overhead cost pools.[3]

If a contractor treats new test equipment as a capital asset, the related depreciation is included in the company-wide overhead pool and charged against all contracts based on their direct costs. On the other hand, if new test equipment is treated as STE or as a company expense, the cost is treated as a direct materials expense on a particular contract.

Because of this asymmetry, the effect of changes in the treatment of test equipment is different for a particular contract than for the whole company.

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[2] Under a fixed price contract, the contract price does not change when costs change. Under a reimbursable cost plus fixed fee contract, the contract price does change when costs change, but the contractor's fee does not change. There are also incentive versions of both types of contract.

[3] Overhead pools will typically be defined for defense divisions or parts thereof, rather than encompassing a corporation's commercial business. In this document, *company-wide* thus refers to all contracts subject to the same overhead pool.

FINDINGS

This chapter describes the findings of the case study analysis from two perspectives: (1) whole company perspective and (2) small contract perspective. We then discuss the sensitivity of the alternatives to additional assumptions.

From the whole company perspective, the choice of whether to acquire ST/STE on behalf of the government or as a contractor-owned asset depends on what the equipment is worth to the contractor at the end of the contract. Only if the equipment is likely to be worth less than its residual book value is government-furnished ST/STE the preferred (more profitable) alternative.

However, when viewed from the perspective of contract size, using government-furnished equipment is profitable for smaller contracts while acquiring equipment as contractor-owned assets is more profitable for larger contracts. Table 1 below summarizes the results of the comparisons. Depending on the type and length of contract, the contract size at which cash flows transition between negative and positive amounts to 65% to 95% of the contractor's total business.

This chapter also discusses the sensitivity of the case study analysis to assumptions concerning the type of contract, length of contract, and discount rate. *It finds that while all three assumptions affect the profitability of alternatives, they do not change the relative standing of the alternatives themselves in the analysis.*

Table 1. Alternative Approaches for Obtaining Automatic Test Equipment

Equipment Source (By Case Numbers)	Change in Cash Flow Discounted at 10%				
	Fixed Price		Reimbursable		
	Whole Company (100%)	Small Contract (5%)	Whole Company (100%)	Small Contract (5%)	Residual Book Value[1]
0. Base Case: None Needed	—	—	—	—	—
1. Existing ST/STE	—	—	—	—	—
2. New ST/STE	(5,833)	28,599	(1,809)	35,053	—
3. New Contractor Assets	23,516	(65,274)	34,297	(64,735)	30,053
4. Old Contractor Assets[2]	10,119	(56,494)	15,898	(56,205)	0
5. New Contractor Expenses	(5,833)	28,599	(1,809)	35,053	—

Notes: 1. Included in cash flow. 2. $60K book value at contract start. ziShading and parentheses indicate negative net present value.

Whole Company Perspective

Table 2. Summary of Comparisons from Whole Company Perspective

Equipment Source (By Case Numbers)	Change in Cash Flow Discounted at 10%		
	Fixed Price	Reimbursable	Residual Book Value[1]
0. Base Case: None Needed	—	—	—
1. Existing ST/STE	—	—	—
2. New ST/STE	(5,833)	(1,809)	—
3. New Contractor Assets	23,516	34,297	30,053
4. Old Contractor Assets[2]	10,119	15,898	0
5. New Contractor Expenses	(5,833)	(1,809)	—

Notes: 1. Included in cash flow. 2. $60K book value at contract start.
Shading and parentheses indicate negative net present value.

Table 2 above summarizes the results of comparisons from the whole company perspective. First, concentrate on the data column showing the results for a fixed price contract.

Case 1: Compared to the base case, using existing government-owned STE does not change the contractor's cash flow.

Case 2: Buying new STE for the government is at best a marginal investment for the company. The resulting cash flow has a net present value of minus $5,833. The problem is that the target profit is not sufficient to compensate the company for tying up its funds awaiting government reimbursement. While the company earns an internal rate of return of 4.6% in this case, that is less than the minimum 10% return assumed the contractor requires.

Case 3: Capitalizing new contractor-owned ATE appears to be a profitable but risky investment. The associated cash flow has a net present value of $23,516 and an internal rate of return of 19%.[4] Depreciation and the facilities capital markup[5] are key factors generating this return.

Note, however, that cash flow also includes the $30,053 present value of the equipment that the contractor will recover at the end of the contract. If the equipment is worth less to the contractor than its residual book value, then the rate of return will be less than we have calculated. For example, if there is no market for the specialized equipment and the company is not awarded another contract that requires it, Case 3 will be very unprofitable. The profitability of capitalizing ATE thus depends crucially on its residual value to the company.[6]

Case 4: Using existing contractor-owned equipment, like using new equipment, appears profitable. The net present value, i.e., $10,119, is less than in Case 3 since the contractor's investment is lower, namely the book value of the equipment at the beginning of the contract. However, the contractor's risk is also lower since the equipment will be fully depreciated at the end of the contract. The $10,119 does not depend on the equipment being worth anything to the contractor at the end.

Case 5: Treating the cost of new ATE as a direct materials expense yields the same cash

[4] This rate tracks closely with the 18.2% return to facilities investment estimated in Osband [1989, p. 96].

[5] Facilities capital markup is defined in Appendix A.

[6] As will be shown, this risk is less for longer contracts.

flow and doubtful profitability as Case 2. However, if the contractor is allowed to retain title to the equipment after the contract, and if the equipment is worth to the contractor, for example, the $30,053 present value assumed under Case 3, then Case 5 could be the most profitable alternative by far.

Summary. From the perspective of company-wide profitability, then, the choice among alternatives depends primarily on what the equipment is worth to the contractor after the contract. The STE alternatives are preferable only when the equipment is likely to be worth much less than its residual book value.

Small Contract Perspective

Table 3. Summary of Comparisons from Small Contract Perspective

Equipment Source (By Case Numbers)	Change in Cash Flow Discounted at 10%		
	Fixed Price	Reimbursable	Residual Book Value[1]
0. Base Case: None Needed	—	—	—
1. Existing ST/STE	—	—	—
2. New ST/STE	28,599	35,053	—
3. New Contractor Assets	(65,274)	(64,735)	30,053
4. Old Contractor Assets[2]	(56,494)	(56,205)	0
5. New Contractor Expenses	28,599	35,053	—

Notes: 1. Included in cash flow. 2. $60K book value at contract start.
Shading and parentheses indicate negative net present value.

From the perspective of a small contract, however, the conclusions are quite different. Now concentrate on the data column showing results for a small, fixed price contract in Table 3 above. Direct costs for the contract are specified as 5% of direct costs for the whole company.

Case 1: As discussed above, using existing government-owned STE does not change the contractor's cash flow.

Case 2: Acquiring STE on behalf of the government seems quite profitable now, with a net present value of $28,599 and an internal rate of return of 39%. This apparent profitability is based on the allocation of indirect costs to the contract. The contract can claim indirect costs equal to 20% (i.e., our assumed overhead rate) of the direct materials costs for acquiring the STE. Profit markups related to both costs and facilities will also increase. While indirect costs for the whole company have not changed, acquiring STE enables the small contract to claim a larger share of those costs (for reimbursement).

Case 3: Acquiring test equipment as a contractor-owned capital asset now appears extremely unprofitable, with a net present value of minus $65,274. While the equipment's acquisition cost is a cash outflow for the contract, its depreciation is included in the company-wide overhead pool and recovered from all contracts based on their respective direct costs. The small contract may thus claim only a 5% share of the increased indirect costs. The only substantial cash inflow for the contract is the equipment's residual book value at the end.

Case 4: The small contract loses somewhat less (i.e., $56,494) by using existing contractor-owned equipment, but only because the initial cash outflow, i.e., the initial book value of the equipment, is less than for new equipment.

Case 5: Treating newly acquired test equipment as an expense appears profitable to the small contract for the same reasons that acquiring new STE appears profitable. That profitability is even higher than we have calculated if the equipment remains valuable and the contractor retains title after the contract.

How should the results from the small contract be interpreted? In the first place, they suggest that managers of small contracts would greatly prefer to acquire new STE for the government rather than invest in company-owned assets. This might be true even though, from a company perspective, acquiring assets is more profitable. However, there may also be cases when the perspective of the small contract is correct. For example, some portion of the company's business may be subject to prices that do not change, due to long-term contracting or market conditions. Then, changes in the allocation of indirect costs to the small contract need not be fully offset by compensating changes in other contracts. Consider Cases 2 and 3:

- *Case 2:* An increase in direct materials cost (for STE) for the small contract increases company-wide direct costs and hence reduces the materials handling overhead rate. This will reduce indirect costs for other reimbursable and newly negotiated contracts. However, prices need not be reduced for some contracts, e.g., fixed price contracts awarded competitively. Thus, the increase in indirect costs assigned to the small contract will not be entirely offset by reductions in other contracts.
- *Case 3:* Depreciation for new equipment assets on a small contract increases the company-wide overhead pool and hence the overhead rate. This tends to raise prices for other reimbursable and newly negotiated contracts, to cover higher indirect costs and related profit markups. However, the company may be unable to increase prices in competitive markets and for some long-term contracts with fixed prices. The company thus may be unable to recover all of the allowable depreciation and potential markups.

Thus, while the small contract perspective is too myopic, the whole company results may not be achievable.

What proportion of a company's prices must be flexible in order that the alternatives be profitable? Table 4 on page 8 addresses this question. It shows the same cash flow data as Table 3 for contract sizes ranging from 5% to 100% of company costs. For Case 2 with a fixed price contract, acquiring STE appears profitable for contracts ranging from 5% to 80% of company costs.

Summary. In other words, acquiring STE appears profitable so long as prices covering no more than 80% to 85% of the company's business must be changed to reflect the lower overhead rate for materials handling. Similarly, acquiring contractor-owned equipment for a fixed price contract under Case 3 appears profitable, providing prices covering at least 75% of the company's business can be changed to reflect higher depreciation overhead. The contract size at which cash flow transitions between negative and positive varies for each case, depending on the type and length of contract, but is generally in the 65% to 95% range.

Table 4. Net Present Value by Relative Size of Contract

Contract Size[1]	Fixed Price			Reimbursable		
	Case 2[2]	Case 3	Case 4	Case 2[2]	Case 3	Case 4
5%	28,599	(65,274)	(56,494)	35,053	(64,735)	(56,205)
10%	26,787	(60,601)	(52,988)	33,113	(59,523)	(52,410)
15%	24,974	(55,928)	(49,482)	31,173	(54,311)	(48,615)
20%	23,162	(51,255)	(45,976)	29,233	(49,099)	(44,820)
25%	21,350	(46,582)	(42,470)	27,293	(43,886)	(41,025)
30%	19,538	(41,908)	(38,964)	25,353	(38,674)	(37,230)
35%	17,726	(37,235)	(35,458)	23,413	(33,462)	(33,436)
40%	15,913	(32,562)	(31,952)	21,473	(28,250)	(29,641)
45%	14,101	(27,889)	(28,446)	19,532	(23,038)	(25,846)
50%	12,289	(23,216)	(24,940)	17,592	(17,825)	(22,051)
55%	10,477	(18,543)	(21,435)	15,652	(12,613)	(18,256)
60%	8,665	(13,869)	(17,929)	13,712	(7,401)	(14,461)
65%	6,852	(9,196)	(14,423)	11,772	(2,189)	(10,666)
70%	5,040	(4,523)	(10,917)	9,832	3,023	(6,871)
75%	3,228	150	(7,411)	7,892	8,236	(3,076)
80%	1,416	4,823	(3,905)	5,952	13,448	719
85%	(396)	9,496	(399)	4,012	18,660	4,514
90%	(2,209)	14,169	3,107	2,071	23,872	8,309
95%	(4,021)	18,843	6,613	131	29,084	12,104
100%	(5,833)	23,516	10,119	(1,809)	34,297	15,898

Notes: 1. Size equals contracts costs as a percentage of the total company's contracts. 2. Use Case 2 data for Case 5. Shading and parentheses indicate negative net present value.

Sensitivity to Assumptions

For reimbursable contracts, as Table 1 previously indicated, the comparative analysis of alternatives is the same as for fixed price contracts. However, the respective reimbursable contracts are a bit more profitable since a smaller portion of government payments are deferred until the end. Similarly, the length of contract affects the profitability of the alternatives, but does not change their relative standing in the analysis. Table 5 on the next page shows the present values of the alternative cash flows for fixed price contracts of different durations. The effect of contract length is also described in Table 5.

Table 5. Cash Flow Comparison by Contract Length (Discounted at 10%)

Case Study Conditions	Contract Length in Years				
	1	2	3	4	5
Whole Company 100%					
1. Existing ST/STE	0	0	0	0	0
2. New ST/STE	(1,299)	(3,748)	(5,833)	(7,807)	(9,674)
3. New Contractor Assets	14,283	21,530	23,516	21,537	16,698
4. Old Contractor Assets	8,223	11,089	10,119	8,671	7,100
5. New Contractor Expenses	(1,299)	(3,748)	(5,833)	(7,807)	(9,674)
Small Contract (5%)					
1. Existing ST/STE	0	0	0	0	0
2. New ST/STE	35,295	31,688	28,599	25,686	22,940
3. New Contractor Assets	(25,195)	(46,816)	(65,274)	(80,946)	(94,165)
4. Old Contractor Assets	(22,043)	(40,743)	(56,494)	(56,566)	(56,645)
5. New Contractor Expenses	35,295	31,688	28,599	25,686	22,940

Shading and parentheses indicate negative net present value.

Case 1: No change.

Case 2: For a longer contract, end-of-contract payments are deferred longer, reducing the net present value of the cash flow. From a whole company perspective, profitability is reduced from minus $1,299 to minus $9,674 as the contract lengthens from one to five years.

Case 3: Again, longer contracts tend to reduce the net present value of payments deferred until the end of the contract. However, there is also an opposing tendency for profitability to increase as contracts lengthen. The generous facilities capital markup, based on the average book value of contractor assets, can be claimed for each contract year. This allows higher profitability for three-year contracts than for one- and two-year contracts. This effect is fairly weak for contracts longer than three years due to the depreciation of book value. Note that the facilities capital markup has a significant effect only from a whole company perspective. Note also that profitability depends much less on the residual value of the equipment for longer contracts. For a five-year contract, for example, the $16,698 present value assumes that the equipment is fully depreciated and worthless to the contractor. However, if the equipment is still valuable, the five-year contract is even more profitable than we have calculated.

Case 4: Profitability is lower than for Case 3. Also, the initial positive effect of the facilities capital markup ends sooner since the equipment is already partially depreciated at the beginning of the contract.

Case 5: The analysis here is the same as for Case 2.

The length of contract thus does not materially change the comparative analysis of the alternatives.

The discount rate used to determine net present value is another key parameter, affecting all of our calculations. The 10% rate, assumed for the study, plausibly reflects the minimum that defense contractors would demand as an after-tax rate of return on combined debt and equity capital. For purposes of comparison, however, Table 6 below presents the cash flow compari-

sons using a 5% discount rate. As should be expected, using this easier standard improves the apparent profitability of all alternatives. However, it does not change our comparative interpretation. Acquiring new STE (Case 2) is still at best marginally profitable for the company, while acquiring new assets (Case 3) remains very profitable, provided more than approximately 70% of the company's contracts receive facility capital incentives, and the residual book value of the equipment accurately indicates the equipment's value to the contractor.

Table 6. Cash Flow Comparison by Contract Length (Discounted at 5%)

Case Study Conditions	Contract Length in Years				
	1	2	3	4	5
Whole Company 100%					
1. Existing ST/STE	0	0	0	0	0
2. New ST/STE	1,730	512	(445)	(1,402)	(2,358)
3. New Contractor Assets	19,538	32,597	40,177	42,986	41,716
4. Old Contractor Assets	11,219	16,975	18,190	18,566	18,766
5. New Contractor Expenses	1,730	512	(445)	(1,402)	(2,358)
Small Contract (5%)					
1. Existing ST/STE	0	0	0	0	0
2. New ST/STE	39,510	37,700	36,248	34,804	33,369
3. New Contractor Assets	(21,642)	(41,669)	(60,165)	(77,219)	(92,914)
4. Old Contractor Assets	(20,249)	(38,918)	(56,091)	(56,072)	(56,062)
5. New Contractor Expenses	39,510	37,700	36,248	34,804	33,369

Shading and parentheses indicate negative net present value.

CONCLUSIONS

Our analysis found that it can be much more profitable for a company to acquire tooling or test equipment as ST/STE on behalf of the government than as a contractor-owned asset when prices covering no more than (roughly) 70% of a company's business adjust to reflect the acquisition.[7]

In other words, it is profitable for contracts representing less than 70% of company costs. And acquiring ST/STE appears more profitable from the perspective of a particular contract, i.e., ignoring price adjustments on other contracts, than it is to the company as a whole. In contrast, acquiring contractor-owned assets tends to be profitable when prices covering more than (roughly) 85% of a company's business adjust.[8] In this case, however, profitability may require that the equipment be worth at least its book value to the company at the end of the contract. The uncertainty of this residual book value may pose a substantial risk to the contractor.

In this case study analysis, acquiring equipment for one contract affects notional target prices for all of a company's contracts by changing overhead rates and capitalization incentives. In practice, however, prices for some contracts are not changed due to government policy, existing contract terms, or competitive conditions.

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[7] The limit may be greater than 70%, depending on the length and type of contract.

[8] The limit may be less than 85%, depending on the length and type of contract.

Appendix A.
Example and Assumptions

This appendix provides additional detail on the methodology presented in the document. The section on Target Price shows the calculation of the target price according to the weighted guidelines approach in the DFARS. The section on Change in Cash Flow illustrates the cash flows and their net present values.

Target Price

When negotiating a contract price, the DOD contracting officer calculates a target price according to the DFARS weighted guidelines approach. The target price is the sum of the following elements: Total Allowable Costs, Working Capital Adjustment, Risk Factor Profit, Facilities Capital Cost of Money, and Facilities Capital Markup. In this section, the determination of target price is illustrated for a small, fixed price, three-year contract with costs equal to 5% of total company costs.

Total Allowable Costs

Total costs include both (1) direct costs incurred for a contract and (2) indirect, overhead costs incurred by the company and allocated to the contract based on its direct costs. Table A-1 illustrates the determination of the overhead rates used for the allocation. The company is assumed to incur direct costs of $33 million per year on all its contracts. Overhead costs amount to $35 million. Overhead rates are calculated by dividing overhead by direct costs for each direct cost category. The overhead rate for general and administrative (G&A) costs is calculated by dividing G&A costs by the sum of all other costs.

The company-wide overhead rates in Table A-1 are used to allocate indirect costs to specific contracts. Table A-2 illustrates a contract with direct costs of $1.65 million per year or 5% of total company direct costs. Indirect costs are determined for each category by multiplying direct costs for the contract by the overhead rates. For a two-year contract, costs would be double those shown in Table A-1.

Working Capital Adjustment

Under a fixed price contract, the government is assumed to provide progress payments to the contractor amounting to 75% of costs as they are incurred; the remaining 25% is paid at the end of the contract. Table A-2 shows the "portion deferred" on this contract: $850,000 per year.

At the end of the contract, the government pays a working capital adjustment to offset the contractor's costs of financing the portion deferred. The working capital adjustment is based on an interest standard determined by the U.S. Treasury Department's CAS 414 rate, which is assumed to equal 6.75%. The average time that payment is deferred is represented by a contract length factor: *0.40* for 1 year; *0.65* for 2 years; *1.15* for 3 years; *1.65* for 4 years; and *2.15* for 5 years.

The working capital adjustment is calculated as the product of the portion deferred, namely, the CAS 414 rate, and the length factor. It is shown in Table A-2 as $66,000. For a reimbursable contract type, the progress payment rate is assumed at 100% of costs (and related markups) as they occur. Thus, no working capital adjustment is needed.

Table A-1. Overhead Rate and Cost of Money Factor

Categories	Direct Costs ($K)	Related OH ($K)	OH Rate (%)	Facilities Capital ($K)	FCCM Factor[1]
Direct Materials	10,000	2,000	20.0%	2,000	0.0135
Direct Engineering Labor	7,000	7,000	100.0%	2,000	0.0193
Direct Manufacturing Labor	9,000	18,000	200.0%	5,000	0.0375
Subcontracts	7,000	—	—	—	—
Subtotal	33,000	27,000	—	9,000	—
G&A	—	8,000	13.3%	1,000	0.0011
Total Costs	33,000	35,000	—	10,000	—

OH: Overhead
Notes: 1. Facilities capital cost of money (FCCM) factor equals Cost Accounting Standard (CAS) 414 rate (6.75%) multiplied by ratio of facilities capital/direct costs.

Table A-2. Annual Project Cost and Related Calculations ($K)

Categories	Costs			Portion Deferred[3]	Working Capital Adjustment[4]	Risk Factor Profit[5]	FCCM[6]
	Direct[1]	Indirect[2]	Total				
Direct Materials	500	100	600	150	11.6	—	6.8
Direct Engineering Labor	350	350	700	175	13.6	—	6.8
Direct Manufacturing Labor	450	900	1,350	338	26.2	—	16.9
Subcontracts	350	—	350	88	6.8	—	—
Subtotal	1,650	1,350	3,000	750	58.2	210	30.4
G&A	—	400	400	100	7.8		0.5
Total Costs	1,650	1,750	3,400	850	66.0	210	30.8

Notes: 1. Contract costs are assumed to be 5% of respective company costs. 2. Equals direct costs multiplied by respective overhead rates. 3. Equals portion of costs not included in progress payments (25% of total costs). 4. Equals "portion deferred" multiplied by CAS 414 rate (6.75%) multiplied by length factor (1.15). 5. Equals subtotal costs multiplied by 4% for performance risks and 3% for contract type. 6. Equals FCCM factors multiplied by respective direct costs (or multiplied by G&A costs).

Risk Factor Profit

The target price includes profit markups to reflect the contractor's risks, including risk factors for performance and for contract type. The performance risk factor is based on a number of considerations and ranges from 2% to 6% on most production contracts. In this analysis, a 4% rate is assumed. The risk factor for contract type ranges from 2% to 4% for a fixed price contract with progress payments. We assume a 3% rate. The total risk factor profit shown in Table A-2 —$210,000 per year—is determined by multiplying 7% by allowable (but excluding G&A) costs. Note

that for a fixed price contract, this markup is not eligible for progress payments but is paid only at the end.

For a reimbursable, cost plus fixed-fee contract, the contract type factor is lower because the contractor is not at risk for cost overruns and because deferred payments are minimal. The factor may range from 0% to 1%. We assume a rate of 0.5%. Progress payment rates of 100% are also assumed to apply to the risk factor markup.

Facilities Capital Cost of Money

FCCM is a payment designed to offset the contractor's cost of financing facilities investment. This payment is necessary because the government does not recognize interest as an allowable contract expense. The FCCM for a particular contract is determined by multiplying its direct costs by the company-wide FCCM factor. The company's cost of financing facilities is thus allocated to contracts in a manner analogous to the allocation of overhead costs. Note that the FCCM is eligible for progress payments.

Determination of the annual FCCM factor is illustrated in Table A-1 on page 14. As in Osband's case study, it is assumed that the company has facilities with a total book value of $10 million. The FCCM factor for each category is determined by first multiplying the CAS 414 rate by the facilities capital and then dividing the result by the corresponding direct costs (or by all non-G&A costs for the G&A FCCM factor). Table A-2 on page 14 then illustrates the determination of FCCM, which in our example amounts to $30,800 per year.

Facilities Capital Markup

The facilities capital markup is an incentive payment to encourage capital investment by the contractor. The contractor can claim this markup for each year of the contract based on the average book value of facilities capital that year. For manufacturing, the markup is 0% for land but may range from 10% to 20% for buildings and from 20% to 50% for equipment. We assume markups of 15% for buildings and 35% for equipment. The markup is eligible for progress payments on reimbursable but not on fixed-price contracts.

The amount of facilities capital used on a contract and eligible for the facilities capital markup is determined based on the FCCM calculations described previously. Implicitly, that process allocated the company's facilities capital and the CAS 414 "interest" for those facilities, to each contract based on the contract's direct costs. The total facilities allocated to a contract can be made explicit by dividing the contract's FCCM by the CAS 414 rate. As shown in Table A-3, the facilities capital for our example contract amounts to $457,000.

Facilities capital for both the company and the contract are assumed to be composed of 8% land, 34% buildings, and 58% equipment. The amount of each type of facilities capital allocated to the contract is determined by multiplying these percentages by the total facilities capital for the contract shown in Table A-3.

The facilities capital markup for each type can then be determined by multiplying facilities capital by the corresponding markup factor. In the case study example, this amounts to $116,000 per year. The facilities capital markup is eligible for progress payments on reimbursable contracts. On fixed price contracts, however, the markup is not paid until the end of the contract.

Table A-3. Facilities Capital Markup ($K)

	Share	Facilities Capital[2]	Facilities Markup Factor	Facilities Capital Markup[3]
Total Facilities Capital[1]	—	457	—	—
Land	8%	37	0%	0
Buildings	34%	155	15%	23
Equipment	58%	265	35%	93
Total	—	—	—	116

Notes: 1. Equals FCCM divided by CAS 414 rate (6.75%). 2. Equals "share" multiplied by "total facilities capital." 3. Equals "facilities capital markup" multiplied by "facilities capital."

Target Price Summary

Table A-4 summarizes the price elements discussed previously. The DOD contract officer would enter price negotiations with an $11.5 million target in mind. Of course, there is no guarantee that the final negotiated price will equal this target. As shown in Table A-4 on page 17, target markups amount to 12.4% of allowable costs

Change in Cash Flow

To evaluate the alternative approaches for acquiring test equipment, changes to the contractor's cash flow were examined under each alternative as compared with a specified base case. The base case is a contract not requiring special equipment, with target price calculated as described previously in Table A-4. To depict the contractor's cash flow, more elements must be added to the preceding discussion: initial equipment purchase, residual book value, income taxes, and net present value discounting. Each element is discussed in further detail in the following sections.

Initial Equipment Purchase

For Cases 2, 3, and 5, the contractor is assumed to purchase test equipment for $100,000 in Year 0, immediately before the contract begins. This cash outflow is illustrated in Table A-5 for Case 2, where the equipment purchased on behalf of the government is shown as a direct materials cost outflow (in the Year 0 column).[1] For Case 3, as shown in Table A-6, the purchase is shown as an investment outflow instead.

Under Case 1, the contractor uses existing government-owned STE and initial cash flow does not change. Under Case 4, the contractor assigns existing contractor-owned equipment with a book value of $60,000 to the contract. Assuming the equipment is worth that much to the contractor, its assignment is treated as a $60,000 opportunity cost investment, i.e., as a cash outflow in Year 0. Finally, under Case 5, the equipment purchase is treated as a direct materials cost, just as in Case 2.

1 Cash outflows are shown as negative amounts while cash inflows are positive.

Table A-4. Summary of Target Price ($K)

	Year 1	Year 2	Year 3	End	Total
Allowable Costs	2,550.0	2,550.0	2,550.0	2,550.0	10,200.0
Working Capital Adjustment	—	—	—	197.9	197.9
Risk Factor Profit	—	—	—	630.0	630.0
Facilities Cost of Capital	23.1	23.1	23.1	23.1	92.5
Facilities Capital Markup	—	—	—	348.0	348.0
Markup Subtotal	23.1	23.1	—	1,199.0	1,268.4
Total Contract Price ($K)	—	—	—	—	11,468.4
Total Markup Rate (%)	—	—	—	—	12.4%

Table A-5. Cash Flow Changes for Case 2

	Year 0	Year 1	Year 2	Year 3	End	Total[1]
Automatic Test Equipment	—	—	—	—	—	—
Investment	0.0	—	—	—	—	0.0
Direct Materials Cost	(100.0)	—	—	—	—	(100.0)
Residual Book Value	—	—	—	—	0.0	0.0
Allowable Costs	—	75.0	0.0	0.0	25.0	100.0
Working Capital Adjustment	—	—	—	—	1.9	1.9
Risk Factor Profit	—	—	—	—	7.0	7.0
FCCM	—	0.0	0.0	0.0	0.0	0.0
Facility Capital Markup	—	—	—	—	(0.1)	(0.1)
Income Taxes	—	(2.6)	0.0	0.0	(0.4)	(3.0)
Total Cash Flow	(100.0)	72.4	0.0	0.0	33.4	5.9
Net Present Value	(100.0)	69.0	0.0	0.0	25.1	(5.8)

Note: 1. Data as presented do not sum to totals due to rounding of the numbers.

Table A-6. Cash Flow Changes for Case 3

	Year 0	Year 1	Year 2	Year 3	End	Total
Automatic Test Equipment	—	—	—	—	—	—
Investment	(100.0)	—	—	—	—	(100.0)
Direct Materials Cost	0.0	—	—	—	—	0.0
Residual Book Value	—	—	—	—	40.0	40.0
Allowable Costs	—	15.0	15.0	15.0	15.0	60.0
Working Capital Adjustment	—	—	—	—	1.2	1.2
Risk Factor Profit	—	—	—	—	4.2	4.2
FCCM	—	4.6	3.5	2.5	3.5	14.1
Facility Capital Markup	—	—	—	—	71.7	71.7
Income Taxes	—	(11.5)	(9.0)	(6.6)	(3.9)	(31.0)
Total Cash Flow	(100.0)	8.1	9.5	10.9	131.7	60.2
Net Present Value	(100.0)	7.7	8.2	8.6	99.0	23.5

Residual Book Value

In Cases 3 and 4, contractor-owned test equipment is considered an asset in accordance with the contractor's own asset capitalization rules. The contractor charges the government for depreciation of the equipment. For Case 3, the equipment is assumed to have an initial cost of $100,000 and a five-year depreciable life. For Case 4, the equipment is worth $60,000 at the start of the contract and has a remaining depreciable life of three years. In both cases, we use a straight-line method of depreciation.

At the end of the contract, the equipment is available for the contractor to sell or use for other purposes. The equipment's book value at that time, i.e., cost minus accumulated depreciation, is used as a measure of what the equipment is worth to the contractor. The availability of the equipment is treated as a cash inflow to the contractor in the amount of the residual book value. *This is the key assumption that permits investing in equipment assets to be profitable on some of the contracts examined.*

Income Taxes

The contractor's corporate income tax payments are affected by the level and timing of cash flow for the contract. In particular, increased markups tend to increase taxes while increased depreciation tends to reduce them.[2]

The contractor's taxes are determined by a combination of two methods: (1) Under the completed contract approach, taxes are deferred until the end of the contract but a portion of expenses (assume 4%) may be deducted (from other income) as they occur rather than at the end. (2) Under the percentage of completion approach, taxes are paid on markups as contract work (and expense) occurs, even if the markups are not paid until the end. The contractor is assumed to use the completed contract approach for 10% of taxes, the maximum permitted.

Net Present Value Discounting

The net present value method is used to model how a company would evaluate a contract's cash flow. This approach recognizes that the company has profitable alternative uses for its funds and that those funds are costly. The contractor is assumed to demand a minimum 10% rate of return (after taxes) on its investments and discount future cash flows at that rate. The net present value of a future cash flow is the amount the company could put in a savings account earning 10% interest today to yield the same future cash flow. For example, an inflow of $100 after one year has a net present value today of only $90.91 since, at a 10% rate, the company could earn $9.09 in interest in one year. To receive that $100 cash inflow, the company might be willing to invest $90.91 today, but would not invest any more than that.

The contract length is divided into six-month periods for purposes of calculating net present value. That is, cash flows occur at the end of the first 6-month period for Year 1, at the end of the third 3-month period for Year 2, and so on. For a three-year contract, end-of contract cash flows occur at the end of the sixth 6-month period.[3]

Table A-5 showed a net cash flow of $5,900 for the Case 2 contract. However, the net present value of the Case 2 cash flow is shown as minus $5,800. In other words, the contractor would earn less than its minimum requirement of 10%. Table A-6 showed a net cash flow of $60,200 for Case 3. The net present value of that flow, namely, $23,500, is much lower but still positive, indicating that the contractor could earn more than the required 10%.

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2 A 34% marginal federal tax rate is assumed. State and local taxes are assumed to be G&A expenses, reimbursable on the contract.

3 We use a 6-month discount rate of 4.88% to yield an annual 10%.

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Glossary

Book Value. The amount shown in the books or in the accounts for an asset, liability, or owners' equity item. Generally used to refer to the net amount of an asset or group of assets shown in the account which records the asset and reductions, such as for depreciation, in its cost [Davidson et al. 1988, p. 903].

Cost Accounting Standard 414. An interest standard determined by the U.S. Treasury Department which is assumed here to equal 6.75%.

Capital Assets. Fixed assets used in production.

Capital Budgeting. Whole process of analyzing projects and deciding whether they should be included in the capital budget, which outlines the planned expenditures on fixed assets [Brigham 1985, p. 309].

Cost of Capital. Capital, as a necessary factor of production, has a cost. The cost of capital is generally computed as a weighted average of the various capital components, including debt, preferred stock, common stock, and retained earnings [Brigham 1985, pp. 249-251].

Discount Rate. Interest rate used to convert future payments to present values [Davidson et al. 1988, p. 909].

Depreciation. The process of allocating the cost of an asset to the periods of benefit over the depreciable life [Davidson et al. 1988, p. 905].

Expense. An outflow or other using up of assets or incurrences of liabilities (or a combination of both) during a period from delivering or producing goods, rendering services, or carrying out other activities that constitute the entity's ongoing major or central operations [FASB 1974, p. 26].

Facilities Capital. Net book value (after depreciation) of tangible and intangible assets subject to amortization and assigned to defense-related segments or divisions.

Facilities Capital Cost of Money. A payment to offset the cost of financing facilities investment.

Facilities Capital Markup. An incentive payment to encourage capital investment by the contractor

Internal Rate of Return. A capital budgeting method. The internal rate of return is that discount rate which equates the present value of a project's expected cash inflows to the present value of the project's expected costs [Brigham 1985, p. 317].

Negotiated Fixed-Price Contract. *Negotiation* means contracting through the use of either competitive or other-than-competitive proposals and discussions. Any contract awarded without using sealed bidding procedures is a negotiated contract (see FAR Part 14.101). *Fixed-price* types of contracts provide for a firm price or, in appropriate cases, an adjustable price [FAR Part 16.201].

Net Present Value. A capital budgeting method which sums the present value of each cash flow, discounted at the project's cost of capital [Brigham 1985, p. 316].

Reimbursable Cost Plus Fixed Fee Contract. A contract that provides for payment to the contractor of a negotiated fee that is fixed at the inception of the contract. The fixed fee does not vary with actual cost, but may be adjusted as a result of changes in the work to be performed under the contract. This contract type permits contracting for efforts that might otherwise present too great a risk to contractors, but it provides the contractor only a minimum incentive to control costs [FAR Part 16.306].

Straight Line Method of Depreciation. The cost of the asset, less its salvage value, is allocated in equal amounts to each year of the expected life of the asset [Salmonson et al. 1985, p. 179].

Acronyms

ATE	Automatic Test Equipment
CAS	Cost Accounting Standard
DFARS	Defense Fedveral Acquisition Regulation Supplement
DOD	Department of Defense
FCCM	Facilities Capital Cost of Money
G&A	General and Administrative
IDA	Institute for Defense Analyses
K	Thousand
ST/STE	Special Tooling/Special Test Equipment

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13. Abstract (Maximum 200 words)

DOD is considering a change in policy governing the acquisition of special tooling/special test equipment (ST/STE). An IDA study team analyzed the potential effect on contractor profits, using a case study analysis to evaluate how five alternative ST/STE policies would affect target profits. Three conclusionsv emerged from the analysis.

- First, it can be much more profitable for a company to acquire test equipment as ST and STE on behalf of the government when prices covering no more than (roughly) 70% of a company's business adjust to reflect the acquisition.
- Second, acquiring ST and STE appears more profitable from the perspective of a particular contract—that is, ignoring price adjustments on other contracts—than it is to the company as a whole.
- Third, acquiring contractor-owned assets tends to be profitable when prices covering more than (roughly) 85% of a company's business adjust. In this case, however, profitability may require that the equipment be worth at least its book value to the company at the end of the contract, which may pose a substantial risk.

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