



Volume V

Appendix G.9

Contracts, Incentives, and Safety/Technical Excellence

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**Report to CAIB:
Contracts, Incentives, and Safety /
Technical Excellence**

Submitted by: Gary Olson and Tim Foster – 27 May2003

Contracts, Financial Incentives, and Safety / Technical Excellence

Summary

NASA efforts to enhance contractor performance have resulted in complex contracts with multiple incentives. The assumptions are:

- The opportunity to increase corporate profits motivates management and workers more than devotion to astronaut safety, to program success, and to their own livelihood;
- Contractors so motivated will act always in the government's interest with minimal oversight;
- These incentives enhance NASA leverage with sole source, non-competitive, cost-reimbursement contractors.

The extensive use of incentives, particularly award fees (the principal one) detracts from technical excellence and safety. For example, they:

- Make fee dollars, not technical excellence and safety, the primary focus for program oversight and review.
- Encourage complacency through high scores, emphasis on contractor strengths, and loophole-ridden "metrics" that often stipulate tolerance for errors and lateness.
- Devalue the contributions of many by assigning relative weights to work areas.

Because the outcome of incentive fee processes has become predictable – high fees (near or above the normal limit) –NASA probably will be unable to regain leverage and avoid contractor complacency absent competition. "Conventional wisdom" in NASA presumes that only aerospace firms can manage shuttle work.

The people and facilities at NASA sites, not corporate logos, are critical to program requirements. NASA's shuttle work is based on NASA-owned technology, done for the most part at NASA-owned facilities by a workforce trained by NASA and dedicated to the facility. Department of Energy, in similar situation, has had no shortage of reputable bidders for management and operating contact work.

The U.S. Naval Nuclear Propulsion Program is evidence that a technical program of comparable complexity and risk can be managed successfully without extensive reliance on contract financial incentives and without being beholden to incumbent contractors.

Recommendation: Rather than hoping to motivate contractors to manage the NASA shuttle program through cumbersome financial incentives, NASA should:

- Develop a strong, stable, self-sufficient Shuttle Program Office of experienced, expert technical personnel capable of effective program management and oversight.
- Establish leverage over contractors by opening to competition by aerospace and non-aerospace companies what are in effect management and operating contracts.

Contract Environment

The NASA Space Shuttle Program relies predominantly on Lockheed Martin and Boeing, either as direct component suppliers or, for operations, through their joint venture creation, United Space Alliance (USA). Lockheed Martin and Boeing formed USA as a

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limited liability corporation in 1996 in response to NASA desires to consolidate work under the Space Flight Operations Contract (SFOC).¹

For SFOC and for major shuttle component work, which NASA decided not to incorporate into SFOC as originally planned, NASA has relied on sole source, non-competitive, cost-reimbursement contracts since shuttle program inception in the early 1970s. These contracts indemnify the contractors against third party claims for injury, loss of life, and property damage arising from shuttle operations. Progress payments ensure these contractors substantial, positive cash flow.² In addition, the contractors are realizing fees for this work averaging about 10% of incurred cost, the limit prescribed by the Federal Acquisition Regulation for cost-reimbursement contracts.³

Without the discipline of competition or fixed priced contracting, NASA provides multiple contract financial incentives to motivate shuttle program contractors. The theory is that since contractors are in business to make money, the best way to promote excellence is to tie fee payments to performance.

The emphasis on contract financial incentives extends beyond NASA; it tends to be government-wide. When the budget process generates fewer dollar and manpower resources than program managers request, the differences are often attributed to “inefficiencies” and lead to calls for better forms of contracting. The goal is to so effectively structure contract incentives that contractors, looking to their own financial interests, will act in the Government’s best interest with little need for oversight.

In evaluating the NASA financial incentives and possible impact on safety, the following sections discuss each contract financial incentive that NASA uses in major shuttle program contracts as they pertain to technical excellence and therefore safety.

Cost Incentive Fees

All major shuttle program contracts are, in part, cost-plus-incentive-fee contracts. From a negotiated target cost and target fee, contractors get more fee dollars if costs at completion underrun the negotiated target cost, but less fee if they overrun the negotiated target cost. The percentages of underrun and overrun sharing are defined in the contract.

Cost-plus-incentive contracts may or may not significantly motivate contractors to reduce cost, depending on the situation:

- In the case of the reusable solid rocket motor contract, NASA program managers became concerned that the contract provisions overly motivated contractor management to reduce personnel, potentially to the program’s detriment. NASA officials, therefore, eliminated the contract underrun sharing provision.⁴
- Cost incentives, on the other hand, can equally motivate contractors to negotiate higher target costs and higher prices for contract changes, or to submit claims for contract price adjustments in the case of potential overruns.

¹ Boeing and Lockheed Martin each put up \$1M to form USA. They appoint top USA management and share profits 50/50.

² Contractor billings, submitted every two weeks and paid within seven days, include incurred costs, accrued costs, and provisional fees.

³ FAR 15.903

⁴ NASA and the contractor agreed to redirect the equivalent fee potential to other areas.

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- For repetitive, non-competitive contracts, a contractor might conclude that the long-term benefits of sustaining a high cost base for future contract negotiations outweigh the near-term advantages of driving down costs.

Determining whether these cost incentive contract provisions actually save money is difficult. However, to outsiders they seem to satisfy the feeling that contractors that spend less should get more fee.

On the plus side, cost-plus-incentive-fee provisions generate little, if any, additional effort or distraction for workforce or management. Beyond a possible tendency towards more aggressive contract price negotiations, these provisions should involve little, if any, additional administrative effort beyond that required for any other cost reimbursement contract; i.e., Government validation of costs incurred.

Conclusion – Cost Incentive Fees

Regardless of the extent to which they may or may not actually reduce costs, cost incentives as used in major shuttle program contracts do not seem likely to detract significantly from technical excellence and safety.

Performance Incentive Fees

Performance incentive arrangements pay fixed sums for meeting prescribed program milestones and impose penalties for failure to meet selected milestones. Performance-based contracting is not uniquely a NASA concept. Rather, the approach arose government-wide as a way to motivate contractors.

NASA policy ties performance incentive fees to objective milestones, either schedular or successful completion of specific tasks or events; e.g., delivery of a product, successful launch, or successful flight. Since successful completion often demonstrates safe operation, these performance standards also fall into the category of safety incentives.

These performance incentive fees are “all-or-nothing” payments. A contractor either earns the performance fee for that event or gets nothing – or may have to pay a penalty.

Whether tying fee payments to performance milestones provides any additional motivation to workers and management is not clear. These performance incentives did not preclude USA from missing milestones that resulted in fee forfeiture of from \$1M to \$3M each on five different occasions. Moreover, shuttle program managers note that contractor / customer relations become more contentious when a contractor might miss an incentivized milestone. In such situations, fee forfeiture can be avoided if the contractor can successfully blame the delay on others.

Whether or not these performance incentives provide added incentive, administration of performance-incentive-fee contract provisions does not seem to impose substantial additional workload on management and workers. The contract milestones tend to be ones that would be the focus of any effective program management system.

Conclusion—Performance Incentive Fees

There appears to be little evidence, one way or the other, that performance incentive fees enhance shuttle program contractor performance. However, they seem to pose little risk of burdening or distracting technical effort from primary functions beyond the possibility of inserting contractor financial and contract specialists more deeply into technical and production work.

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Award fees

Background

In addition to having cost-plus-incentive-fee provisions, all major shuttle program contracts also have cost-plus-award-fee provisions. This means that every six months a performance evaluation board subjectively evaluates contractor performance, assigns a numeric performance grade, and recommends to a fee-determining official an award fee as a percentage of available fee assigned for that period.

Award Fee Process and Scoring

The purpose of the award fee is to make contractors more responsive to customer needs. Since contractors are in business to make money, the theory is people who actually manage and execute the work can best be motivated if they see a connection between their work and corporate profits. According to NASA policy, the award fee process is designed to promote "... more effective communications among Government and contractor personnel, at management levels where decisions can be made and results achieved."⁵

The award fee process seems inevitably to result in high scores and realized fee levels near or above the normal 10 percent maximum limit for cost reimbursement contracts.⁶ The question is whether the high scores actually reflect exceptional performance across the board or are they largely a predictable outcome. Also, if the performance is as good as indicated, should the success be attributed primarily to the award fee process?

NASA policy specifies a contractor that satisfactorily meets contractual commitments will fall into the "good" range (score: 71-80). However, overall ratings for shuttle program contractors tend always to fall in the mid-80s to low-90s on a scale of 100. For the period preceding the Columbia accident, all major shuttle program contractors rated "excellent", which NASA policy defines as "exceptional performance".

The complexity of the performance evaluation process varies by contract. For SFOC, NASA contract monitors, called Technical Manufacturing Representatives, assess contractor strengths and weaknesses against nearly 400 elements grouped within thirteen functional areas. Some eighty of these elements are stated in the SFOC along with measures of performance, referred to as "metrics", for each one.

Each monitor assigns a numerical grade for his or her area of oversight. These scores, after weighting for relative importance and budget significance, determine the recommended overall contractor performance rating. Interestingly, the grades assigned by three of the twelve monitors determine 75 percent of the proposed SFOC award fee score.

For major shuttle program contracts other than SFOC, NASA managers also list strengths and weaknesses, and assign weights to perhaps a dozen areas of performance. However, the award-fee provisions are much simpler than the elaborate process followed in the SFOC. In essence, program managers for these contracts are not so constrained by metrics in arriving at their subjective evaluations of contractor performance.

⁵ NASA *Award Fee Contracting Guide* section 3.7.1

⁶ Under the Federal Acquisition Regulation, NASA may approve individual and class deviations from this limit.

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The award fee process, occurring every six months with interim assessments at the midpoint, seems to have become the principal forum for reviewing work. But the process differs from more traditional reviews in that issues are translated into fee dollars.

To reduce performance evaluation to a score, the award fee process compares contractor strengths and weaknesses. This balancing of good with bad might be useful for rationalizing performance scores, but is of little value in accomplishing work. In the absence of these incentives, traditional reviews would emphasize problems, potential problems, actions needed on critical path items, and areas that need management attention.

Overall performance scores vary within a relatively small range from period to period.

There are reasons, aside from possible performance, why ratings tend to be much higher than “good”.

- NASA policy encourages high awards, stating: “...an award fee contract should provide the contractor with a reasonable opportunity to earn the maximum award fee available”.
- The NASA managers who have day-to-day responsibility for each area assign grades for contractor performance in that area. Poor contractor grades might reflect adversely on their own performance.
- Poor contractor performance scores could strengthen the hand of program critics and jeopardize program support for the budget arena.
- When contractors respond to a customer-identified area of emphasis, performance evaluators may feel obliged to increase the score, which over time can lead to rising grades.
- Higher grades are less subject to contractor rebuttal in front of the performance evaluation board.

Corporate Profit Maximization Is Not The Best Focus and Motivator for Those Who Actually Do the Work

The risk with award fees is that both customers and contractors begin focusing on the award fee process rather than on the work itself.

It is hard to imagine that, for all those involved in shuttle program work, the prospect of influencing in some small way corporate profits could surpass the incentives inherent in the work itself. They are contributing to a nationally recognized, prestigious program the fate of which (not to mention their own livelihood) depends upon public confidence and safety. The importance of their work to the safety of the astronauts they see working around them is certainly well recognized and to suggest the opportunity to earn the company a little extra fee would enhance their concern would be to do them a great disservice.

NASA policy requires grading based on evaluation factors weighted as to relative importance. This is not conducive to technical excellence. For example, does it promote technical excellence to assign, as NASA has in the SFOC, a 20 percent weight factor to “Operational Safety”, which includes industrial safety? Or, does it inspire technical excellence to assign “Quality” the same 15 percent weighting as contractor performance in awarding contracts to small, minority, or disadvantaged business?

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In a similar vein, the SFOC, as previously noted, defines more than 80 performance elements with associated “metrics”, the apparent result of a procurement initiative to demonstrate commitment to performance-based contracting. From a practical standpoint, the metrics run counter to the pursuit of excellence.

Many of the contract metrics stipulate customer tolerance for errors or lateness. Others include loopholes that render them largely irrelevant. The following are examples of “expected” levels of performance. The contract also identifies for many items an even lower level of acceptable performance called maximum error rate.

- **Safety, Mission Assurance, and Product Assurance:**
 - “Expectation: 85% of risk packages presented to the Government are accepted.”
 - “Expectation: 85% of items correctly assessed as no increased risk validated through use, Government audit, or Government surveillance.”
 - “Expectation: 15 mishaps per year.” (“Mishaps” are injury to non-SFOC contractor personnel or damage to NASA property by accidents / incidents during processing.)
- **Quality Assurance:** “Expectation: 95% of all mandatory Government inspections are accepted.... Success rate of SFOC work volume greater than 90%.”
- **Orbiter Logistics:** “Expectation: 96% of all reparable Orbiter hardware requirements satisfied by the negotiated need dates.”
- **Backup Flight System (and Pass Flight Software):** “Slips or redelivery caused by BFS not meeting negotiated schedules or due to a redelivery to correct an error are allowed if no additional resource impact to outside organizations is incurred.”
- **Launch Readiness:** “Expectation: 97% of all items on the initial launch countdown constraints list completed and closed prior to Launch Countdown Call-to-Stations.”
- **Engineering, Maintenance, and Operations Support for Flight Operations System:** “Expectation: 5% late, but in no case impact safety, mission success, or major program schedule milestones.”

Finally, the award fee process tends to result in making engineering and other technical personnel more accountable to financial and contracting people whose job is to try to win as large an award fee as possible. The rewards for portraying contractor performance in its best light are inconsistent with prompt and candid problem reporting and performance self-assessment, which is vital to successful management of complex technical programs.

Conclusions -- Award-fee contracts:

Continued reliance on award-fee provisions would significantly detract from emphasis on technical substance and problem resolution. An environment that, in effect, tries to make engineers and technical people their own corporate profit centers is not conducive to technical excellence.

Other Contract Financial Incentives

Major shuttle program contracts include other, less significant, financial incentives. These include:

- “Performance Plus” incentives. These are relatively small amounts program managers are able to use at their discretion to focus contractor attention on near-term actions.

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- “Value Engineering” incentives. These are standard government contract provisions designed to encourage contractors to recommend cost-saving modifications to specification requirements. If accepted by the government, the contractor shares in the estimated savings.
- “Employee Incentives”. USA, for example, makes a flat payment to all non-supervisory employees each year depending on USA success in earning award fee. NASA, however, is not involved in these incentive payments except that NASA, not USA, bears the full cost of this program.

Conclusion – Other Contract Financial Incentives.

Whether or not these incentives are effective, they seem to impose little or no additional effort or adverse impact on those who perform the work. The Program Plus incentive, however, further reinforces the notion that the customer, in effect, must “tip” the contractor to get its work done.

Fee Reduction for Catastrophic Loss.

The most prominent, safety-related contract financial incentive in all current major shuttle program contracts is a clause entitled “Fee Reduction for Catastrophic Loss”.

As explained earlier, the government indemnifies shuttle program contractors from liability for such loss, whether loss of life, damage to government property, or other third party liability. The Catastrophic Loss clause, however, allows NASA to reduce contractor fee by a prescribed amount if NASA determines that the accident was due to that contractor’s actions or failure to act.⁷ The clause requires the NASA finding to be based on an accident board’s finding.

Interestingly, only the most recent external tank contract contains the Catastrophic Loss clause. The contract under which Lockheed Martin delivered the external tank used on the last Columbia flight has no such clause.⁸

From a practical standpoint, the Catastrophic Loss clause – or any other clause of that sort, regardless of amount – is unlikely to enhance contractor management or workforce attention to safety. Even at \$10M or more in forfeited fees, the damage to the corporate image due to loss of life and technical failure in such a highly visible program would be incomparably greater. Nor is there reason to believe the clause would stimulate managers and workers to apply higher standards than they would otherwise apply. Their connection to the program, to the astronauts, and to their own jobs is no doubt stronger than their devotion to corporate finance.

Conclusion – Catastrophic Accident Penalty.

The effect of the Catastrophic Accident clause on contract performance seems minimal – certainly not negative. However, having the provision is helpful to demonstrate a measure of recompense where a contractor is responsible. This provision, which

⁷ The SFOC specifies no fee for the six-month period in which the accident occurred. The most recent external tank contract stipulates a \$10M penalty. The Space Shuttle Main Engine and Reuseable Solid Rocket Motor contracts specify a \$10M penalty and forfeiture of all fees for the six-month period in which the accident occurred.

⁸ According to NASA officials, Lockheed Martin was unwilling to accept the clause without a corresponding increase in contract fee.

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predetermines the forfeiture amount, is preferable to leaving the question open for possible litigation.

Overall Conclusion

NASA relies very extensively on contract financial incentives to motivate major shuttle program contractors. There is no evidence these contract provisions directly contributed to the Columbia accident. Nor is there evidence they actually motivate contractors and enhance excellence.

To the extent financial incentives might help focus additional attention on cost reduction and key milestones, they can be positive. If instead financial incentives encourage contractor personnel to try to game the system by initially inflating contract prices or by setting the stage constantly to be able to blame others for missed milestones, they can be counterproductive. Overall, however, the cost incentive and performance incentive processes demand little, if any, additional effort or distraction on the part of those actually doing the work. The cost incentive is based on incurred costs; the performance incentives on events or tasks most likely to be tracked in any event.

In contrast to the cost and performance incentives, the contract award fee provisions are cumbersome and counterproductive.

- The award fee process in practice results almost inevitably in high grades and near maximum fees for major shuttle program contractors. These high grades, together with an award fee process that emphasizes contractor strengths as well as weaknesses, can encourage complacency.
- The assignment of relative weights to elements of contract performance based on several factors, including budget share, although required for award fee purposes, can do more harm than good. It tends to diminish the importance of the contributions that all must make in contract execution.
- The award fee process now seems to be the primary forum for program oversight and review. That this forum must translate technical and production issues into fee dollars sends a message that money, not technical excellence, is the important objective.
- The “metrics”, which the NASA procurement community apparently required to be included in SFOC, tend to undermine excellence, not encourage it. The standards are filled with loopholes that make many of them useless. They concede customer tolerance for errors and late deliveries.

The Catastrophic Loss contract provision bears most directly on safety by prescribing that a contractor must forfeit \$10M or more in cases where NASA determines that contractor is responsible for the accident. However, that management and the workforce would view this forfeiture of corporate fee as a more powerful incentive for safety than their inherent commitment to the safety of the astronauts, to the well being of the program, and their own livelihoods is unlikely.

Overall, the extensive use of contract financial incentives in the space shuttle program seems more a reaction to government-wide procurement policies than something NASA managers invented as an important program management tool. The award fee structure in the SFOC seems to have been primarily the work of procurement personnel, not technical program managers.

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In a budget-constrained environment and under pressure to reduce its federal payrolls, NASA contracting efforts focus on trying to structure incentives so effective that the contractor, pursuing its own financial interests, will automatically work to the government's benefit – with limited NASA oversight. Consequently, management attention on both sides tends to focus on dollars vice technical excellence. Financial incentives are no substitute for oversight by experienced, expert technical customer representatives. To this end, NASA should ensure that the Space Shuttle Program Office becomes a strong, stable, and self-sufficient entity capable of performing that function.

Contract financial incentives, such as NASA uses for shuttle program work, are not the only path to technical excellence and safety. NASA's Administrator has characterized the highly successful Naval Nuclear Propulsion Program as perhaps the most similar to NASA's space shuttle program in terms of engineering challenge. Both must apply complex and demanding technologies in a hostile environment with the lives of crewmembers as well as National interests at stake. The Naval Nuclear Propulsion Program, however, goes about the task much differently insofar as contracting.

The Naval Nuclear Propulsion Program avoids financial incentives in contracts with its major prime contractors – opting instead for close oversight by relatively small, but technically competent, headquarters and field organizations. Naval Nuclear Propulsion Program prime contractors operate under low-fee, cost-plus-fixed-fee contracts that include no contract financial incentives.

The theory behind this approach is that the best way to sustain an environment conducive to technical excellence and objectivity is to free those doing the work from corporate pressures to maximize profits. Program decisions with respect to assigning work and whether to extend or re-compete management and operating contracts provide ample business leverage to ensure contractor responsiveness to program needs. NASA, in efforts to focus more clearly on technical substance, might be well advised to consider the Naval Nuclear Propulsion Program approach.

With nearly 30 years of cost-plus-award-fee contracting tradition for major shuttle program work, incumbent contractors have no doubt become accustomed to high profit, no-risk, no investment, and generous cash flow associated with these contracts. With this background, effecting any substantive change in contracting approach through sole source negotiations with incumbent contractors may be impossible.

Should NASA consider significant change, it should reevaluate “conventional NASA wisdom” that only aerospace firms are candidates to compete for what in most cases amounts to management and operating contracts similar to the contracts the Department of Energy uses for nuclear weapons and naval nuclear propulsion work. As with the Department of Energy, to a large extent, critical NASA resources are government-financed technology, government-owned facilities, and workforces largely acquired, trained, and supported for decades at government expense.

NASA has historically concluded that only aerospace firms can be considered for NASA shuttle program work – a conclusion most recently reinforced by the NASA Space Shuttle Competitive Sourcing Task Force study published last fall. In contrast, the Department of Energy solicits competitive bids for management and operating contracts with the result that nationally known construction firms, component manufacturers, non profit institutions, universities, and even aerospace firms regularly vie for the work at a fraction of the fee NASA pays for these services. If they can design nuclear weapons and

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naval nuclear propulsion plants for the Department of Energy – why cannot NASA overcome its attachment to the aerospace industry to seek management and operating support from a broader base?

The transition of SFOC work to USA demonstrated that change of operating contractors at NASA -sites could be effected with minimum impact without adverse effect on personnel retention or on pensions. Under the circumstances, no valid reason seems to exist beyond tradition that NASA should remain principally beholden to two contractors, or to the aerospace industry, for work at NASA sites. Department of Energy experience suggests no shortage of firms willing to assume responsibility for managing and operating complex work at its government sites.

The challenge to NASA in effecting significant change may be less formidable once the agency realizes that the people and facilities at NASA sites, not corporate logos, are critical to program requirements.