AD-750 849

A STUDY OF THE F-15 CONTRACT STRUCTURE AND ITS CONTRIBUTION TO EFFECTIVE PROGRAM MANAGEMENT

Gerald A. Christenson, et al

Air Force Institute of Technology
Wright Patterson Air Force Base, Ohio

15 September 1972

A STUDY OF THE F-15 CONTRACT STRUCTURE AND ITS CONTRIBUTION TO EFFECTIVE PROGRAM MANAGEMENT

Capt. G. A. Christenson
and
Capt. J. C. Horne

SLSR-27-72B

UNITED STATES AIR FORCE

AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

R
172

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
Air Force Institute of Technology
School of Systems and Logistics

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
A Study of the F-15 Contract Structure and its Contribution to Effective Program Management

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Thesis

5. AUTHOR(S) (First name, middle initial, last name)
G. A. Christenson(Captain, USAF) and James G. Horne (Captain, USAF)

6. REPORT DATE
15 September 1972

7a. TOTAL NO. OF PAGES
172

7b. NO. OF REFS
58

8a. CONTRACT OR GRANT NO.

b. PROJECT NO.

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
SLSR-27-72B

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT
Publish and distribute under Provisions of Statement A, unlimited distribution. (DDC,AFR 80-45)

11. SUPPLEMENTARY NOTES
Cleared for public release IAW AFR 190-17.

12. SPONSORING MILITARY ACTIVITY
JERRY C. HIX, Capt, USAF
Director of Information

13. ABSTRACT

Government contracting personnel have had a history of accepting a procurement procedure which appeared to be successful in past programs and erroneously applying those same procedures to new and different programs. The F-15 contract contains some new and some uniquely applied standard contract clauses. These clauses were described, analyzed, and presented independently in the thesis. After the independent study of the clauses, a summary of the interrelatedness of these clauses was presented. The authors' interpretation of what external factors influenced the F-15 contract and how the F-15 contract philosophy evolved are also presented. The authors have made recommendations which apply to the future use of the F-15 contract clauses.

KEY WORDS:

Contract Definition
Contract Management
F-15 Acquisition
Government (DOD) Contracting
Procurement
Weapon System Acquisition

DD Form 1473

I

Unclassified
Security Classification

SLSR-27-72B

A STUDY OF THE F-15 CONTRACT STRUCTURE AND ITS CONTRIBUTION TO EFFECTIVE PROGRAM MANAGEMENT

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Gerald A. Christenson, B.S.
Captain, USAF

James C. Horne, B.S.
Captain, USAF

September 15, 1972

III.

This thesis, written by

Captain Gerald A. Christenson

and

Captain James C. Horne

and approved in an oral examination, has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

Date: 15 September 1972

William O. Baker
Committee Chairman

ACKNOWLEDGMENTS

The authors wish to acknowledge Major General Benjamin N. Bellis, F-15 Program Director. Although the authors have neither met nor worked for General Bellis, the high degree of motivation, loyalty and esprit de corps consistently displayed by all personnel within the System Program Office during the period of thesis research clearly indicated that an exceptional manager was at the helm.

A special debt of gratitude is owed to Mr. Don Robinson, Captain Art Charles and Captain Roy Mase, Contracts Branch of the F-15 SPO. This thesis would not have been possible without the special assistance in obtaining information granted by these individuals.

Sincere appreciation is extended to Major William Patzig who guided the authors to a successful thesis completion.

Last, but by no means least, a warm thanks to our wives, [redacted] for their patience, moral support, and direct assistance associated with completing this thesis.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

PROBLEM

Problem Statement

Evidence made available from the F-15 Systems Program Office (SPO) indicated that factions within the procurement community have been willing to accept the F-15 contract and the F-15 management program as a successful format to be followed in other major weapon system acquisitions.[1] This infers that portions of the F-15 program have already been deemed a procurement success by these factions and that they are willing to expend funds based upon the foundation of applied principles within the F-15 SPO. Should the F-15 contract structure and management programs be adopted by other program directors without careful adaptation, grave errors could possibly occur.

Background

The Government procurement arena is one which is

---

[1]Captain Arthur R. Charles, USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS). F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Personal interviews, November 17, 1971, December 23, 1971 and July 29, 1972.

typified by change.[2] Many different procurement policies and procedures have been developed through the years and applied to the procurement of major weapons systems.[3]

Procurement policy has fluctuated a great deal within the Department of Defense in the years since World War I when cost plus percentage of cost and cost plus fixed fee contracts were popular.[4]

Negotiated contracts were the preferred acquisition tools in the years during and immediately following WWII. Legislation was passed which allowed negotiated contracting but stipulated that formal advertising should be employed whenever possible. The eventual passage of the Armed Forces Procurement Act of 1947 was a significant landmark in the history of government procurement legislation because it provided for seventeen exceptions to the advertised procurement doctrine.[5]

Title II of the First War Powers Act, which gave defense secretaries added latitude in procurement procedures during wartime, was extended beyond WWII and was used extensively during the Korean conflict. The Title II provisions were

---

[2]F. Trowbridge von Baur, "Fifty Years of Government Contract Law," Federal Bar Journal, p. 305.

[3]Edward Cox and C. C. Jarrett, Historical Development of Procurement Methods, Office of Assistant Secretary of Defense, Washington, D. C., pp. 1-44.

[4]F. Trowbridge von Baur, p. 305.

[5]Ibid., p. 328-32.

extended and re-extended by Congress through 1958.[6]

In 1961 under Secretary of Defense McNamara, the philosophy of shifting as much risk as possible onto the contractor was nurtured. This philosophy was converted to firm guidelines which were outlined in the Armed Services Procurement Regulations (ASPR).[7] This shift in risk policy carried with it an implied willingness to compensate the contractor for the assumption of risks. However, the trend was to shift the risk and to drive prices down. This occured because of increased competition and the reversion to fixed price contracts for formally advertised procurements. It became apparent that these policies were too stringent and that the DOD would have to make other changes which would provide contractors with profits comensurate with the assumed risks.[8]

The current procurement policy must be recognized as the marriage partner of the changing management philosophy within DOD. While DOD is striving to equitably distribute the risk in contracting, it is, at the same time, establishing management systems which allow higher visibility of

---

[6]Ibid., p. 333.

[7]U. S. Department of Defense, Armed Services Procurement Regulation, Section 3-908, Washington D. C.: Government Printing Office, January 1, 1969, P360.3.

[8]Claude Witze, "Declining Defense Profits--Government Economy, or a National Security Risk," Air Force, April 1968, p. 131.

statistics and well defined positions of responsibility. It has been recognized that an essential element of program success is the early determination and definition of the risks to be assumed by the contractor as well as those to be assumed by the Government.[9]

Current acquisition contracts are being structured in accordance with the above philosophy. The F-15 and Airborne Warning and Control System (AWACS) programs both have cost plus incentive fee type contracts for system development and fixed price incentive successive target type contracts for the actual production. This tends to actually tailor the contract to the degree of risk involved as time passes and programs progress.[10]

The danger involved with current policy is linked to the tendency to adopt a procedure which has been successful in one program, codify it into law or regulation, and apply that procedure directly to other programs without proper adaptation. Conversely, when a policy or procedure appears to have been unsuccessful within a particular program, the technique is dropped or banned from the inventory of accepted procurement practices.

---

[9]Hudson B. Drake, "Major DOD Procurements at War With Reality," Harvard Business Review, January-February 1970, p. 125.

[10]U.S. Department of Defense and National Security Industrial Association, Symposium Proceedings on Major Defense System Acquisition, Washington D.C., August 11-12, 1971, p. 134.

It appears as though too little consideration has been given to the events leading to success or failure of a technique or policy. The tendency is to reject a technique that has failed and to endorse those that succeed--even though the techniques may have been limited to use in only one or two programs.

Contact with F-15 SPO personnel has revealed a concern that the practices outlined above may be repeated using contracting and management techniques currently incorporated within that SPO without being tailored to each specific program.[11]

Effective program management is dependent upon a myriad of factors. The vast majority of these factors may be aligned under five major categories:

1. The adequacy and currency of procurement policies.
2. The decentralization of authority and visibility of program directors.
3. The proper staffing and management (internal and external) of the SPO.
4. A responsive contractor-DOD relationship.
5. A well structured contract.

---

[11]Charles interview.

This thesis has dealt primarily with the last category--a well structured contract. It must be recognized that an inter-relationship of the five categories does exist. All should be present for maximum effectiveness to be achieved. Within this thesis a special emphasis has been placed upon those contractual clauses which are "unique" to the F-15 program. Some of the clauses are unique only with respect to their application in this contract while others have never before been applied to weapon system acquisitions.

Specifically this thesis has dealt with the basic F-15 contract, F33657-70-C-300 for the F-15 System Support Services and Data. This contract is between the U. S. Government and McDonnell Aircraft Company (MCAIR) of the McDonnell-Douglas Corporation. The contract award date was December 31, 1969. This thesis has also dealt with supplemental agreements and documents related to the basic contract where it was essential to the development of a particular topic.

This thesis did not address itself to the contracts between the Government and other contractors for the major assemblies for the F-15, such as Pratt-Whitney for the engines and Hughes Aircraft Co. for the radar. These contracts are considered outside the scope of this thesis.

CHAPTER II

OBJECTIVES

The contract for a major weapon system is an enigma to most people both inside and outside the Department of Defense. It is understood only by a comparatively small group of individuals who formulate, structure, write, administer, and modify the contract through its life cycle. Those individuals outside the contract administration profession who do refer to the contract are often staggered by the voluminous provisions which are required by the Armed Services Procurement Regulations (ASPR).

The first objective of this thesis was to:

> Describe the new or unique clauses contained within the F-15 contract, and compare these clauses with those of other programs and the requirements of the ASPR.

The emphasis has been on the contract provisions which addressed themselves specifically to the F-15 program and not the general provisions or "boiler plate" clauses required by ASPR. The description and comparison of these clauses should aid in bridging the gap between the professional contract administrator and those outside the profession who have an interest in the F-15 program.

The second objective of the thesis was to:

> Analyze whether these selected contract clauses have contributed to effective program management.

In formulating the second objective, the contract was viewed as an abstract model of DOD management philosophy. The influence of the contract clauses on program effectiveness as they were implemented was our focal point in structuring the second objective.

The third and final objective was to:

> Determine the feasibility of applying these contract clauses to other programs.

Should the Milestone Procurement Concept as implemented in the F-15 program[1] be applied to other programs? If so, to what extent should it be applied?

The third objective of this thesis has been to answer, in total or in part, the question of applying F-15 contract clauses to other acquisition contracts. The clauses determined to be of special significance and in consonance with the objectives of this thesis were:

Multiple Incentive Structure Contract Item 1.

Multiple Incentive Structure Contract Item 2 and 3.

Target Profit

---

[1]Lt. Col. Delbert H. Strube, "Milestone Procurement," The Review (Defense Supply Association), Sept.-Oct.,1970, p. 98.

Award Fee

Demonstration Milestones

Limitation of Government Obligation

Separation of Costs

Cost Schedule Control System Criteria

Current Pricing Data

Engineering Change Proposals

Dollar Limitation Clause

Parametric Pricing

Value Engineering Clauses

A number of these clauses fit into homogeneous categories which were collectively analyzed in the same chapter. It was found that these clauses were too dependent and interrelated to treat separately.

The resultant categories and functional areas to which the research was directed were:

Development Incentive Structure Contract Item 1

Production Incentive Structure Contract Item 2 and 3

Profit Objectives

Demonstration Milestones

Limitation of Government Obligation

Cost Control

Change Control

Parametric Pricing

Value Engineering Clauses

The format of Chapters VI through XII, which cover the above contract clauses was structured in such a manner that the research questions were answered within each chapter. Addressing the research questions within each chapter permitted a streamlining of presentation or research findings and continuity of homogeneous factors.

The general format followed in Chapters VI through XII was:

1. A description of the specific F-15 contract clause and a comparison of that clause to the present ASPR required clauses.

2. An analysis of the development of the clause.

3. An analysis of how the clause is presently functioning and contributing to cost, schedule and technical conformance standards.

4. An analysis of the feasibility of applying the clause to follow-on programs.

CHAPTER III

RESEARCH QUESTIONS AND METHODOLOGY

Research Questions

In order to accomplish the stated objectives, this research effort has addressed itself to answering the following research questions:

1. What unique F-15 clauses exist and what are the purposes of each? Why are they needed?

2. Have these clauses contributed to the success of the F-15 Program.[1]

3. Should these clauses be incorporated into other programs?

Methodology

Extensive, indepth, longitudinal interviews and intensive investigations of available contract documentation

---

[1]Success is defined here in terms of cost, schedule and performance criteria. It is not the authors' intent to prejudge the entire F-15 program as being successful.

and related information were the principal methodological approaches used to collect and analyze the data upon which the conclusions and recommendations in this study are based.

Personal interviews were conducted with both Government and industry representatives. The former group consisted of policy makers, Procurement and Production Directorate managers technical specialists, negotiators, and contracting officers. Individuals of McDonnell Aircraft Company were also interviewed. The basic interview guide used is shown as Appendix A.

The basic contract and supplements along with the contract files located in the F-15 Procurement Office were valuable sources of information for answering research questions one and two.

In order to develop the broadest possible base from which to answer research question number three, a search was made for pertinent material from the Defense Documentation Center, Logistics Studies Information Exchange, Air Force Institute of Technology and the Air Force Logistics Command libraries.

It is important that the reader be cognizant of the fact that all data used in the formulation of this thesis was gathered prior to 31 July 1972. It was necessary for the authors to establish this cut-off date for data inputs based upon scholastic schedule time constraints.

CHAPTER IV

F-15 PROGRAM OVERVIEW

The F-15 development contract award was the result of an intensive DOD study and analysis of the proposals submitted by three major competitors. North American Rockwell, Fairchild-Hiller and McDonnell-Douglas all competed for the F-15 contract with McDonnell-Douglas finally receiving the contract award in December of 1969.

McDonnell-Douglas began work on internal concepts and designs for an air superiority fighter as early as 1961.[1] Many of these early concepts were incorporated into the final proposal submitted to the Air Force in December of 1968. It is important to note that it is a common practice of aircraft companies to maintain a small scale research effort on a continuing basis even though no immediate DOD contract requirement is pending. It is the authors' conjecture that the early and continuing research conducted by McDonnell-Douglas gave that company a significant headstart toward the F-15 proposal which they ultimately submitted.

Developing a proposal for a new weapon system is no

---

[1]McDonnell-Douglas Spirit, October, 1971, p. 5.

small task. The final proposal submitted by McDonnell-Douglas was 37,500 pages in length and was bound in 308 separate volumes.[2] It would be virtually impossible for any company to generate such a copious work between the time that the Air Force initiated the Request For Proposals and the proposal due date unless a great deal of data already existed within the company's library.

The contract awarded to McDonnell-Douglas was structured to include three major items. Item 1 provisions are subject to the cost plus incentive fee clauses. Items 2 and 3 are subject to the clause entitled "Incentive Price Revision (Successive Targets)" which simply means a fixed price contract with periodic resets of the target prices. The major sections within each item are:[3]

A. Item 1:

1. Design
2. Development (Airframe)
3. Engineering
4. Testing
   a. Category I Tests
   b. Contractor efforts in Category II Tests
5. Development
   a. Simulation
   b. Mock-ups

---

[2]Ibid., p. 6.

[3]U.S. Department of Defense, "Acquisition Contract (Phase II) for F-15 Systems Support Service and Data Therefor," Contract F33657-70-0300, Dec. 31, 1969, p. 25-30.

B. Item 2:

1. Test aircraft (20 total)
2. Spares and AGE to support flight tests
3. Training equipment (initial)

C. Item 3:

1. Production aircraft (107 initially)
2. Training equipment (final)

Items 4 and 5 deal with the provisioned spares and AGE and are the subject of a thesis by Captains Robert L. Jones and Robert S. Darden entitled, "Determination of Effective Procedures for Provisioning of the F-15 Weapon System." Since this thesis has not given special consideration to the provisioning aspects of the acquisition contract, the reader is encouraged to refer to the above cited thesis for information concerning spares and aerospace ground equipment (AGE).

In addition to an eight per cent of target cost profit, the cost plus incentive fee portion of the contract provides for a maximum incentive fee of $2 million to be spread over a five year period. Incremental awards of up to $400,000 may be granted yearly. These awards are not cumulative - the contractor must earn the entire $400,000 within the period under consideration. Any portion of the $400,000 that is not awarded to the contractor for a particular period may not be awarded to him during a following period (year).

The amount of the award fee is determined by an evaluation board made up of members from DOD and the F-15 SPO.

The performance categories which were considered during the first year evaluation proceedings were:

A. Systems management

B. Weight control

C. Logistics management

D. Cost-schedule control system criteria

E. Management of Category I testing

F. Management of operational requirements

G. Management of training requirements

H. Configuration management

An award of $320,000 was granted to McDonnell-Douglas based upon the board's evaluation of the company's performance during the first full year of contract execution.[4] This award determination is final and not subject to negotiation. The board's findings and evaluations were summarized and furnished to the president of MCAIR by the Assistant Secretary of the Air Force for Installations and Logistics.

Although the F-15 program was already underway when the results of the Fitzhugh Blue Ribbon Defense Panel were presented in 1970, it is interesting to note how the F-15 Program Management Organization closely parallels the recommendations made by that panel. The Deputy Secretary of

---

[4]Captain Arthur R. Charles, USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS). F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Personal interviews, November 17, 1971, December 23, 1971 and July 29, 1972.

Defense, the Honorable David Packard formalized the Blue Ribbon Panel recommendations in a memorandum to the heads of all appropriate offices within the Department of Defense hierarchy in May of 1970. This memorandum is presented in total as Appendix B to this thesis as it is extremely pertinent to what is now considered to be "current procurement policy". The similarily between the procedures being followed in the F-15 program and those outlined in Mr. Packard's memorandum lead one to believe that there was a very close coordination between the Blue Ribbon Committee and DOD directors during the actual examination of acquisition processes and that at least some of the recommendations were implemented prior to their formal presentation in 1970.

The authors further believe that it is necessary to inject the feeling that has been expressed by a member of the defense industry which touches on the current DOD contracting policy as well as the demonstration milestone programs. The following statement was issued by Mr. Thomas L. Phillips, President, Raytheon Company as an industry response to military and DOD presentations at the Department of Defense/ National Security Association Symposium Proceedings held in Washington, D. C. during August, 1971.

> A second comment I would like to make is the contracting policy that Mr. Packard enunciated that we will do development programs on cost-based contracts and production programs on a fixed-price basis. It's very easy to know the motivation of the contracting officer. The safest thing he can do is to get the lowest price and get it locked up on a fixed-price

contract. There is no way to get around that. His job is most secure by doing that.

I believe it's going to take a much more active role on the part of the materiel commanders to really implement the policy that Mr. Packard enunciated and the three service managers here have so eloquently supported.

We could rationalize that the policy is new and, therefore, we have not had time, but the facts of life are that Mr. Packard put out preliminary guidance along these lines around May of 1970 in a very well documented piece of paper, and even today high risk development programs are still being procured on a fixed-price basis. I was very glad to hear General Brown say that the guy down the line better get the word. That's got to be done. Otherwise, the whole thing is not going to fly.

Finally, one last suggestion. Having been a participant and observer on this scene for some 25 years and having watched the pendulum swing one way and then the other, one of the common mistakes we make is shortly after a period of having been burned due to some policy we say to ourselves we must never, never make that mistake again. The real danger that I foresee now is the pendulum swinging too far the other way under the new procurement policy. I think the milestone approach to procurement is essential to avoid the mistakes of concurrency, but what I am much afraid of now is that a program will come to the end of its development, the DSARC will have to act in order to put it into the next phase and the DSARC will not be aware that they have to act so it'll take 6, or 9, or 12 months for them to get aboard before they can put it into the next phase.

Some extraordinary effort on the part of the DOD and the services will have to be made at this time to make the milestone program work, for people to do their homework in advance, so that when we reach these milestones, we can pass them in a reasonable amount of time. Otherwise, I'm afraid we stand in danger of fielding systems that take about a 12-year cycle, and by the time we field them, they are obsolete. The hostile world in which we live may not allow such a luxury.

That is the new danger that we must be alert to as we attempt to never, never make the mistakes of the sixties again.[5]

---

[5]U. S. Department of Defense and National Security Industrial Association, Symposium Proceedings on Major Defense System Acquisition, Washington D. C., August 11-12, 1971, pp. 178-79.

The authors believe that these selected presentations reveal that the contracting innovations that have been incorporated into the F-15 program are directly related to a shift in DOD contracting policy which will result in new management concepts and procedures.

Throughout this thesis an attempt has been made to point out how particular contract clauses have been structured to implement the recommendations of the Blue Ribbon Panel and how these contract clauses impact upon management practices.

CHAPTER V

CONTRACT PHILOSOPHY

The Department of Defense has tried many new management and contracting techniques in recent years in the hope of improving the acquisition process for major weapon systems. In 1968 when the requirement for a new advanced fighter aircraft had been justified, the Commander of the U.S. Air Force Aeronautical Systems Division (ASD) formed a committee which was charged with the task of evaluating prior methods of major weapon systems procurement.

This committee was staffed with nine procurement and legal experts from within ASD and was chaired by Mr. E. J. Trusela, Assistant to the Deputy for Procurement and Production, ASD. Mr. Trusela had been the Contracting Officer for the C-5A transport aircraft. Mr. Trusela's presence on this committee was considered significant by the thesis authors in view of the highly controversial total package procurement concept used in the C-5A program. Mr. Trusela's close association with the C-5A and its contract failures (or undesirable results) most certainly had a significant impact upon the contracting changes formulated by this committee for future weapon systems. The recommendations of this committee formed the basic contract philosophy upon which

the F-15 contract was constructed.[1]

The committee developed a series of facts and considerations which they determined to be primary points upon which contract success or failure hinges. The authors have summarized these facts and considerations for the reader.

Fact One: Past Weapon Systems Acquisitions Had Resulted In Iceberg Procurement

The acquisition and operation of most new major weapon systems had involved the separate negotiation of a development contract for prototype hardware, a separate initial production contract, individual (usually yearly) follow-on production contracts, and contracts for training, spares, support items, and other auxiliary equipment. The development contracts were usually negotiated in a competitive atmosphere but the emphasis had been on technical excellence. Unfortunately, the performance promises made by the contractors were rarely backed up by binding contractual arrangements; the absence of meaningful and enforceable cost commitments meant that the Government was in the position of accepting something less than it had bargained for. Then, because of the time and expense involved if another source were chosen for subsequent contracts, non-competitive negotiations with development contractors were inevitable if the system was to

---

[1]Mr. Donald Robinson, Chief, Systems Division Procurement and Production Directorate, F-15 Systems Program Office, Wright-Patterson AFB, Ohio, Personal interview, June 22, 1972.

be introduced into the defense inventory. This is the meaning of "iceberg procurement".

The committee recognized that contractors must be prevented from "buying in" during the early stages of system acquisition and then profiting unjustly from the follow-on contracts. The committee recommended that a variation of the total package concept could be formulated whereby the various stages of a systems development could be included in a single contract, incentivized separately, and thereby make it unattractive for a contractor to attempt the old "buying in" ploy.

Fact Two: The Committee Determined That Government Contracts Do Not Contain Long-Range Motivational Factors For The Contractor

Since the development of strategic and tactical weapon systems affords little opportunity for the contractor to cultivate commercial or foreign sales of the product developed, it was determined that the two motivational factors which evolved from Government contracts were the maintenance of reputation and the immediate profits to be obtained under that contract.

These factors were assessed by the committee to actually discourage maximum technical achievement. It was reasonably assumed that contractors would strive only for minimum performance requirements because there were no long range motivational aspects and therefore marginal system performance would be achieved.

This fact prompted the committee to insure that extensive consideration be applied to the performance standards established for future systems. This consideration manifested itself in the F-15 contract via the well defined performance milestones that were established and written into the acquisition contract.

An additional phenomena which was anticipated to evolve from this consideration was the contractor's recognition of the relatively constant profit potential over the life of the weapon system which could be developed only through realistic and sustained profit policies negotiated within each stage of the systems development. This aspect is covered more thoroughly in Chapter VIII of this thesis.

Fact Three: The Committee Emphasized The Changes In Technique Of Weapon System Acquisition

The Government had not been able to use the development and thorough testing of experimental designs and test models prior to contracting for the production of a weapon system since shortly after World War II. Todays weapon systems require that the whole process of definition, design, development, testing, and production be telescoped into the shortest possible time period to preclude obsolescence prior to the completion of the production run. The result of this is that new programs must be committed to production prior to complete development and testing. This creates an environment of maximum technical and cost risk, particularly where state-of-the art advances are required.

This consideration prompted the use of a cost plus incentive fee type contract for the early stages of the F-15 development. It was realized that the Government must assume more of the risk involved in the early development stage, when unknown unknowns normally crop up, in order to be consistent with all of the other steps taken to direct the contractor into a policy of uniform profit incentives throughout the entire program. Chapter VI of this thesis covers this aspect more thoroughly.

Fact Four: The Committee Emphasized The Importance Of Early Competition Among All Contractors

With the advent of the philosophy of making one contractor responsible for all phases of a systems development came the realization that competition, with regard to a particular weapon system, would cease to exist upon contract award. This meant that the motivation to "buy in" would still exist among competing contractors. To counter this it was necessary to insure that Government cost estimates be as accurate and complete as possible so that each contractor's estimates could be realistically analyzed.

The committee did not have the power to increase Government emphasis in the area of cost estimating, but they did make their beliefs known. It is too early to tell whether or not Government estimates of the F-15 acquisition costs were totally accurate. This is a very important area for continued study.

Fact Five: The Committee Recognized The Possibility Of Suppressing Technological Advances

The steps that are required to tie the contractor to well defined cost and time milestones have an inherent disadvantage of causing the contractor to by-pass or ignore technological advances unless he is profit motivated to introduce these advances.

The Government's responsibility here, then, is to determine in fact that state-of-the-art advances are not concealed until after a contract has been awarded - then presented as a justification for a profitable (to the contractor) contract change. Conversely, the Government must provide an incentive great enough to encourage development and presentation of technological advances during the contract life.

The Committee's Summarized Objectives

It should be kept in mind that it would be virtually impossible to optimize each objective. The committee hypothesized that the Government, while preparing a procurement plan or method, must strive to achieve an optimum balance among the following goals:

1. Establish the maximum degree of system definition possible at the outset of the program.
2. Adhere to the initial configuration to the greatest extent possible.
3. Allow flexibility to accommodate essential changes due to changed mission requirements or advanced technology.

4. Encourage competition to the maximum extent possible.

5. Develop firm pricing arrangements wherever practicable.

6. Promote avoidance of any management technique which would motivate under engineering on the part of the contractor.

7. Develop a contractual procedure that would motivate the contractor to design, develop and produce the best possible system within the time constraints and at a cost within reasonable range of the original estimates.

The Air Force contemplated a fixed price incentive total package acquisition contract similar to that used for the C-5A aircraft procurement when it initially submitted its request for proposals in 1968. Following an Air Force study, completed in September of 1968, and the review of the committee recommendations cited above, it was concluded that a fixed price total package contract would inhibit the technical advancement necessary to develop a truly superior fighter aircraft. It was generally concluded that the use of the total package arrangement could cause premature commitment of the system to production without the Government having sufficient control over its technological development nor contractual flexibility to make the most advantageous trade-offs between technical performance and cost. Because of these considerations, the Air Force was motivated to develop a procurement approach that (1) emphasized technical requirements during the early development stages of the program by reducing the risk to the contractor during development and (2) would

provide for effective and highly visible cost control during the production phase of the program.

It was believed that such an approach would maintain the advantages of competetive pricing and, through the use of a single contract, the most advantageous features of cost reimbursement and fixed price type contracting would also be preserved.

The preceding introduction to the contract philosophy should prepare the reader for the chapters which follow. Within the following chapters is a description and analysis of how this contracting philosophy was actually incorporated into the final contract. A serious attempt has been made to point out which of the F-15 contract clauses are considered to be innovative and which may lead to better Government contracting arrangements in the future.

CHAPTER VI

DEVELOPMENT PROGRAM INCENTIVE STRUCTURE

Purpose of Incentives

Before discussing the effectiveness of the cost plus incentive fee (CPIF) portion of the F-15 contract, it is necessary to understand the objective of the Department of Defense (DOD) in using an incentive contract. According to the DOD and NASA Incentive Contracting Guide:

> "The objective of any incentive contract is to motivate the contractor to earn more compensation by achieving better performance and controlling cost. The incentive arrangement must also reflect, in a practical way, failure to achieve desired performance and cost control by reduced compensation; it must be designed to relate compensation more accurately to value received."

The Government's basic objective is cost reduction and/or cost control. An incentive contract designed to meet this objective should communicate the Government's objectives to the contractor and motivate the contractor's management to convey those objectives throughout the contractor's organization.

The reader should be cognizant of the fact that incentive contracting is not merely a process of rewarding good performance and penalizing bad. The real purpose is to have the

contractor share in each expended dollar.

The Cost Reimbursement Portion of the F-15 Contract

In keeping with the contract philosophy outlined in Chapter V of this thesis, the Government opted to use a cost plus incentive fee type contract to cover the design and development phase of the F-15 aircraft. It is a well known fact that the contractor's risk is highest during the design and development stages of a system since this is the period where the majority of unanticipated change requirements are generated. Recognizing this fact, the Government decided that the best approach would be to minimize the contractor's risk while still encouraging him to control costs. Another consideration which affected the Government's decision to use a CPIF type arrangement during the design and development stages was the fact that it was necessary to guard against inhibiting technical innovation.

The reason the contractor is motivated to develop the highest quality aircraft possible under the CPIF portion of the contract is directly related to dollars. Since all of the production line hardware, including the twenty test aircraft, are under the fixed price portion of the contract, the contractor definitely has an incentive to do the development and design properly the first time in order that he may avoid rework costs under fixed price conditions. (The first production run calls for 107 aircraft.)

This arrangement becomes even more attractive to the

Government when one stops to realize that the major portion of total system costs is incurred during the production phase of the weapon system contract.

The CPIF type contract during the development stage also facilitates the flexibility objective that was stated in the contract philosophy chapter of this thesis. If major changes or redirections should occur, the necessary contractual adjustments would be more easily made with a CPIF arrangement than would be the case in a fixed price contract. Under the CPIF portion of the F-15 contract, cost is a very important factor but not an overriding one.

The above philosophy infers that an extra dollar spent on necessary design or development changes will ultimately save money for the Government and contractor as well during long run production.

Specifically, the CPIF provisions apply to Item 1 of the F-15 contract. Within Item 1 the design of the aircraft, aerospace ground equipment and tooling are covered. In addition, Item 1 covers Category I (contractor conducted) flight testing, contractor support for Category II (jointly conducted) flight testing plus structural fatigue and other pertinent testing.

It should be pointed out that a CPIF type contract always states the maximum fee and usually contains a minimum fee as well. The target fee will naturally be somewhere between the maximum and the minimum. For Government

development contracts, the maximum fee normally will not exceed 15 per cent of target cost and for production contracts it may not exceed 10 per cent.

The sharing formula may vary according to the degree of confidence the contracting parties have in their cost estimates and other factors. As a rule of thumb, the Government will not assume more than 85 per cent of the over-run liability.

The principle to be followed is that the incentives should be put on performance and/or schedule under certain specified conditions, but always in conjunction with cost incentives. The demonstration milestone concept fits in nicely with this principle.

The F-15 contract provides for a total target cost of $588 million for Item 1. The total target fee is 8 per cent ($47 million) of the target cost. A 90/10 (Government/ contractor) sharing arrangement was established with the maximum fee set at 12 per cent and a minimum fee of 2 per cent. This arrangement is depicted in Figure 6-1.

In addition to the 90/10 share agreement in the CPIF portion of the contract there is an additional $2 million incentive fee which the contractor may be awarded over a five year period. Up to $400,000 may be awarded yearly to the contractor based upon the findings of a special Government evaluation board.

ITEM 1 CPIF TARGETS AND SHARE ARRANGEMENT

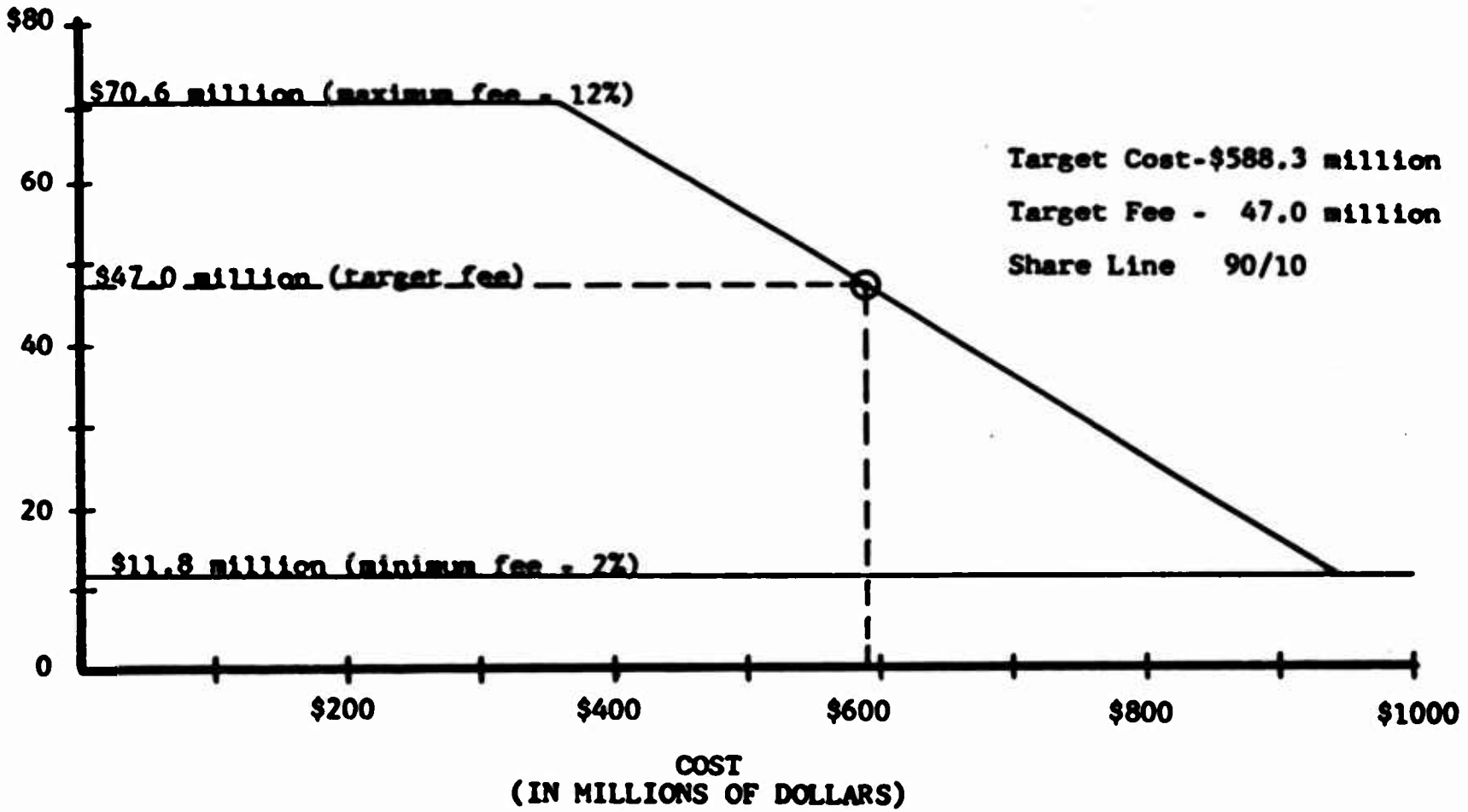


Figure 6-1

The performance categories upon which the contractor is evaluated may vary from year to year. This gives the Government added leverage in incentivizing a particular aspect of the total program as the various milestones are met and as current developments warrant. Since this award is not cumulative, the contractor is very much aware of the Government's desires and should strive for as much of the $400,000 as is possible each year. As was stated earlier in this thesis, the contractor received $320,000 as an award fee after the first year of contract execution.

The performance categories upon which the contractor will be evaluated during the second year (January 1, 1972 through December 31, 1972) are:[1]

A. Systems management

B. Logistics management

C. Cost-schedule control system criteria

D. Management of Category I testing

E. Management of operational requirements

F. Management of training requirements

G. Configuration management

H. Maintenance of reliability factors

I. System maintainability considerations

J. Management of weight control

---

[1]Captain Arthur R. Charles, USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS). F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Personal interview, August 7, 1972.

The reader should be aware of the fact that, although the contractor is cognizant of this list of evaluation factors, the exact priority weights that the evaluation board applies during evaluation are not made available to anyone outside of a select group of DOD officials.

Is The CPIF Portion Of The Contract Meeting The Previously Stated Objectives?

Based upon the tangible evidence available to the authors up to July 31, 1972, it has been concluded that the contractor has responded to the incentives provided for in the CPIF portion of the F-15 contract. All of the preset milestones have been met and the program is proceeding on schedule and under cost. The contractor, although not receiving the entire $400,000 award fee for first year performance, satisfied the Government evaluation board to a degree meritorious enough to prompt an award of $320,000. It is considered significant that this fee was based primarily on management considerations. This would indicate to the authors that a sound foundation has been established upon which the remainder of the contract may firmly rest.

Because the contractor is bound by the contract to report any anticipated deviation from scheduled fund allotments seventeen months prior to occurrence, it is imperative that sound management practices and information flows be established early in the life of the contract. The group of factors chosen by the Government upon which the first year

contract award fee was based is considered by the authors to be a key factor. Future programs should provide an incentive to the contractor for the development of management programs which provide not only timely current data but which provide for accurate projections.

The management information interface between McDonnell-Douglas and the F-15 SPO allows near real time access to cost data. This factor has allowed Government planners and analysts to assist the contractor in warding off potential cost problem areas.

The Government supplied the contractor with 180 detailed aircraft performance specifications. Also included were reporting plans upon which computer programs were to be based. The high degree of detail developed prior to the implementation of the reporting system is considered to be one of the significant factors which has enhanced the cost control efforts of DOD and the conttractor as well. The high degree of visibility provided by the reporting system allows joint decisions to evolve which precede rather than follow cost crisis situations.

Recommendations

It would be folly to state that the CPIF type contract is a panacea for all development contracts. Each program must be evaluated individually. The B-1 bomber contract employed selected portions of the F-15 contract (LOGO and TSPR--see Chapters VII and XII) after careful evaluation of the

development and production requirements of that specific airframe. The Government did not use the F-15 contract as a template for the B-1 contract. They did use the F-15 approach of attempting to develop the highest degree of definition possible and provided contractual arrangements commensurate with the degree of risk involved. The B-1 program is utilizing a Parallel Undocumented Development (PUD) Program that does not lend itself to the same type of CPIF/FPIS contract form that is found in the F-15 program.

It is not recommended that the F-15 contract form be applied to programs such as the space shuttle. Because a program such as the space shuttle requires going considerably beyond current state-of-the-art designs, special consideration must be given to flexibility of time schedules as well as monetary costs. Although flexibility exists to a degree in the F-15 contract, it is not considered to be a good alternative or template to be used for a program which has a high number of known unknowns and a comensurately high risk of unknown unknowns developing.

CHAPTER VII

PRODUCTION PROGRAM INCENTIVE STRUCTURE

Purpose Of Fixed Price Incentives

A fixed price incentive (FPI) type contract is normally used when there is too much risk involved for the contractor to reasonably agree to a firm fixed price at the time of contract award. This is a situation that usually accompanies large weapon system acquisitions.

When there is a reasonable hope or estimates indicate that reductions in cost or improvements in performance will or can occur during the course of the contract, a fixed price incentive with successive target resets (FPIS) may be used. This type of contract is based upon the philosophy that a range for price, performance, and/or delivery time will evolve. The underlying assumption is that the contractor's motivation and management practices will make the difference as to where in this range actual performance will fall. To reward positive effort the Government is willing to include an incentive arrangement which will relate profit to the contractor's achievement under the contract.

In establishing a FPIS contractual arrangement the initial target cost, the initial target profit, a price ceiling, the formula to be used for fixing firm target profit,

and a point (or date) in production at which the formula is to be applied must be negotiated. A ceiling and floor which applies to firm target profit is established and is included in the formula for fixing the target profit. When the production point for applying the formula is reached, a firm fixed price (FFP) or fixed price incentive with firm target (FPIF) type contract is negotiated. Normally under the FPIS contractual arrangement, after all work has been completed, the contractor and the Government jointly determine the final costs and share the overruns or underruns according to the cost sharing formula. For instance, when there is an established share ratio of 90/10, the Government would retain 90 percent of each dollar that the contractor underran the target cost while the contractor would retain 10 percent. Conversely, if the contractor overran the target cost, the Government would pay 90 percent of each dollar overrun and the contractor would pay 10 percent.

Influence Of The F-15 Contract Philosophy

The Government objectives of cost control and high technical performance of the aircraft were the primary objectives to mate in the FPIS portion of the contract. An obvious contractor strategy for avoiding overruns in the share arrangement previously described would be to increase the target cost to the greatest extent possible. This tendency was a prime DOD consideration when it was decided to pursue the extensive cost estimates and high degree of milestone definition which

evolved in the F-15 contract.

By setting the target cost as accurately as possible, the Government hoped to obtain benefits for both itself and the contractor. A realistic target cost meant lowering the probability of an overrun of which the Government would have to pay 90 per cent; it also meant that the contractor would receive a 9 per cent of target cost profit which is higher than DOD contracts historically have yielded.[1]

The Government introduced a high ceiling cost (150 per cent of target in Item 2 and 145 per cent of target in Item 3) as a protective hedge against extraordinary inflation for the contractor. This "good faith" measure was a hedge for the Government also. Because the ceiling costs could be adjusted downward only, the DOD required some insurance against the type of overruns charged against the C-5A.

Additionally, the ASD committee which established many of the contract objectives had taken note of a poor practice which had commonly accompanied past FPIS type contracts. This practice was to negotiate the reset so far into the performance of the contract that the benefits to be gained were lost.

What had actually happened was that the contractor did not or could not respond to a renegotiation because his costs and fate were firmly established prior to the reset.

---

[1]U.S. Government Report to the Congress, "Defense Industry Profit Study," March 17, 1971, p. 25.

The result was that the Government ended up with a fixed price contract usually for an amount above that which was established as the initial target cost.[2] Consequently, the F-15 contract was structured to allow for early reset dates with provisions for renegotiations at later dates.

The Item 2 FPIS Arrangement

The first portion of the F-15 contract that is subject to a FPIS type arrangement is Item 2. As the reader will recall, Item 2 includes the fabrication of the first twenty aircraft which will be used for the Category I and II tests. Also included in Item 2 are all spares and AGE to support the test aircraft and the initial training equipment.

The initial target cost established for Item 2 was $468.9 million and the initial target profit was $42.2 million (9 percent of target cost). The ceiling price established was 150 per cent of target cost or $703 million. A 90/10 (Government/contractor) share arrangement was established to apply to the cost figures.

The 90/10 share arrangement is higher than traditionally found in similar contracts but was established to encourage superior technical performance by the contractor. This is evidence of the sincere effort expended by the contract authors to achieve a balance among the contract objectives

---

[2]Mr. Donald Robinson, Chief, Systems Division Procurement and Production Directorate, F-15 Systems Program Office, Wright-Patterson AFB, Ohio, Personal interview, June 22, 1972.

cited in Chapter V. This arrangement is illustrated in Figure 7-1 on the following page.

The established point at which the target resets will be negotiated for Item 2 is thirty days after the delivery of the fourth test aircraft. According to the demonstration milestone schedule, this would place the reset date in March 1973.

The Limitation Of Government Obligations

Although it is not a new concept for the Government to limit its obligations to a contractor, the manner in which the limitation of Government obligation (LOGO) clause has been applied in the F-15 contract is certainly significant.

Historically, under cost reimbursement type contracts, the allowable cost fixed fee and payment clause established the limitation of the Government's obligation. When, in the 1950's, fiscal year funding of contracts became the general practice, the allowable cost fixed fee and payment clause was augmented by an incremental funding clause. In the B-70 contract, this clause was called a limitation of cost clause.

The LOGO clause, as it applies to the F-15 and B-1 contracts, cuts across the entire spectrum of contract relationships. The Government is not required to reimburse the contractor, during any year, more than the fixed amount stated in the contract for that year. In addition, the contractor does not have the right to stop work or even to slow

ITEM 2 FPIS TARGETS AND SHARE ARRANGEMENT

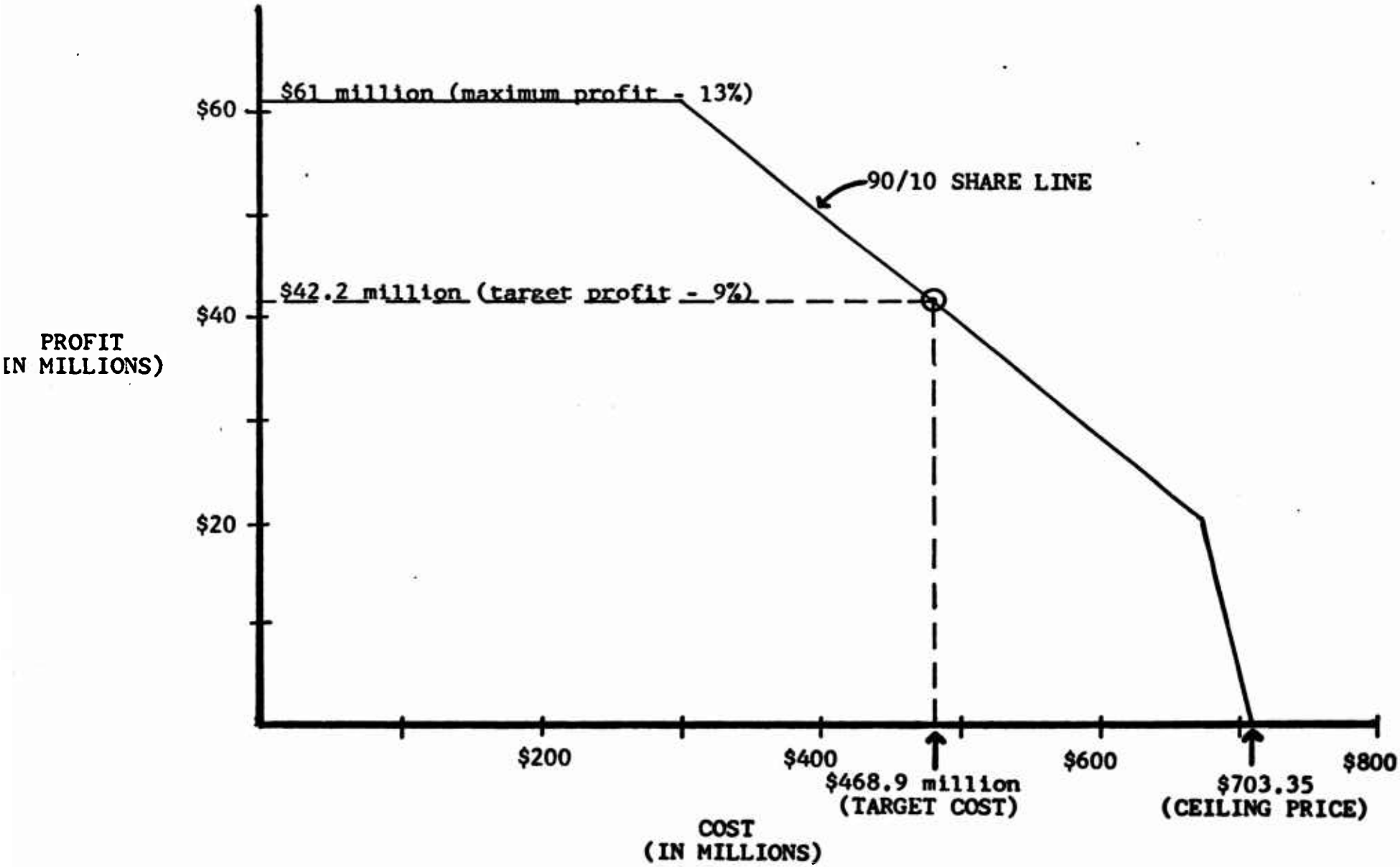


Figure 7-1

from the established demonstration milestone schedule simply because he has spent more than that year's allocated funds.

The LOGO clause applies to Items 1 and 2 of the F-15 contract with respect to research and development funds. Under the provisions of this clause the Government is not obligated to provide funds at a faster rate than that which is described in the funding plan of the contract.[3] (See Figure 7-2 for the funding plan).

The contract funding may be revised if the contractor notifies the contracting officer at least seventeen months prior to the date of the scheduled increment. Additionally, based upon the availability of funds, any costs incurred by the contractor which are in excess of the amount alloted will be considered allowable costs only in the event the Government subsequently increases its allotments.

This clause significantly affects the contractor's motivation to control costs. The fact that the contractor cannot stop or slow work simply because he has overexpended allotted funds places him in a position of staying within cost parameters or facing the unwanted alternative of applying his own capital toward the contract execution.

To date, there have been no requests from the contractor for funds other than those scheduled. Adjustments have been

---

[3]U.S. Department of Defense, "Acquisition Contract (Phase II) for F-15 Systems Support Service and Data Therefor," Contract F33657-70-0300, Dec. 31, 1969, p. 31, 31a, and 31b.

FUNDING - ITEM 1

I Fiscal Year	II Total Planned FY Allotment	III Date of Allotment of Initial Increment of Planned FY Allotment	IV Latest Date To Request Adjustment of Planned FY Allotment
1970	$ 80,138,000	Award Date	Award Date
1971	190,787,000	1 August 1970	Award Date
1972	93,903,000	1 August 1971	1 March 1970
1973	125,600,000	1 August 1972	1 March 1971
1974	81,186,000	1 August 1973	1 March 1972
1975	35,136,000	1 August 1974	1 March 1973
1976	28,562,000	1 August 1975	1 March 1974

FUNDING PLAN

ITEMS 2AA THROUGH 2AJ

I Fiscal Year	II Total Planned FY Allotment	III Date of Allotment of Initial Increment of Planned FY Allotment	IV Latest Date To Request Adjustment of Planned FY Allotment
1970	$ 102,000	Award Date	Award Date
1971	66,413,000	1 August 1970	Award Date
1972	166,097,000	1 August 1971	1 March 1970
1973	143,691,000	1 August 1972	1 March 1971
1974	30,879,000	1 August 1973	1 March 1972
1975	8,312,000	1 August 1974	1 March 1973
1976	4,928,000	1 August 1975	1 March 1974

Figure 7-2

made where the contractor completed work far in advance of the milestone schedule but no additional funds have been allotted. The total effect of this type of arrangement is that the contractor is working in a firm fixed price environment even though he is still under the FPIS portion of the contract.

The Item 3 FPIS Arrangement

The second segment of the F-15 contract covered by an FPIS arrangement is Item 3. Item 3 provides for the first production run of aircraft (107 total) which will be used to equip an operational wing with F-15 tactical fighter aircraft. The final training equipment will also be provided under this portion of the contract. The spares and AGE for the first operational wing are to be priced separately.

The earlier portions of the contract all pointed toward the philosophy of offering the maximum incentive to the contractor while the foundation of the weapon system was being formed. Since Item 3 deals with the first production run, the Government negotiators believed that the contractor will have learned enough by this point to assume an increasing degree of risk. Consequently, the ceiling price of $936.59 million was established. This was 145 percent of the target cost ($645.9 million). In addition a cost share line of 85/15 (Government/contractor) was established. The maximum profit was reduced to 12 percent of target costs (Item 2 provisions allowed for a 13 percent maximum profit).

The target profit was established at the same 9 percent of target cost rate found in the Item 2 provisions. This arrangement is shown in Figure 7-3.

The point at which these targets are to be reset is thirty days after the fifteenth aircraft has been delivered. According to the demonstration milestone schedule this reset point should be reached in June 1974.

Recommendations

The fact that the FPIS type contract has been reintroduced to the DOD procurement arena and appears to be working well with respect to the F-15 program should not start a stampede toward future FPIS contractual arrangements. The ultimate success of the F-15 contract hinges upon continued cost control and the proof of time as to whether or not earlier estimates and milestones were accurately projected.

A program where many unknowns are involved which may precipitate change proposals and schedule adjustments would be very difficult to administer under a contractual arrangement similar to the F-15's. A multiple incentive contract without highly selective and accurate data reporting systems in the current inflationary economic environment can easily spell disaster in terms of cost overruns. The value of the information received through reporting systems can be fully realized only when original projections are realistic.

The willingness of the Government to assume a greater degree of risk during the development phase of a weapon system

ITEM 3 FPIS TARGETS AND SHARE ARRANGEMENT

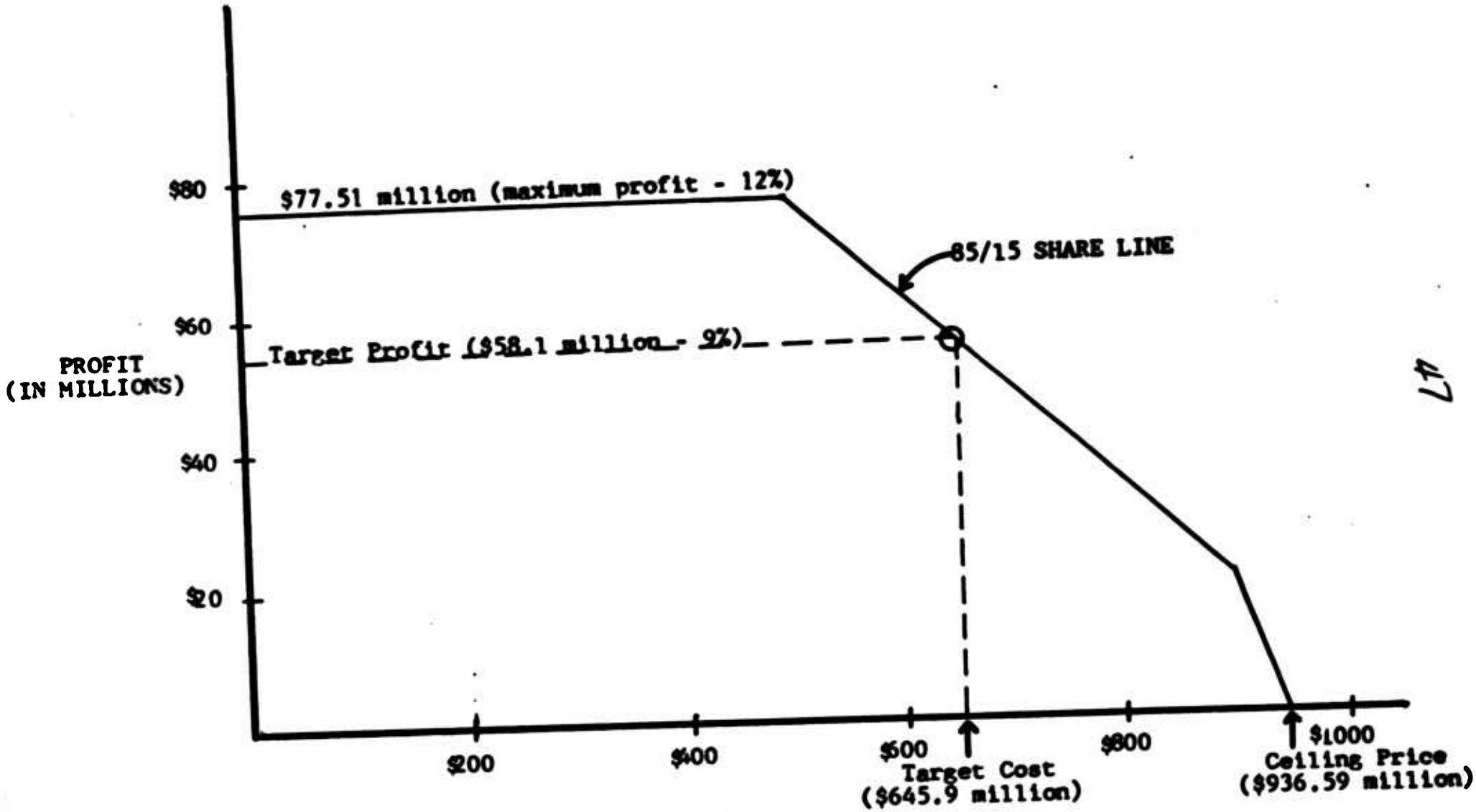


Figure 7-3

while concurrently guiding the contractor's management of cost control programs is not a new concept. The F-15 program has refined the concept by specifically defining areas of concentration for the contractor early in the program and by incrementally motivating the contractor toward those objectives throughout the contract. The F-15 program has used more positive (dollar) motivation than has been the practice in the past.[4] The negative motivation (contractor assuming large percentages of cost overruns) found in past contracts has not resulted in the desired cost control. Systems contractors merely assumed that the Government would adjust their share of cost assumption toward the end of a program rather than allow a contractor to default due to bankruptcy. This practice manifested itself in the C-5A. The risk sharing arrangement must be a function of each system's attributes, complexities, and uncertainties; it should not be the sole result of a previously used formula.

---

[4]This motivation is the result of higher ceiling costs, better share ratios, and the identification of realistic profit objectives throughout the lifetime of the program. This precludes the contractor from buying-in at a loss and hoping to make up that loss during production.

CHAPTER VIII

PROFIT OBJECTIVES

A discussion of major weapon systems contracts would not be complete without addressing the question of profits. This is especially true in the case of incentive contracts.

Profit is the basic motivating force behind the contract incentive.[1] There is an implied assumption on the part of the Government that the contractor will be motivated if he has a chance to increase his profits. The contractor, by accepting the contract, is agreeing (at least superficially) with the Government.

By incorporating the use of a profit incentive into Government contracts, both Government and industry have given recognition to the simple principle that, with obligation goes responsibility and any additional rewards that may accrue for having satisfied the obligation should be measured in the end by the degree to which such responsibility was met. The greater the responsibility, the greater the profit; the lesser the responsibility, the lesser the profit.[2]

---

[1]Lawrence V. DuLude, "Incentive Contracting," National Contract Management Journal, Spring, 1969, p. 115.

[2]Ibid.

Stated F-15 Profit Objectives

The profit objectives for the F-15 program were: 8 per cent for Item 1, 9 per cent for Item 2 and 9 per cent for Item 3. These profit objectives were dictated to the three prime contractors in competition for the F-15 (North American Aviation, Fairchild-Hiller, and McDonnell Aircraft Company). The competition was so intense for the contract that none of the companies questioned the amount of profit stated in the Government's Request for Proposal (RFP).

The present cost position of MCAIR is a slight overrun of target cost on Item 1 and underrun of target cost on Item 2. Overall, this results in a cost underrun of $11-12 million.[3]

It appears that the contractor has been motivated to perform well and keep cost under control at the same time. There are too many variables involved to determine if the positive motivation was attributable mainly to profit. Would the contractor have been motivated to a greater extent if the profit ratio had been 10 per cent, 12 per cent and 14 per cent? Or would he have been motivated to a lesser extent if the profit ratio had been 4 per cent, 5 per cent and 5 per cent on Items 1, 2 and 3, respectively? These are questions which cannot be answered at this time. However, in evaluating the

---

[3]Captain Arthur R. Charles, USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS). F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Personal interview, August 14, 1972.

results up to this point, it appears that at least the first half of the Department of Defense (DOD) profit policy has been fulfilled.

DOD Profit Policy

The DOD policy toward profits has been stated as follows:

> "It is the policy of the Department of Defense to utilize profit to stimulate efficient contract performance. Profit generally is the basic motive of business enterprise. The Government and defense contractors should be concerned with harnessing this motive to work for more effective and economical contract performance. Negotiation of very low profits, the use of historical averages, or the automatic application of a predetermined percentage to the total estimated cost of a product, does not provide the motivation to accomplish such performance. Furthermore, low average profit rates on defense contracts overall are detrimental to the public interest. Effective national defense in a free enterprise economy requires that the best industrial capabilities be attracted to defense contracts. These capabilities will be driven away from the defense market if defense contracts are characterized by low profit opportunities."[4]

It is the latter part of stated DOD policy toward profit which will be addressed at this time.

The United States Government relies primarily on privately owned, profit-oriented industry for the development and production of weapon systems or other military hardware. The success of such an arrangement depends upon a multitude of factors. One of the factors is "a fair and reasonable" profit.

---

[4]U.S. Government, Armed Services Procurement Regulation, Section 3, January 1, 1969, p. 3-808.1.

While there is some difficulty in defining a fair and reasonable profit in the defense industry almost everyone will agree that it is essential for continued defense business.

In their study of 65 companies, LMI was able to gain considerable insight into profits of defense industries in relation to profit of firms in the commercial sector of the economy. Some of the highlights of the study were:[5]

1. Profit on defense contracts has dropped sharply since 1958. Profit on commercial work has increased.

2. Between 1958 and 1966 defense profits as a percentage of the Total Capital Investment (TCI) ranged from a high of 10.2 per cent in 1958 to a low of 6.3 per cent in 1964 and stood at 6.9 per cent in 1966.

3. The comparable figures for commercial business by the same firms in the same period ranged from a low of 4.7 per cent in 1961 to a high of 11.6 per cent in 1965 and stood at 10.8 per cent in 1966.

4. Again in the same period, defense TCI turnover, which is the ratio of sales to TCI, declined from 3.8 in 1958 to 2.9 in 1966. The commercial TCI turnover ranged from 2.0 in 1958 to 2.2 in 1966.

5. The defense business ratio of profit to sales declined from 2.7 per cent in 1958 to 2.4 per cent in 1966.

---

[5]Defense Industry Profit Review, LMI Task 66-25, Volume 2 and 7, Logistics Management Institute, Washington, D.C., November, 1967.

The commercial business of the firms showed increases from 3.4 per cent in 1958 to 5.0 per cent in 1966.

6. The decline in defense profits was caused primarily by the decline in turnover and to a lesser degree by a decline in profits on sales increased steadily in the same period has resulted in a widening of the gap between defense profits and commercial profits on TCI.

7. The nondefense portion of defense industry business has been expanding at a slightly faster rate than commercial business in general. The defense portion of defense industry business, therefore, has been declining as a percentage of their over-all business.

8. Most defense contractors plan to increase their commercial business as a percentage of the total. They will concentrate their growth efforts on nondefense business. Here are their reasons for this decision:

(a) Commercial business is growing more rapidly than defense business and will continue to do so.

(b) Financial risk has shifted significantly from the Government to contractors in the defense business.

(c) There is a greater profit potential in commercial business.

(d) Commercial business is less competitive and has more production stability than defense business.

The LMI study also addressed the vital problem of investment capital and the profit seeking individuals who provide the capital for all industry--defense and commercial--the stockholders.[6] Companies were grouped into four categories: defense, commercial, mixed, and Dow Jones industrials. Figure 8-1 shows what would have happened to $1,000 invested in each of the four groups and spread evenly among the companies within each group.[7]

In a more recent defense industry profit review,[8] LMI indicated there is a conscious effort by high and medium volume companies to reduce the ratios of defense to total sales as indicated in Figure 8-2.[9]

Figure 8-3 illustrates a ten year trend of profit as a per cent of sales on commercial and defense products for large and medium volume companies.[10] A three year running average profit for defense sales was 4.38 per cent.[11]

This profit figure is more meaningful when it is broken out by contract type. Figure 8-4 shows the distribution of the

---

[6]Claude Witze, "Declining Defense Profits--Government Economy, or a National Security Risk?" Air Force, April 1968, p. 31.

[7]Ibid., p. 135.

[8]Defense Industry Profit Review, LMI Task 69-1, Logistics Management Institute, Washington, D.C., March 1969, p.39.

[9]Witze, p. 136.

[10]LMI Task, 69-1, pp. 91-92.

[11]Ibid., p. 77.

profit to sales for high and medium volume companies for 1967.[12] For a comparison the 1966 profits are shown in Figure 8-5.[13]

In a study done by the General Accounting Office[14] (GAO), the profit rates by contract type closely coincide with that in Figures 8-4 and 8-5.

A New Approach To Profit Objectives

All these findings indicate that profit, before federal income taxes on defense work measured as a per cent of sales, is significantly lower than comparable commercial work.[15] The GAO recommended the development of a new uniform Government-wide guidelines for determining profit objectives for negotiating Government contracts that will emphasize consideration of the total amount of contractor capital where effective price competition is lacking.[16]

The new profit policy was implemented early in 1972 by DOD on a number of carefully selected contracts.[17]

---

[12]LMI Task 66-25, p. 21.

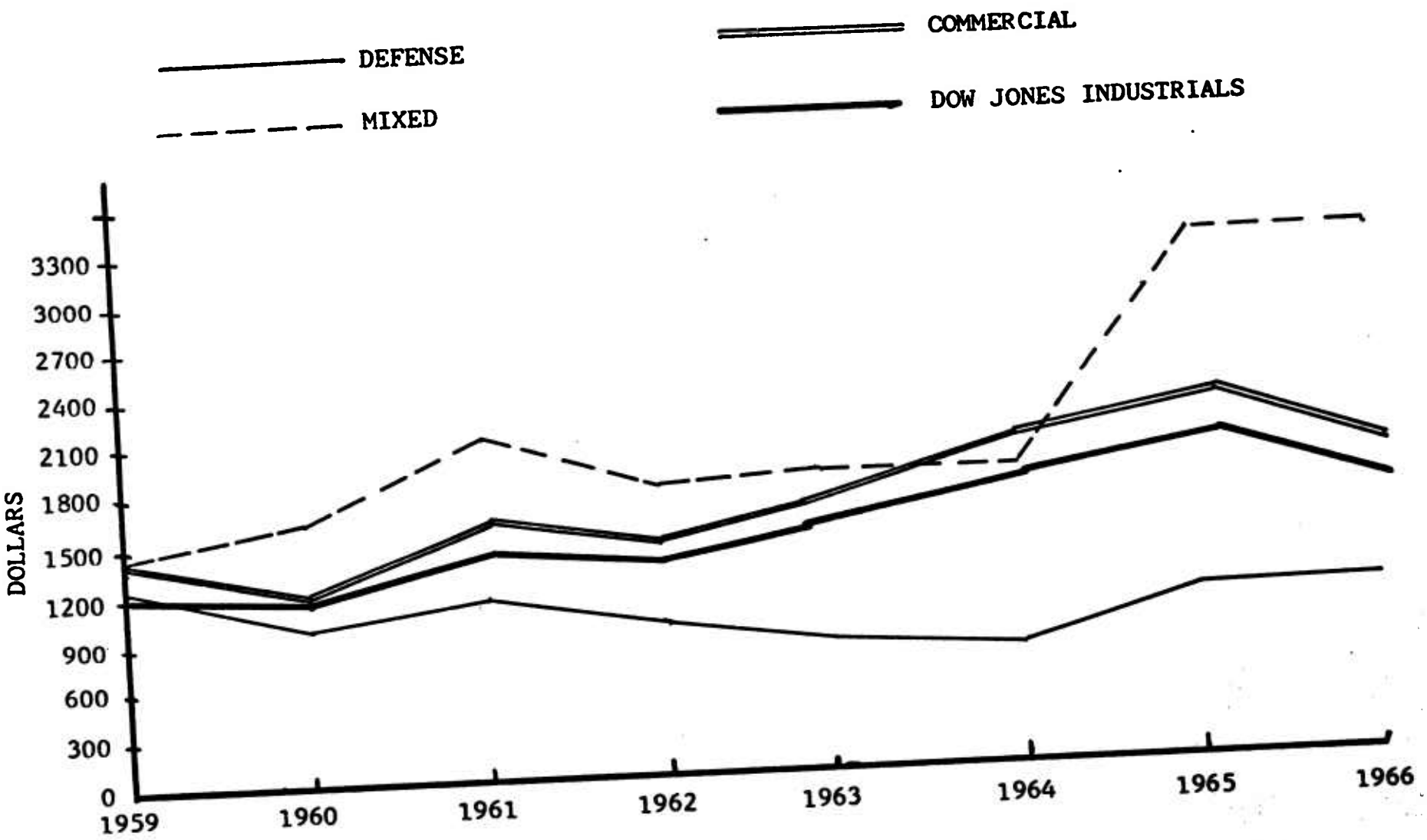
[13]LMI Task 69-1, p. 92.

[14]Report to the Congress "Defense Industry Profit Study by the Comptroller General of the United States, Washington, D.C., March 17, 1971, p. 25.

[15]Ibid., p. 1.

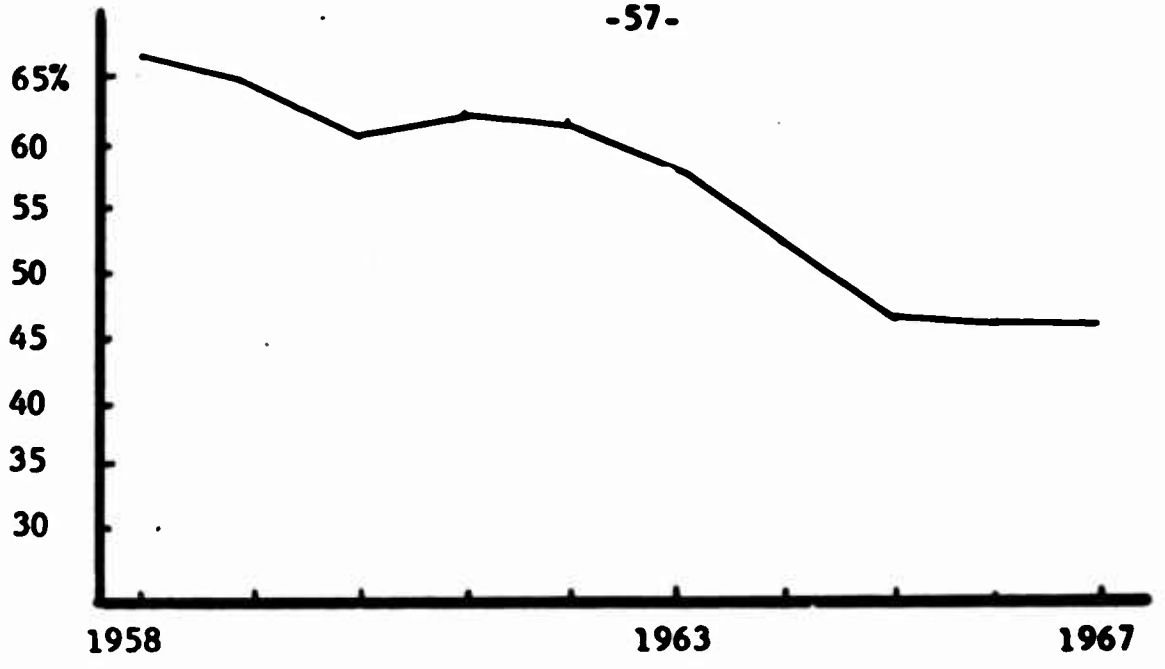
[16]Ibid., p. 5.

[17]"Pentagon Set to Test New Profit Policy For Defense Jobs Tied To Capital Outlays," The Wall Street Journal, January 10, 1972, p. 4.

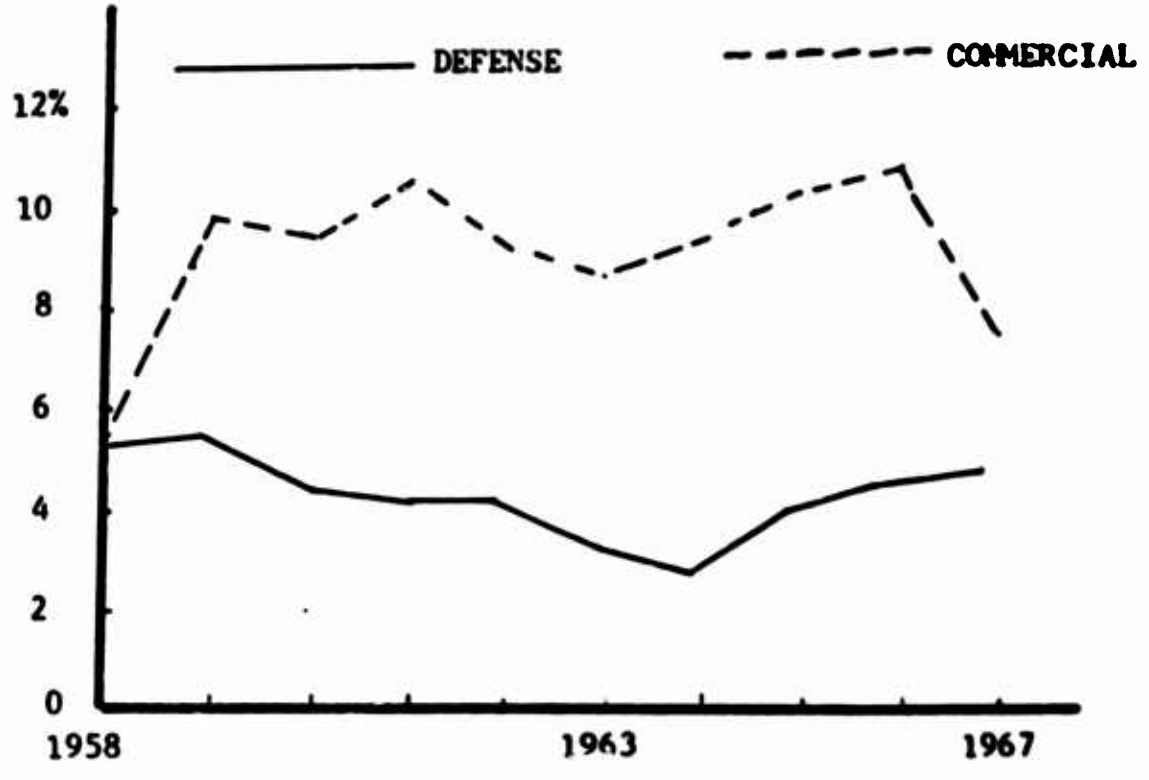


Capital Market Analysis

Figure 8-1



Comparison of Defense Sales/Total Sales
(High and Medium Volume Companies)
Figure 8-2



Profit/Sales Military and Commercial
(Total Population)
Figure 8-3

DISTRIBUTIONS OF THE PROFIT TO SALES RATIO
BY TYPE OF CONTRACT SALES

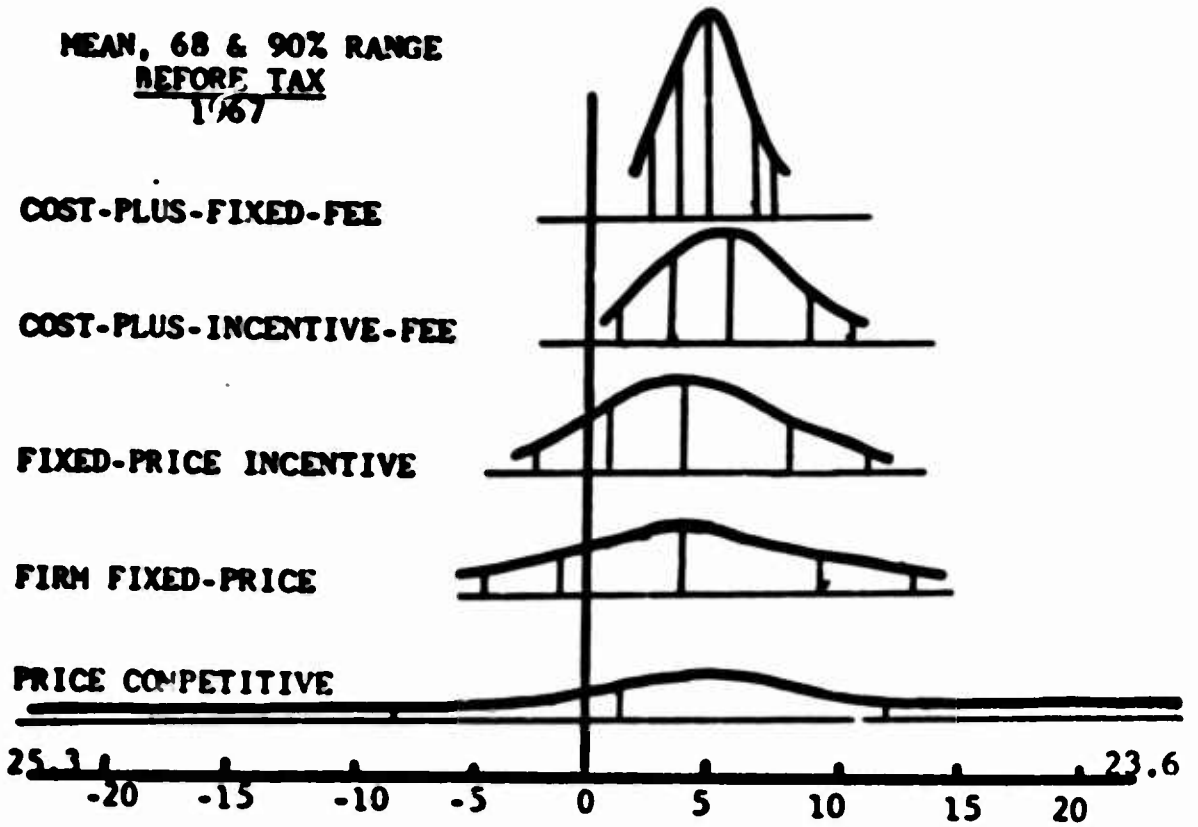


Figure 8-4

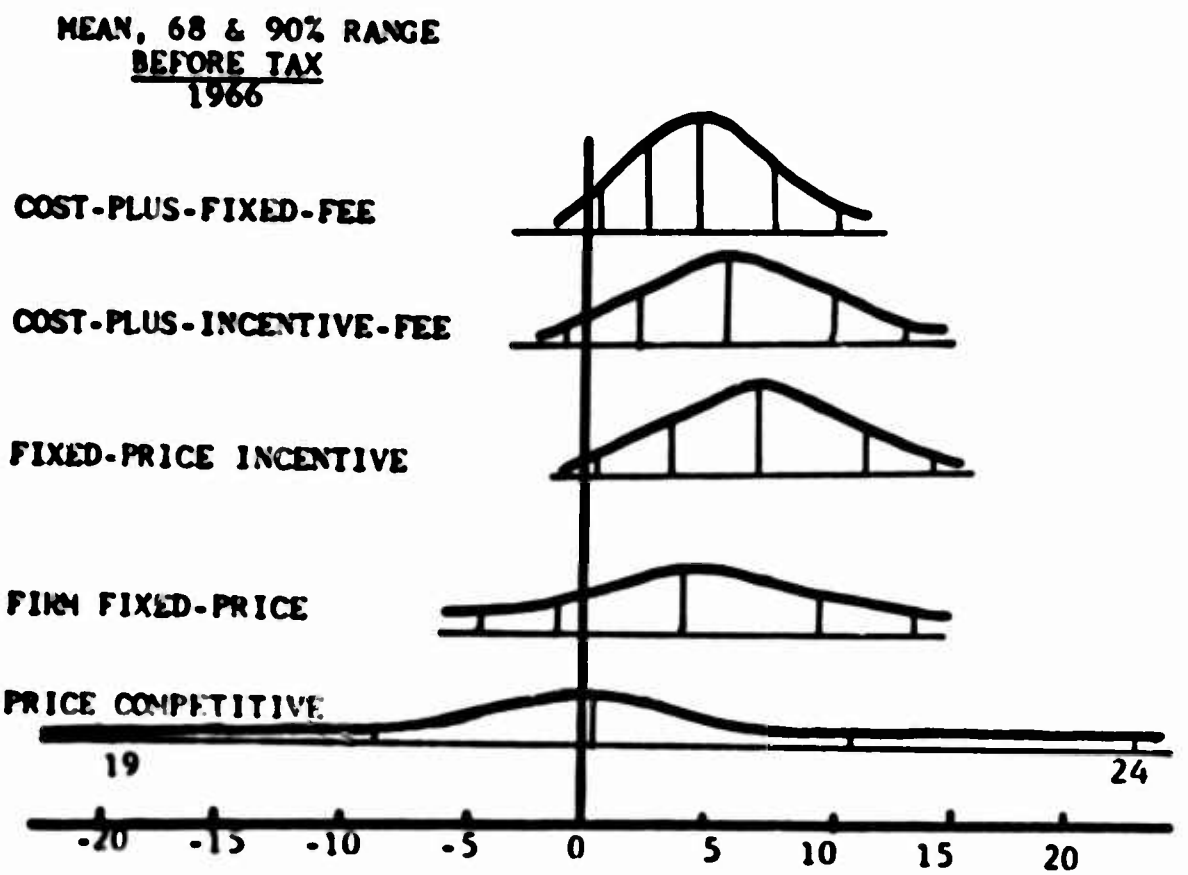


Figure 8-5

Industry reaction to the new approach has been mixed depending on the size of a company's capital investment. Capital intensive contractors such as electronics companies would reap higher profits under the new formula, but many aerospace and aircraft firms who have relatively small investments would be hurt.

This approach to profits would probably motivate contractors to invest in their own capital equipment and let the Government get out of the "facilities business." The Government presently furnishes approximately six per cent of total capital required for defense business.

Contigious with the capital approach to profit are DOD recent procurement practices aimed at generating adequate competition: prototyping, fly-offs, "fly before you buy." Where adequate competition exists, the PCO is not required to compute a profit based upon the amount of contractor capital. In this case, the profit factor can be specified in the RFP. This practice by the Government could result in declining profits for the defense industry. The contracting office, may be more concerned with negotiating low, short run profit factors rather than achieving profit factors which consider the long range social and economic implications of continually forcing contractors to accept low percentage profit contracts.

The F-15 Contract

It is not possible at the time of this writing to

conclude that the profit structure of the F-15 contract will be totally successful in avoiding the pitfalls revealed by the LMI studies. The authors are confident, however, that the errors committed in the past were considered and serious attempts to circumvent the tendency of contracting for short range objectives were made.

The target profits established for the various items within the contract are higher than those found in past DOD acquisition contracts. It was previously stated that "coming out" profits have been historically lower than the "going in" target profits. The authors believe that this tendency will be minimized because of the way the F-15 contract has been segemented and profit targets have been individually set for each major contract item. In addition, the extensive studies performed on cost, schedule and performance requirements prior to contract definition have made the established target profits more visibly attainable than has been the case in the past.

The contractor is acutely aware of the fact that he cannot use one section of the contract to "get well" on the results of poor management of earlier sections. Therefore, he is motivated to meet the objectives of each section independently of the others. By following the established contractual guidelines, the contractor should achieve a profit which is very close to the established targets.

Two factors in favor of the contractor with respect to his ultimate "coming out" profits are the higher initial targets

and the potential $2 million incentive award fee. Even if the contractor does undershoot the targets of eight, nine and nine per cent slightly his position relative to that of contractors in the past (who undershot much lower target profits) is still excellent.

CHAPTER IX

DEMONSTRATION MILESTONES

The decade of the sixties was characterized by an increasing complexity of Government procurement. Technological breakthroughs resulted in Department of Defense demands for more complex and intricate weapon systems with higher performance requirements. These developments were accompanied by Secretary of Defense McNamara's policies of centralization of authority and responsibility and a heavy shift of procurement risk from the Government to the contractors.

McNamara's policy of centralization of authority and responsibility led to a deterioration of contract administration. The authority of contracting officers was severely limited by required clearances with DOD and other officials. The DOD policy of shifting risk to contractors was implemented by increased use of fixed price contracts (as opposed to cost-type contracts) even for areas such as research and development. This transferred the burden of dealing with the unknowns and the unknown unknowns to the contractor. The stated DOD policy was also to compensate contractors for assuming these risks, however, this policy was never implemented in a practical sense.

A by-product of the heavy shift of risk to defense contractors was an extremely large number of claims submitted by

the contractors to the Government. A primary reason for the large number of claims was a side effect of the use of fixed price contracts. When fixed price contracts are used, many cost items which were reimbursable to the contractor under a cost-type contract, now require constructive change orders which result in claims from the contractor to the contracting officer. One result of these claims is higher acquisition costs.[1]

In 1969, DOD identified a possible 1.8 billion dollars in potential cost overruns in military programs. The Navy shipbuilding program accounted for more than one third of the total. The remainder was attributed to five programs: the Lockheed C-5A heavy logistics transport aircraft for the Air Force, the Lockheed AH-56 helicopter for the Army, the Boeing short range attack missile (SRAM) for the Air Force, the General Motors main battle tank (MBT) for the Army and the General Dynamics FB-111 fighter for the Air Force.[2] In addition to cost overruns, serious technical problems also plagued the FB-111 fighter. The FB-111 failed to meet performance specifications in several critical areas including ferry range, takeoff weight, takeoff distance and landing distance.[3]

---

[1]F. Trowbridge von Baur, "Fifty Years of Government Contract Law," Federal Bar Journal, pp. 352-358.

[2]"Laird Takes Hard Line with Defense Complex," Business Week, May 10, 1969, pp. 82-84.

[3]"F-14 Vs. F-15: Will it Come to a Shootout?" Armed Forces Journal, February 28,1970, pp. 20-21.

Expected cost overruns on the C-5A vary from a conservative Air Force estimate of $882 million to a Congressional estimate of two billion dollars extra for building 120 aircraft. The C-5A was the first U.S. aircraft to be produced under a total package procurement contract.[4] The intent of the C-5A contract was to obtain a total price for both development and production of the aircraft under competitive conditions. This total package approach revealed, however, that serious difficulties arise when the technique is applied over too long a time span. The economy can fluctuate in unanticipated ways and unexpected technical problems can arise. A rigid fixed-price contract is far less adaptable to these types of changes than a cost-type contract. Another reason for cost overruns with the C-5A was the complex repricing provision in the contract which permitted even the ceiling price to be adjusted upward.[5]

There are several other reasons for cost overruns and other difficulties associated with acquisition of major weapon systems. Past emphasis has often been on concurrent development and production. Procurement practices have not been sufficiently tested before their adoption. Development and acquisition contracts have been written as if there would be

---

[4]"Laird Takes Hard Line."

[5]"The Dogfight Over the F-15," Business Week, December 20, 1969, pp. 96-98.

no changes and the pricing system has also been based on this erroneous assumption. Also, in the past contracts have not been sufficiently tailored to the nature of the system being procured.[6]

As a result of cost overruns and other problems of the past, Congress and the DOD have pushed for improvement in managing weapons acquisitions. In 1969, Secretary of Defense Laird began to voice a DOD procurement policy which would involve several major changes. More prototype development was to be used instead of paper analysis, thus forcing manufacturers to give proof of concept or design validation before getting production contracts. Less emphasis was to be placed on concurrency of development and production. Fewer demands were to be made on achieving major technological advances with each new weapons program. Cure notices were to be used more frequently for weapons programs in serious trouble. In this case, if a contractor did not come up with an acceptable solution to serious weapon system problems, he could face cancellation of the contract. Fewer total package contracts were to be used along with less use of rigid fixed price contracts in complex development programs. Also included in this new DOD policy was a demand that a milestone approach be used for

---

[6]Lt. Col. Delbert H. Strube, "Milestone Procurement," The Review (Defense Supply Association), Sept.-Oct., 1970, pp. 98-110.

research and development.[7]

Deputy Defense Secretary Packard reemphasized this milestone approach in his 28 May 1970 policy memo on major weapon system acquisitions. He stated that:

> ". . .it is essential to have assurance that those problems encountered during the earlier development stages (of a major weapon system) have in fact been solved. This requires that milestones be established to demonstrate achievement of objectives at appropriate points in the development program."[8]

Simply defined, a milestone is a significant event or activity scheduled for accomplishment at a predetermined time in a system, program, or project. It can be used as a means of evaluating progress in terms of an estimated time schedule.[9] Milestones have long been used to measure contractor performance. Therefore, the use of milestones in the acquisition process is nothing new. However, tying milestones to a provision in the contract rather than to a management information system is new. The milestone concept may be stated as a means of identifying successive stages throughout the development and acquisition of a weapon system where the contractor

---

[7]"Laird Takes Hard Line".

[8]"Packard Guidelines on Major Weapon Systems Acquisitions," Armed Forces Journal, June 13, 1970, pp. 22-23.

[9]Fred Gluck, ed., A Compendium of Authenticated Logistics Terms and Definitions, Air University, 1970, pp. 277-278.

must demonstrate that he has successfully accomplished that portion of the task at the proper time and within the parameters of estimated cost.

To enable the Government to track the contractors progress, milestones are first selected during the validation phase. This insures that a contractor's technical performance can be measured before the Government authorizes funds for long lead time items. The milestones selected must be significant enough that if the contractor failed to accomplish one on schedule, the deficiency would have a serious effect on system cost, schedule, or performance. Milestones must be selected such that the contractor can demonstrate and his progress can be verified as to whether each milestone was satisfactorily accomplished. Milestones and their measurement criteria are selected in competition. Each contractor in the validation phase proposes those milestones he considers significant for his internal control and recommends the criteria that the Government should use to measure their accomplishment. Those milestones recommended by the contractor and those required by the Government for management visibility are negotiated into the development and production contract.[10]

If the contractor fails to achieve a required milestone, he would not be permitted to proceed further until the required

---

[10]Strube, "Milestone Procurement".

activity is accomplished. Additional work may be required such as redesign or more tests. From the contractors' standpoint, failure to achieve a milestone on time means that he cannot move into production or some other aspect of development as soon as he would like. This in turn reduces his profits.[11] In extreme cases if a milestone is not achieved at its designated time, the program may be reoriented or abolished.[12]

Each milestone is tied to a calendar date. This insures that a technical achievement can be related to the release of funds for a subsequent portion of work on the contract. The specific milestones used to evaluate a contractor's performance will vary from program to program depending on the type of weapon system involved. For example, milestones on an aircraft program would be established at significant points in the development and testing of the engine, the avionics system, and the airframe itself.[13]

Development of F-15 Demonstration Milestones

In early 1969 Aeronautical Systems Division (ASD) proposed the new contractual approach for the F-15 involving the

---

[11] "Dogfight Over the F-15".

[12] Cecil Brownlow, "F-15 Deliveries Tied to Milestone Concept," Aviation Week and Space Technology, September 14, 1970, pp. 20-22.

[13] Strube, "Milestone Procurement".

use of a CPIF/FPIS contractual arrangement. This arrangement has been described in detail in Chapter V. Shortly after this contractual approach was developed, ASD, in response to general guidance from Headquarters USAF, initiated a study pertaining to the use of selected development milestones as a technique for management control of the F-15 program.

As a part of this study the contractors were requested to provide recommendations on the nature, scope, and timing of the milestones of key significance in the attainment of program development objectives. In addition, the contractors were invited to discuss their positions on using the demonstration milestones at an on site meeting held by the SPO at the contractor's organization in February and March of 1969. Early in May 1969, ASD, in conjunction with the Air Staff, performed an analysis on the contractual implementation of the development milestone approach under a new program schedule which would allow completion of one year of flight test before significant commitment to full scale production.

The demonstration milestone approach, along with an alternate schedule involving less concurrency, was presented to the Secretary of the Air Force. Secretary Seamans forwarded the proposal to Secretary Packard in May of 1969. The contractors provided briefings of their proposed milestones to ASD in May and to the Secretarial Staff during the latter part of June.

It was ASD's position that the Request for Proposal (RFP)

should be amended to include the requirement for demonstration milestones. Control of production releases would be used to contractually implement the demonstration milestone approach as follows:

> ". . .production release decision points will be keyed to the accomplishment of significant technical achievements or milestones. You are required to include in your proposal, based on your proposed development schedule those achievement points which will demonstrate technical confidence in the program meeting its objectives. These milestones shall be defined and the criteria for measurement criteria and provisions to be incorporated into the contract will be negotiated in Phase IC. In the event the contractual milestones are not met, the Government will reserve the right to adjust and/or defer (affected) R&D milestones and production releases or schedules until the milestones are satisfactorily accomplished as unilaterally determined by the government. When the release of a production segment is delayed, the delivery requirement for the delayed items may be subject to a negotiated adjustment. Such adjustment shall not extend the delivery of any aircraft (for which the release to production has been delayed) for a period greater than a lapse in time from the scheduled release to production to the actual release to production. The delay in production release, milestone accomplishment and schedule adjustment will be at no adjustment in the initial target cost, initial target profit and ceiling price. . ."[14]

In implementing the milestone concept three requirements had to be met:

1. Meaningful and measurable milestones had to be specified.

---

[14]U.S. Government, Request for Proposal, F-15 Air Superiority Fighter.

2. The milestones had to be defined in clear and unambiguous terms.

3. The basis for determining whether the milestone had in fact been achieved had to be specified.

Achieving the above requirements on a development program where there was a large amount of research and development was a very difficult task. To stipulate in a contract a milestone which will be reached years later in the development and to determine in fact, that the milestone has been reached required a great deal of forecasting and planning. In reorienting the F-15 development program to achieve overall program objectives, the SPO had to implement the milestone approach by identifying in the RFP, typical milestones which could be tied to production lot releases. In addition, each contractor submitted their own proposed milestone as part of his technical proposal. Some typical milestones proposed by the SPO are as follows:

1. Static Test
   a. Test article available
   b. First condition tested
   c. First aircraft released to 100% loads
   d. Static test report approved
   e. All operational aircraft released to 100% loads

2. Fatigue Test

   a. Test article available

   b. First pass completed

   c. One lifetime completed

   d. Two lifetimes completed

   e. Three lifetimes completed

   f. Four lifetimes completed

3. AEDC full scale inlet/engine/nozzle testing completed.

4. Satisfactory completion of bench operational and integration tests for the avionics and instrumental subsystem.

5. All component qualification tests completed.

6. Engine airframe compatibility demonstrated throughout the flight envelope.

7. Formal technical orders delivered.

8. Operational AGE including depot level qualified and in place.

9. All reliability testing completed.

10. Successful demonstration of the ejection seat system by sled test.

From an analysis of these milestones, it is readily apparent that they are reasonable as a basis for adjustment of production releases of a production program but not for sequential progression from one research and development (R & D) milestone to the next.

Implementing the milestones on the recommended CPIF/FPIS type of contract provided the contractor an incentive to complete the development within a reasonable risk. The true incentive to the contractor was to obtain the production commitment. If the Government had the unilateral right to delay the production commitment at no adjustment in the initial target cost of the FPIS portion of the contract, the contractor had to be motivated to adequately complete the development program as scheduled. It was recognized that as a result of any delay in the production commitment, even with a schedule adjustment, the contractor would share in the increased cost equal to the initial share arrangement established on the FPIS contract. This would be an adequate but not excessive penalty for proper motivation of the contractor. If this were a fixed price type contract, it would be difficult for the contractor to propose or agree to a meaningful price with the Government having the right to delay production. Also if the Government should delay production and require additional effort on the development portion of the contract, the contractor could be forced to sacrifice development effort and adequate production planning in the interest of cost. The cost

reimbursement development portion of the proposed CPIF/FPIS contract eliminates this excessive risk and places an incentive on the Air Force to weigh total program impact prior to making a decision for a delay, because the Government will bear the majority of the resultant increase in cost. It was therefore concluded that in implementing the development milestone approach, the CPIF/FPIS combination would be the most suitable type of contract.

Although the use of development milestones as a technique for control of the development program as well as the production program was considered, ASD reached the conclusion that this type of control by the Government in the development portion was inadvisable. There are a number of reasons for this conclusion:

1. Although reasonable milestones can be established at the time of program initiation, experience indicates that the critical problems and critical paths initially defined are not necessarily the critical ones as the program evolves.

2. The interaction between program elements in terms of progress, cost, impact on subsequent events and actions required cannot be predicted with reasonable confidence at program initiation.

3. In order to proceed with a reasonable degree of certainty that a potential problem area

would be subject to management control under the development milestone approach, it might become necessary to select a multitude of relatively small milestones for Government review and decision. This could mean that the Government would in effect have to virtually supplant company management in the detailed execution of the development effort. Abrogation of the contractor's management prerogatives to this extent is considered unwise from the standpoint of meaningful contractual commitments on the program.

4. To define, before the fact, contractual provisions which will be in the best interest of the Government is complicated by the dynamic nature of the development program and the range of management actions, the choice of which will be dependent on the specific conditions encountered. Meaningful pricing and enforceable provisions under the range of possible conditions described are severely inhibited and negotiation and writing of such a document would be extremely complicated.

5. Although the application of development milestones is not recommended as a contractual technique to adjust the development program, it is possible to establish for program management purposes, periodic program reviews and technical

audits which would determine the necessity for program reorientation. The changes provision of a contract gives the Government the right to direct such a reorientation of the program at a negotiated equitable adjustment to the contract.

The application of the development milestone approach for control of production releases under the CPIF/FPIS contractual arrangement represents the preferred course of action for the F-15 program.

The F-15 program will be managed during each phase of the contract by a total of twenty-four milestones culminating with Tactical Air Command's acceptance of the aircraft into its operational inventory.[15] The demonstration milestones, the dates by which they are to be accomplished, and their criteria for their measurement are as follows:

1. Preliminary Design Review 30 Sep 1970

This milestone is achieved when the Government concurs with the contractor's F-15 airframe and avionics preliminary design approach or approves the contractor's plan to correct deficiencies identified by Government Requests for Action (REAs).

---

[15]See Figure 9-1.

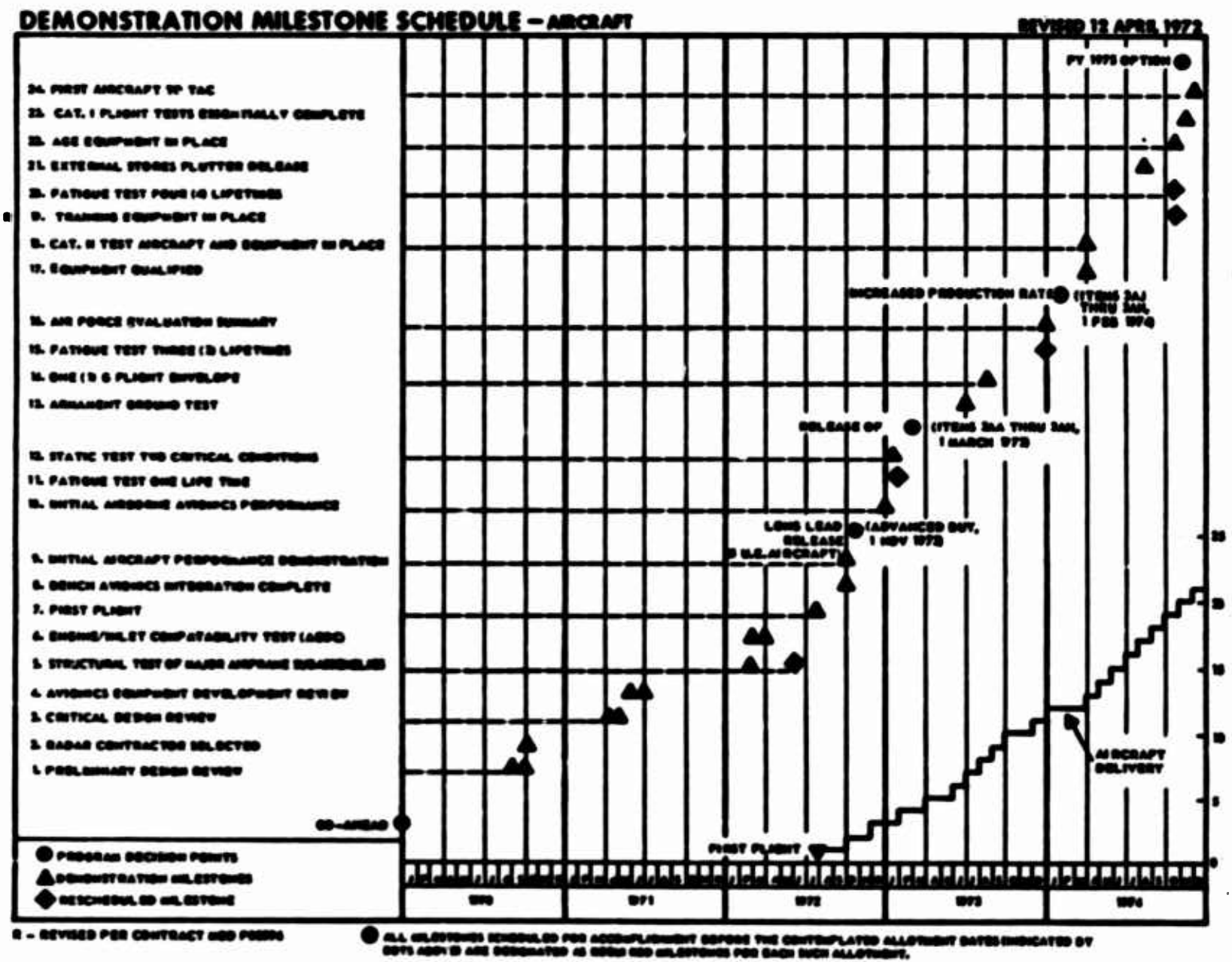

DEMONSTRATION MILESTONE SCHEDULE – AIRCRAFT
REVISED 12 APRIL 1972
24. FIRST AIRCRAFT TO TAC
23. CAT. I FLIGHT TESTS DESIGN FINALLY COMPLETE
22. AGE EQUIPMENT IN PLACE
21. EXTERNAL STORES FLUTTER RELEASE
20. FATIGUE TEST FOUR (4) LIFETIMES
19. TRAINING EQUIPMENT IN PLACE
18. CAT. II TEST AIRCRAFT AND EQUIPMENT IN PLACE
17. EQUIPMENT QUALIFIED
16. AIR FORCE EVALUATION SUMMARY
15. FATIGUE TEST THREE (3) LIFETIMES
14. ONE (1) G FLIGHT ENVELOPE
13. ARMAMENT GROUND TEST
12. STATIC TEST TWO CRITICAL CONDITIONS
11. FATIGUE TEST ONE LIFE TIME
10. INITIAL AIRBORNE AVIONICS PERFORMANCE
9. INITIAL AIRCRAFT PERFORMANCE DEMONSTRATION
8. BENCH AVIONICS INTEGRATION COMPLETE
7. FIRST FLIGHT
6. ENGINE/INLET COMPATABILITY TEST (ADDD
5. STRUCTURAL TEST OF MAJOR AIRFRAME SUBASSEMBLIES
4. AVIONICS EQUIPMENT DEVELOPMENT REVIEW
3. CRITICAL DESIGN REVIEW
2. RADAR CONTRACTOR SELECTED
1. PRELIMINARY DESIGN REVIEW
GO-AHEAD
PROGRAM DECISION POINTS
DEMONSTRATION MILESTONES
RESCHEDULED MILESTONE
FY 1973 OPTION
INCREASED PRODUCTION RATE
(ITEMS 2AJ THRU 2AM, 1 FEB 1974
RELEASE OF
(ITEMS 2AA THRU 2AH, 1 MARCH 1973
LONG LEAD RELEASE
(ADVANCED BUY, 1 NOV 1972
AIRCRAFT DELIVERY
FIRST FLIGHT
1970
1971
1972
1973
1974
R – REVISED PER CONTRACT MOD PENDING

Figure 9-1

2. Radar Contractor Selected 30 Sep 1970

This milestone is achieved when the subcontractor is selected to develop and produce the attack radar for the F-15 system, as defined in Aircraft/Attack Radar Interface Plan.

3. Critical Design Review (CDR) 30 Apr 1971

This milestone is achieved when all F-15 airframe CDR's have been conducted and the Government concurs that detail design of each configuration item meets the design requirements established in Configuration Item (CI) specifications and the interfaces between each CI and related equipment/facilities are established.

4. Avionics Equipment Development Review 30 Jun 1971

This milestone is achieved when the Government concurs that satisfactory progress has been achieved for the items reviewed during an Air Force-MCAIR Avionics Technical Review held to review the design, fabrication, and test status of the major CFE avionics equipment. The criteria by which the status of each equipment shall be measured will be based on the detailed development schedule negotiated prior to the subject subcontract award between MCAIR and their avionics subcontractors and the applicable prime item specification. At the option of the Government, selected data presented by

the supplier at these reviews will be verified by actual test or demonstration during the review.

5. Structural Test of Major Airframe Subassemblies — 15 Jun 1972

This milestone is achieved when structural tests including all static, fatigue, and sonic testing of major subassemblies required under the Preproduction Design Verification Test Category in the Aircraft Structural Integrity Plan (ASIP) and/or Structural Test Plans are completed and the test requirements are met in accordance with the following tests:

TEST

Stabilator Root Structure/Spindle-
Static Test

Wing Structural Box/Carry Thru-
Static Test

Stabilator Root Structure/Spindle-
Fatigue Test

Wing Structural Box/Carry Thru-
Fatigue Test

Integral Fuel Tank Sealing
Characteristics Fatigue

Test requirements will be met when test results of the above tests are approved.

6. Engine/Inlet Compatibility Test (AEDC) 31 Mar 1972

This milestone will be achieved when stable, stallfree engine operation, both steady state and transient (rapid throttle bursts and chops, afterburner light-offs and shutdowns) has been consistently demonstrated at all test points.

This full scale engine/inlet test, as defined in CP76301A328A082 including simulation of the local induced flow field, will be conducted in the transonic and supersonic sections of the AEDC Propulsion Wind Tunnel. Testing will be conducted at selected mach, altitude and attitude points. Points selected will be subject to Government approval and will be based on those conditions which are most adverse to the propulsion system and are anticipated to be most prevalent in ultimate aircraft utilization. This demonstration can be preceded by an initial test period during which the control systems operation will be investigated and adjustments incorporated.

7. First Flight 31 Jul 1972

This milestone is achieved when the first F-15 aircraft becomes airborne and the low and moderate mach number portion of the flight envelope is accomplished within reasonable constraint with respect to safety and risk.

8. Bench Avionics Integration Complete — 30 Sep 1972

Achievement of this milestone is defined as the integration of all of the preproduction models for the F-15 Avionics System. Interface compatibility, functional operation, and compliance with those performance specifications that can be tested in accordance with test information sheets on a representative mockup. The equipment to be integrated includes all contractor furnished avionics and all available GFAE avionics.

9. Initial Aircraft Performance Demonstration — 30 Sep 1972

This milestone shall be accomplished during the tests required by the Air Vehicle Specification and is achieved when:

a. The following performance requirements have been demonstrated without engine or inlet stall: flight to 80% MAX MACH; achieve level flight at 45,000 feet; perform a symmetrical maneuver to a positive 80% limit load factor.

b. Complete an accumulated flying time of at least 15 hours.

10. Initial Airborne Avionics Performance — 31 Dec 1972

This milestone is achieved when all CFE and available GFAE avionics are operated as an integrated subsystem in an airborne environment for a period of at least five (5) F-15 flights totaling a minimum of five (5) flight hours.

11. Fatigue Test One Lifetime 31 Jan 1973

This milestone is achieved when 4000 hours of the Government approved design loading spectrum have been sustained by the full scale test article in accordance with the Structural Test Plan without failure.

12. Static Test Two Critical Conditions 31 Jan 1973

This milestone will be considered complete when the full scale static article has sustained limit load (67% design ultimate) and ultimate load for the maximum up-bending horizontal tail load condition on the fuselage, without detrimental permanent deformation or failure.

13. Armament Ground Test 30 June 1973

This milestone is achieved when the ground tests for all required and available air-to-air stores and the 20MM gun are completed in accordance with the armament specifications, and the systems are qualified for flight.

14. One (1) G Flight Envelope 15 Aug 1973

This milestone is achieved when the Air Vehicle in the Basic Air Superiority Mission configuration has been cleared by the Government for first flight throughout the design speed/altitude envelope.

15. Fatigue Test Three (3) Lifetimes — 31 Dec 1973

This milestone is achieved when 12,000 hours of Government approved design loading spectrum, applied in accordance with the Structural Test Plan have been sustained without major failure by the full scale article.

16. Air Force Evaluation Summary — 31 Dec 1973

This evaluation will be considered complete when the SPO identified mandatory corrections items, reported during the Air Force Preliminary Evaluation on the flying qualities, performance, and avionics aircraft (#1, 2 and 3), have been corrected and verified by the Air Force. The verification will be accomplished during the Category II evaluation tests.

17. Equipment Qualified — 31 Mar 1974

This milestone is achieved when all air vehicle equipment components listed in the F-15 Specification Tree are qualified in accordance with Section 4 of the applicable specification.

18. Category II Test Aircraft and Equipment in Place — 31 Mar 1974

This milestone is achieved when the first Category II aircraft, one set of organizational and intermediate level

production AGE, and contractor engineering technical service personnel are operational at the Category II test facility designated by the Government.

19. Training Equipment In Place 31 Oct 1974

This milestone is achieved when one (1) Mobile Training Set (MTS) is set up and operational at the facility specified to support the first operation unit.

20. Fatigue Test Four (4) Lifetimes 31 Oct 1974

This milestone is achieved when 16,000 hours of Government approved design loading spectrum, have been sustained without major failure by the full scale article.

21. External Stores Flutter Release 15 Aug 1974

This milestone will be accomplished when:

a. The tests for flutter identified in Section 4 of the Air Vehicle Specification have been completed for the following two conditions:

   (1) The Basic Air Superiority aircraft in the ferry configuration.

   (2) The Basic Air Superiority aircraft in an external stores configuration determined by the Government.

b. The Government has granted flutter clearance of the aircraft in the configuration identified.

22. AGE Equipment In Place — 31 Oct 1974

This milestone is achieved when all CPE Unit Equipment AGE required to support an operational squadron as is in place and operational at the site specified by the Government.

23. Category I Flight Tests Essentially Complete — 15 Nov 1974

This milestone shall be defined as that point during the Category I Flight Test Program when:

a. The major functions and subsystem problems have been resolved.

b. The flight test requirements of the Prime Item Development Specifications have been essentially demonstrated.

c. Fifteen hundred (1500) Category I flight test hours have been accumulated on the F/TF air vehicles.

24. First Aircraft to TAC — 30 Nov 1974

This milestone is achieved when the Air Force accepts the first F/TF-15 aircraft for operational use.[16]

---

[16]All demonstration milestones described above have tied to them detailed design specifications, engineering requirements, performance specifications, and interface plans. Reference to these detailed specifications have not been included in this thesis due to space limitations. For those readers interested in these specifications, they are urged to consult attachment number five of the F-15 contract.

To date seven of the twenty-four milestones have been achieved.[17]

Milestone	Date Required	Date Accomplished
Preliminary Design Review	Sep 30, 1970	Sep 3, 1970
Radar Contractor Selected	Sep 30, 1970	Sep 3, 1970
Critical Design Review	Apr 30, 1971	Apr 8, 1971
Avionics Equipment Development Review	Jun 30, 1971	May 27, 1971
Airframe Structure Test	Jun 15, 1972	Feb 29, 1972
Engine/Inlet Test	Mar 31, 1972	Mar 6, 1972
First Flight	Jul 31, 1972	Jul 27, 1972

All milestones have thus far been accomplished earlier than required.

Controlling schedule appears to be the most significant aspect of the milestone concept. Milestones are performance goals. No trade-offs have been made thus far on the original performance specifications for the F-15. Thus milestones appear to be effective in controlling performance as well as controlling schedule.

It is pertinent to point out, however, that there are

---

[17]Captain Arthur R. Charles, USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS), F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Personal interviews, November 17, 1971, December 23, 1971 and July 29, 1972.

still a number of contractual issues to be resolved for successful implementation of this concept such as:

1. In implementing the milestone control of production releases, the Government must have the unilateral right to determine when a milestone is satisfactorily accomplished. Additionally, the Government must have the right to authorize part or all of the production release, to sustain the production rate, or to withhold the release until the event is satisfactorily accomplished. There is a question as to whether or not this unilateral decision should be subject to the disputes provision of the contract.

2. The feasibility of holding the systems contractors responsible for any delays in GFAE development resulting from the implementation of the milestone approach of the GFAE contract.

3. Questioning whether or not the approval or the acceptance of a milestone event constitutes incremental acceptance of aircraft performance, or whether the waiver of accomplishment of a specific milestone waives any future Government rights under the contract.

These additional issues which have been raised over the

use of demonstration milestones are certainly worth considering here:[18]

1. Whatever causes a program to be delayed or to over-spend by the time the milestone is achieved, is also quite likely to cause a significant change in its projected costs or schedules. Expecting contractors to hold to their option prices or leadtimes at such times thus is unrealistic, and serves to shift too much of the risk of a program to these contractors.

2. Another question raised about the technique is the possible negative effect that selecting single, simply-stated milestones for progress measurement might have on a development program as a whole. Large programs are complex, with many parts in various stages of development--and even early production--at any given time. Also, efficiency in the use of technical resources within and among programs is highly dependent on the opportunity to shift these resources with maximum flexibility and to go forward on discrete workable pieces as rapidly as possible. Should you, for example, hold up an entire program for review until the slowest part of the

---

[18]Norman Waks, Current Issues In Military Program Control, Report to the American Management Association Briefing Panel, September 9, 1969, (Bedford, Massachusetts: Mitre Corporation, 1969), pp. 12-13.

program has passed some special test? And should you be encouraged to bunch most of your best resources on a particular aspect of a program simply because that aspect will be under such close scrutiny?

3. Development programs do not proceed in a straight line. Rather, there is much feedback to and much iteration of the various parts of such programs. The question thus arises about whether the readings taken at any given or even several "milestone" points can be considered to be sufficiently conclusive to warrant, say, the cancellation of a program.

The usefulness of demonstration milestones applied to other major programs may be appropriate, however, their usefulness as a continuing procurement technique may well rest on the satisfactory resolution of these six major issues.

CHAPTER X

F-15 FORWARD PRICING AGREEMENT

Contract changes have an enormous impact on the procurement process. They are the largest single source of administrative headaches in contract administration and management. More appeals, claims, litigation and controversy results from contract changes than any other single cause.[1]

The Armed Services Procurement Regulation, in Section 1, paragraph 201.2, defines contract change as:

> . . .any written alteration in the specification, delivery point, rate of delivery, contract period, price quantity or other contract provisions of an existing contract whether accomplished by unilateral action in accordance with a contract provision, or by mutual action of the parties to the contract.

Contract changes may be classified into many different categories. The simplest and most straight-forward way to classify changes is as "task" or "non-task" changes.[2]

---

[1]Paul A. Baron, "Current Problems and Developments In Contract Changes," NCMA News Letter Anthology, Vol. I (Ingleside, California: National Contract Management Association), June, 1970, p. 1.

[2]James S. Reece, "'The Management of Change': A Catchword or An Opportunity?" National Contract Management Association, Vol. 5 (Spring 1971), pp. 123-137.

Task changes alter, add to, or delete tasks which were specified in the original contract and the accomplishment of these tasks was necessary to fulfill the original contract requirements. These are changes which physically alter the product configuration or make other non-hardware changes, such as changing flight test programs.

Non-task changes result in alterations of the quantities to be produced, delivery schedule and changes of funding rate adjustments.

The "Changes" clause is a required contract clause in all contract types currently in use for the procurement of weapons systems.[3] As mentioned earlier, the Procuring Contracting Officer (PCO) may make changes unilaterally or bilaterally (within the terms and conditions of the contract). In all cases, the Government will dictate what the requirements of the changes are to be. The Government, however, has to compensate the contractor for making changes. Compensation paid for the change in contract requirements is never a unilateral decision made by the Government, but must be negotiated and agreed upon by both parties to the contract. This equitable adjustment of contract change may be negotiated (1) at the time the change is made, (2) after the contract is over or (3) before the task is undertaken.

---

[3]U.S. Department of Defense, Armed Services Procurement Regulation Section 3-807.12, Washington, D. C.: U. S. Government Printing Office, 1969, p. 702.

This third method of the contract change and equitable adjustment is the one presently used by the F-15 Contracting Officer. The adjustments are made via a Forward Pricing Agreement (FPA) and are based upon statistical relationships between weight and cost.

Before the FPA is examined in detail to explore the advantages it provides, it would be helpful to examine the lengthy definitization process and the dysfunctional results when a FPA is not used, as well as the recognized need to shorten the change definitization process.

The Lengthy Definitization Process

A proposed change to the hardware or non-hardware items may originate with either the contractor or the Government. Usually the Government suggests changes at the systems performance specification level, the contractor is the one required to generate detailed engineering change proposals (ECPs) for Government evaluation. Normally when the contractor originates a change, he generates a preliminary ECP or an advanced change notice (ACN) to determine whether the Government is interested, then the contractor will generate the minutely detailed cost proposal. The cost proposal is the normal type "bottoms up" or "grass roots" industrial engineering approach.[4] This approach starts at a low level in the

4 C. A. Batchelder, et. al., An Introduction to Equipment Cost Estimating, Report No. RM-6103-SA, Santa Monica, California: The Rand Corporation, 1969, p. 2.

manufacturing organization by examining separate segments of work at a very low level of detail. The component estimates are then summed to the sub-assembly level and then to the end item level. This flow is indicated in Figure 10-1.

This detailed approach to estimating requires considerable time.

Once the Systems Program Office (SPO) receives the cost proposal, it must evaluate the proposal. The SPO generally requests the Air Force Plant Representative (AFPRO) and the Defense Contract Audit Agency (DCAA) for an technical evaluation. This technical evaluation involves the AFPRO, Industrial Engineer, Price Analyst, Industrial Specialist, Quality Assurance Representative, and the DCAA Auditor. They evaluate the proposal from the top to the bottom or "grass roots" level. They are provided assistance in their efforts at the lower levels by the contractor's industrial engineer who estimated the change originally.

When the SPO receives the evaluations, it must formulate a negotiation position, schedule negotiations, negotiate the change, and issue a supplemental agreement to the contract. This is an extremely long and drawn out procedure. See Figure 10-2.

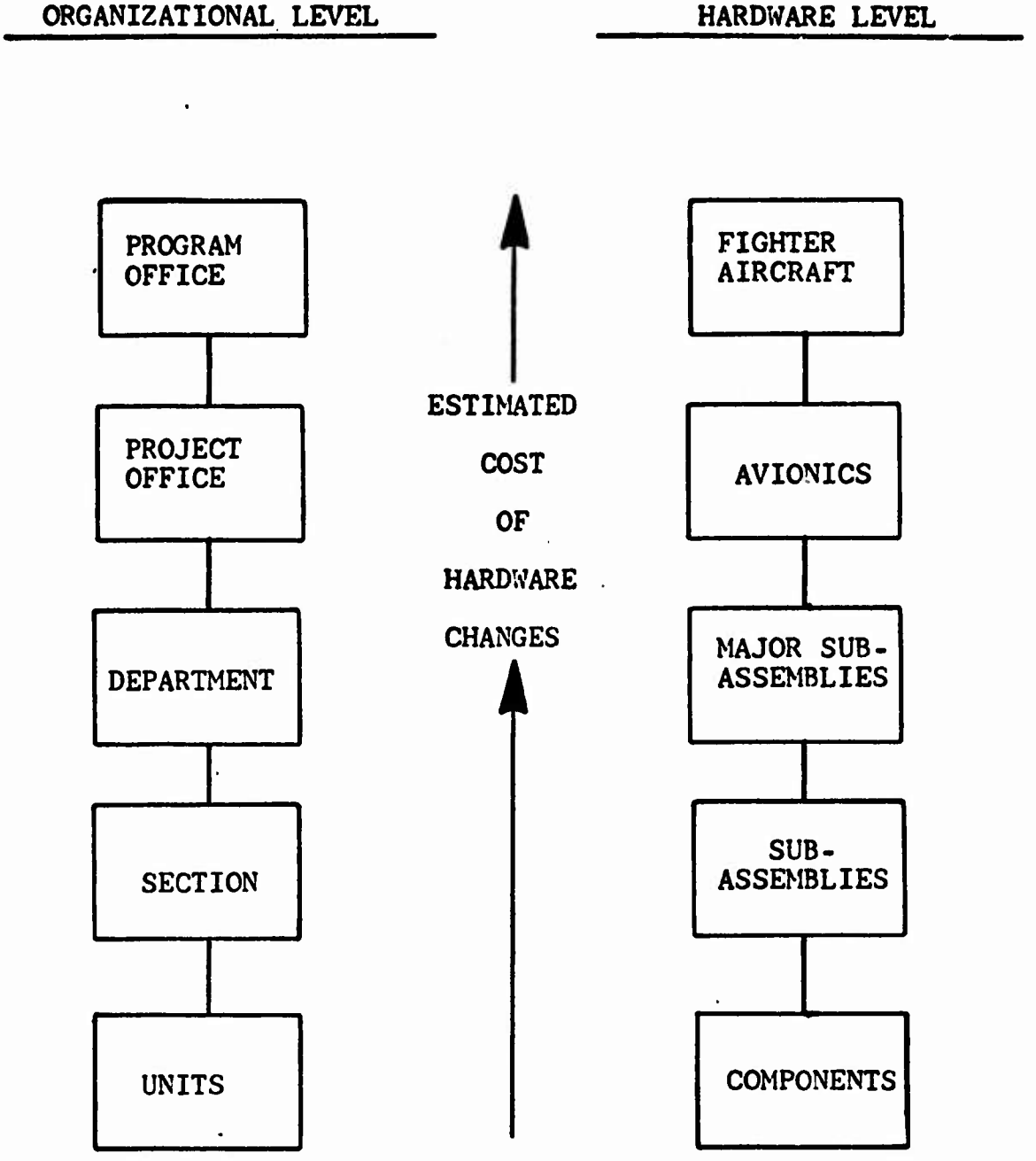


Figure 10-1

"Grass Roots" Approach to Estimating

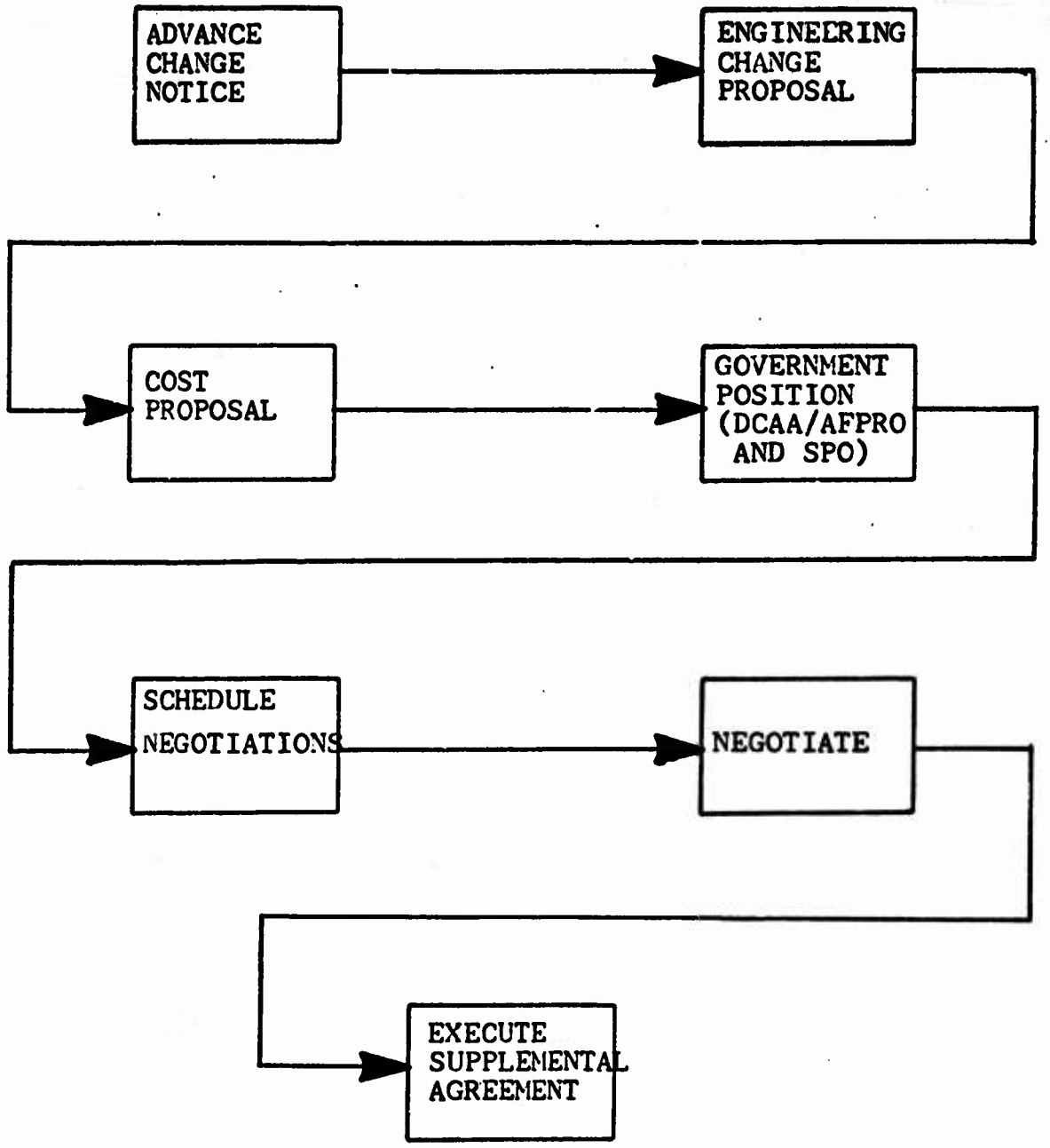


Figure 10-2

Lengthy Definitization Process

Results of Lengthy Definitization Process

The lengthy definitization process will often impact the effectivity of the change on the hardware. The longer it takes to implement the change, the more units move down the production line past the station at which the change could have been incorporated at the least amount of incremental cost. This results in a "redo" or "undo" task performed out-of-station (further down the production line or after delivery). One study indicated that this out-of-station rework takes, on the average, four times as long as the same task performed in-station and with a much higher material scrappage rate.[5]

The long change process clouds the communications channels between the SPO, AFPRO, and the Contractor. The fact that there is so much paper floating around in the communication channel can stagnate the design-decision process and prevent an equitable adjustment of the contract change.[6]

The numerous ECPs within the system can result in engineering changes obtaining an undefinitized status. This happens when the Configuration Control Board (CCBD)

---

[5]Reece, "Catchword or Opportunity", p. 131.

[6]Captain Arthur R. Charles, USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS), F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Personal interviews, November 17, 1971, December 23, 1971 and July 29, 1972.

agrees to a change and the change is not promptly negotiated. The Government's practice has been one of negotiating cost effects of changes after the work has already been accomplished.

The disadvantages of allowing changes to go "undefinitized" are many. While the Government may unilaterally direct changes, it lacks the authority to unilaterally set prices (except in the case of PCO determinations which are subject to appeal by the contractor). The price of an authorized but undefinitized change can become virtually what the contractor desires it to be. That is to say, the contractor is literally operating with a blank check with respect to any effort he wishes to attribute to the effects of the undefinitized change. Undefinitized changes not only lack dollar limitations, but are also written in broad terms, which make it all the more easy to attribute costs to the effects of the undefinitized change. This broad technical definition just naturally provides a greater area of interpretation for allocability of costs. Such a situation allows for the possibility referred to as "getting well."

Suppose the contractor is experiencing variances from his midpoint of expected cost outcome (contract target costs) on the definitized contract he is operating under, and the contractor has an undefinitized, broadly written change on hand to which he can assign costs considered by him to be within

the scope of the broadly written undefinitized change. A method of getting well on his basic contract's cost problems, and thereby protecting his original profit, becomes apparent. To assert that a deliberate misallocation of costs takes place would be to presume fraud. Convincing evidence would be required for such an allegation. In face of the contractor's ability to make broad interpretations in view of a broadly written change, the Government would be at a disadvantage with respect to substantiating such an allegation. The recognition of the above situation by all parties tempts one to conclude that undefinitized changes directly and specifically aid contractors in "getting well" on basic contracts. Others may call this situation de facto misallocation.

A related condition is one where the determinant of the ultimate cost of the change is related more to what can lawfully be spent on the change rather than what should be spent. Without the responsibility to deliver a product (the change effort) at a specified cost, the contractor has no incentive to control his expenses; the eventual profit he will request is never threatened. Such a situation has the characteristic of the illegal cost plus a percentage of cost method of contracting. Were an individual able to justify committing to have a home built with no commitment from the contractor as to price, he could then easily believe that

the undefinitized change approach is an acceptable way of conducting business.

The problem of undefinitized changes can operate in another direction. Suppose a change is contemplated and rough informal cost estimates are made by the contractor and subsequently the Government gives unilateral authority for the contractor to proceed with the change. Under conditions of a rather major change, the informal estimate can be so significant that the basic program may be threatened. Accordingly, reviews and deletions of requirements take place to bring the program costs back into acceptable bounds. Good sound requirements, otherwise cost effective, get dropped in the name of economy. Subtly the informal estimate, probably excessive, has become the "real" value and forces the balance of the program to suffer. Under such conditions it is easy to speculate that the informal estimate, once definitized, would become the subject of active value engineering by the contractor thereby doubling his already guaranteed profit on the basic change.

Also, the contractor is able to authorize work faster than he is able to budget for it. The result is work being performed on changed products using the old budget. The foreman thus loses control over performance and cost.[7]

Accordingly, the extent to which the Government is

---

[7]Reece, "Catchword or Opportunity", p. 132.

vulnerable to exploitation, by its use of undefined changes, appears to be limitless.

Recognized Need For Different Approach

The Blue Ribbon Defense Panel found a definite need for statistical approaches to cost estimating. The panel stated:

> Parametric cost estimation techniques offer the potential for improved planning of cost factors. These parametric methods require the analysis of historical data to establish some broad guage such as cost per pound for component units of the program being evaluated. The broad nature of this type of analysis precludes detailed comparisons with the estimated program costs developed from its elements, but the difference in gross totals can indicate a probable range of magnitude of the costs of contingencies. The use of the parametric approach to cost estimation is, of course, a clear acknowledgement of the inherent limitations and imprecision of any cost prediction methods.[8]

In their recommendations, the Panel concluded:

> Increased use should be made of parametric costing techniques to improve the quality of original and subsequent estimates, and to help offset the difficulties of estimating the cost of unknowns.[9]

Hudson B. Drake, in an article in the Harvard Business Review, made the following new policy recommendations to the buyers of advanced weapons systems:

---

[8] Report to the President and the Secretary of Defense on the Department of Defense by the Blue Ribbon Defense Panel, Gilbert W. Fitzhugh, Chairman, Washington, D.C.: Government Printing Office, 1970, p. 83.

[9] Ibid, p. 84.

> . . .Use parametric estimating techniques to project total program cost, which will allow for the emergence of unanticipated unknowns. . .. Compare the total "parametric" cost and the total itemized cost, and develop a reasonable and proper mix of performance, schedule and cost incentives on the basis of this comparison. ....[10]

Parametric techniques and related FPA parametric pricing methodology will be further defined in the next section.

F-15 Program Forward Pricing Agreement (FPA)

The Armed Services Procurement Regulation (ASPR) defines FPAs as follows:

> A forward pricing rate agreement is a written understanding negotiated between a contractor and the Department of Defense to make certain rates available for use during a specified time in pricing contracts or modifications. Such rates represent reasonable projections of specific costs to be incurred in future periods that are not easily estimated for, identified to, or generated by a specific contract end item or task such as, but not limited to, labor rates, overhead rates, material obsolescence and usage, spare parts provisioning, and material handling.[11]

The ASPR clause on the forward pricing agreement implies use of the FPA for plant wide standard variable items such as overhead pools and not the unique non-standard items related to one program. The F-15 Procurement Division is the

---

[10]Hudson B. Drake, "Major DoD Procurements at War With Reality," Harvard Business Review, Jan.-Feb. 1970.

[11]U.S. Department of Defense, Armed Services Procurement Regulation Section 3-807.12, Washington, D.C.: U.S. Government Printing Office, 1970.

first one to use a FPA to price unique non-standard items over the entire development, production and deployment phases.[12]

The F-15 FPA is an extra-contractual agreement signed by representatives of MCAIR and Aeronautical Systems Division (ASD) on 24 September 1971. FPA rates and factors are good for one year, but can be discontinued by either party at any time if the agreed upon rates and factors get too far out of line.

The rates and factors proposed by MCAIR were audited by the SPO, AFPRO and DCAA personnel. All fact-finding and negotiation was conducted at the MCAIR plant in St. Louis.[13]

The FPA contains mutually agreed upon parametric estimating relationships.

The parametric relationship is an independent variable through which dependent variables may be expressed. In the case of the F-15 FPA, the independent parametric is usually actual physical weight of an engineering change.

Parametric projecting of costs based upon aircraft weight is not new to the aerospace industry. The normal approach, however, is to use aggregate total weight of the aircraft to predict costs for specific changes. MCAIR has

---

[12]Charles interview.

[13]Ibid.

further refined the parametric estimating technique by gathering data based on aircraft sections. The sections used in the F-15 FPA are:

Forward Fuselage	Controls/Hydraulics
Center Fuselage	Furnishings
Aft Fuselage	Electrical
Wing	Fuel Systems
Empennage	Engineering Instrumentation
Landing Gear	Armament
Canopy (windshield)	Other

These costs per pound were based on statistics gathered on in-house effort at the St. Louis plant from 1949 to present, and is based upon experience with the F-4, F-3H, BANSHEE and F-101 aircraft.

Parametric Pricing Methodology

An actual illustration will now be presented to show the power of the forward pricing technique using parametric relationships. Weights, man hours per pound, and percent factors have been altered to preclude disclosure of proprietary information.

Suppose the Configuration Control Board has approved an engineering change. MCAIR says this change results in a net increase of ten pounds. The AFPRO and SPO engineers concur. We wish to price out non-recurring and recurring engineering costs for the change to the forward fuselage.

The procedure is indicated in Figure 10-3. Flow chart is shown as Figure 10-4.

By being computerized the entire procedure takes minutes rather than weeks or months as described in the section of this report on the lengthy definitization process. Changes which result in a decrease in aircraft section weight or changes which delete effort are handled in the same manner. Contract target costs are adjusted if the hardware change (upward or downward) is greater than $100,000.

Figures 10-3 and 10-4 show only one parametric relationship and only one application. The FPA between the SPO and MCAIR contains 51 parametric relationships with 106 applications. This allows the FPA to apply to most emergent changes. Even the flight test program changes can be priced in this manner by specifying the number of measurands (points of measurement) which are to be added or deleted.

Actual F-15 costs are tracked by MCAIR and reported monthly to the SPO. These actual costs (entered on a computer program) are compared to the rates provided in the FPA. This procedure serves two main purposes; it provides a basis for negotiating the FPA the following year or at any time the trend reflects that a factor has changed significantly and satisfies the requirements of PL87-653 (Truth in Negotiations) by supplying current cost and pricing data. In addition, the

FORWARD FUSELAGE

Non-Recurring Engineering

Section Weight:			
Before Eng Change	1,168 lbs.		
After Eng Change	1,178 lbs.		
Net	10 lbs.		
Section Manhours Per Pound	150		
10 lbs. @150 hrs/lb	1,500		
3% Eng Planning Factor	45		
20% Systems Integration	300		
Basic Design Eng Hours	1,845		
Eng Labor Rate @$10./hr		$18,450	
Eng Overhead (O/H) Rate @10%		1,845	
Total Eng Labor Cost			$20,295
Project Management Factor @15% of Basic Eng Hours	277		
Project Management Labor @$20./hr		$5,540	
Project Mgt O/H rate @2%		111	
			$ 5,651
Total Non-Recurring Eng Cost			$25,946

Recurring Engineering Hours

Basic Engineering Hours on 60% improvement curve (Assume 100 units)	420		
Engineering Labor @$10./hr		$4,200	
Engineering O/H @10%		420	
Total Recurring Eng Cost			$ 4,620
TOTAL ENGINEERING COST			$30,566

Figure 10-3

Forward Fuselage Engineering Cost

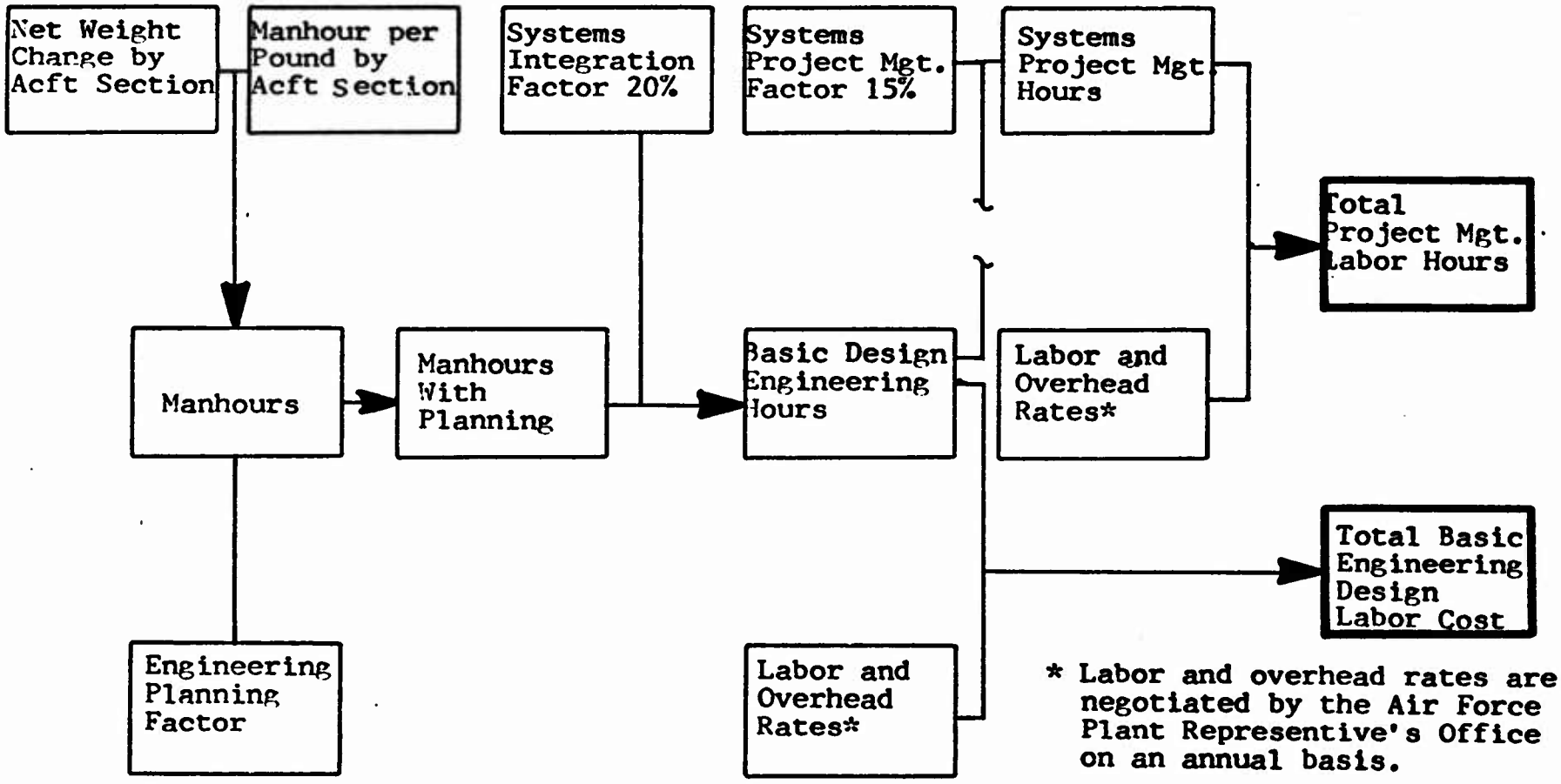


Figure 10-4

Engineering Flow Diagram

F-15 SPO will be better informed and better equipped to negotiate the re-sets of the FPIS targets within a minimum time period.

The parametric cost technique is a step forward in that it provides a powerful tool for estimating and pricing contract changes. The parametric technique provides a statistical "tops down" method of estimating changes which allows for speedy adjustments to production budgets in the plant, as well as saving the Government a considerable bit of time and money in the use of its scarce resources.

It aids both the Government and contractor in knowing (in real time) what the firm baseline is--not only in terms of cost but also in terms of schedule and performance. This is in lieu of having hundreds of authorized but undefinitized changes both in terms of cost and scope of effort.

In addition, the FPA provides an objective statistical procedure based upon actual historical data. The historical data has been modified with unique complexity factors which permit its use on the F-15 program.[14] This procedure provides for a fair and reasonable price without the necessity for the typically biased subjective judgment of engineers and the "haggling" and "rug merchant" approaches so typical of contracts personnel.

---

[14]A "complexity factor" would be applied for example when titanium is used instead of aluminum. A complexity factor of say, 1.33 would be added to the historical data which has aluminum as its base. All "complexity factors" are mutually agreed upon by the Government and MCAIR.

Parametric forward pricing agreements are an extremely useful and time saving management tool. The FPA provides the Government a means of effective control over the numerous contract changes generated during the acquisition of a weapons system. The contractor is also better able to achieve control over his budget.

Parametric forward pricing agreements should be used between the Government and contractor whenever a valid and reliable data base exists.

CHAPTER XI

F-15 VALUE ENGINEERING CONTRACT CLAUSE

Value Engineering (VE) is concerned with the elimination or modification of anything that contributes to the cost of an item but is not essential for performance, quality, reliability, standardization or interchangeability. The value engineering effort is aimed at analyzing the function of an item for the purpose of achieving that function at the lowest possible cost. In this context VE requires a novel and innovative approach to the design, engineering, manufacturing, and purchasing in achieving the necessary function at minimal cost.[1]

The Armed Services Procurement Regulation (ASPR) further defines VE in the following manner:

> "Value engineering as contemplated by this part constitutes a systematic and creative effort, not required by any other provision of the contract, directed toward analyzing each contract item or task to ensure its essential function is provided at the lowest overall cost. Overall cost may include, but need not be limited to; acquiring, operating, and logistically supporting an item or system."[2]

---

[1]Emanuel Kintisch, "Value Engineering Contract Clauses" Defense Industry Bulletin, Defense Supply Agency, February, 1970, pp. 13-14.

[2]Armed Services Procurement Regulation, Part 17, Section 1, June 30, 1969, p. 198.29.

It is the policy of the Department of Defense (DOD) that contractors will utilize value engineering techniques to reduce the cost of systems. Major prime contractors are also expected to encourage subcontractors to utilize value engineering.[3]

There are two types of value engineering clauses: (1) the value engineering incentive clause which provides for the contractor to share in cost reductions that ensue from change proposals he submits; and (2) the value engineering program requirements which require contractually for the contractor to engage in value engineering efforts in accordance with an established schedule. This schedule is worked out between the contractor and Government and provides for the contractor to share in the cost reductions ensuing from change proposals he may submit.

The VE incentive clause is required of all contracts in excess of $100,000. The VE program clause is required of all contracts in excess of $1,000,000.[4]

Since the F-15 contract is for two billion dollars, one would expect to see the VE program clause in the contract. This is not the case. The F-15 procurement office requested

---

[3] W. H. Riemer, Handbook of Government Contract Administration, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968, p. 999.

[4] ASPR, Part 1, Section 17, p. 198.31.
There are exceptions to the above requirements, but the stated values are the general policy figures for the inclusion of VE clauses.

and obtained permission to exclude the VE program clause. A recent report indicates that the program clause will probably become optional in the near future.[5]

The F-15 contract does contain the VE incentive clause. The basic incentive clause, however, has been substantially reworked to tailor it to the specific requirements of the F-15 weapon system.

As stated earlier, the VE incentive clause imposes no mandatory requirement nor provides any separate funding for a value engineering effort. The F-15 VE clause is further restrictive in that it doesn't require MCAIR to use its "best efforts" to include VE arrangements in any subcontracts. In addition, paragraph J, which calls for the sharing of future acquisition savings, has been dropped from the F-15 VE clause.

The contractor's benefits accrue only with successful value engineering accomplishments. There is no provision for offsetting costs incurred in unsuccessful value engineering efforts. This contractual arrangement places the burden on contractor management to analyze and determine the period and degree of their participation in the value engineering program, and to assure the existence of an organizational structure which will facilitate the successful operation of value engineering.

---

[5]Report on case 70-13, Value Engineering, ASPR Committee, Washington, D.C., May 24, 1972.

The VE sharing arrangement established by ASPR provides the contractor with from fifty (50:50)[6] to seventy-five per cent (25:75) of the instant contract saving for fixed priced type contracts.[7] The F-15 contract deviates from this share pattern substantially in setting up a 90:10 share ratio (90 per cent for the Government and 10 per cent for MCAIR) for any VE savings achieved on the development effort and 85:15 share ratio on the production effort. In addition, the contract targets remain constant and contractor reward is essentially delayed pending contract completion.

The reason for this strategy is that by having a 90:10 VE share ratio and 90:10 contract incentive structure, there will be no trade-offs made between value engineering and normal prudent management action.[8] By waiting until the contract is over to reward the contractor, he is rewarded only for real savings to the Government and not "paper" savings.

Consider the example indicated in Figure 11-1. For simplicity, target cost is 200 at point A. Target profit is X. Suppose the contractor submits a VECP which will reduce the cost to where target cost is now 100 at point B after readjusting the incentive curve. Now suppose at the end of the contract,

---

[6]The first number is always the Government's share and the second number is the contractor's percentage share of the savings.

[7]ASPR, Part 1, Section 17, p. 198.38.

[8]See Chapter VI.

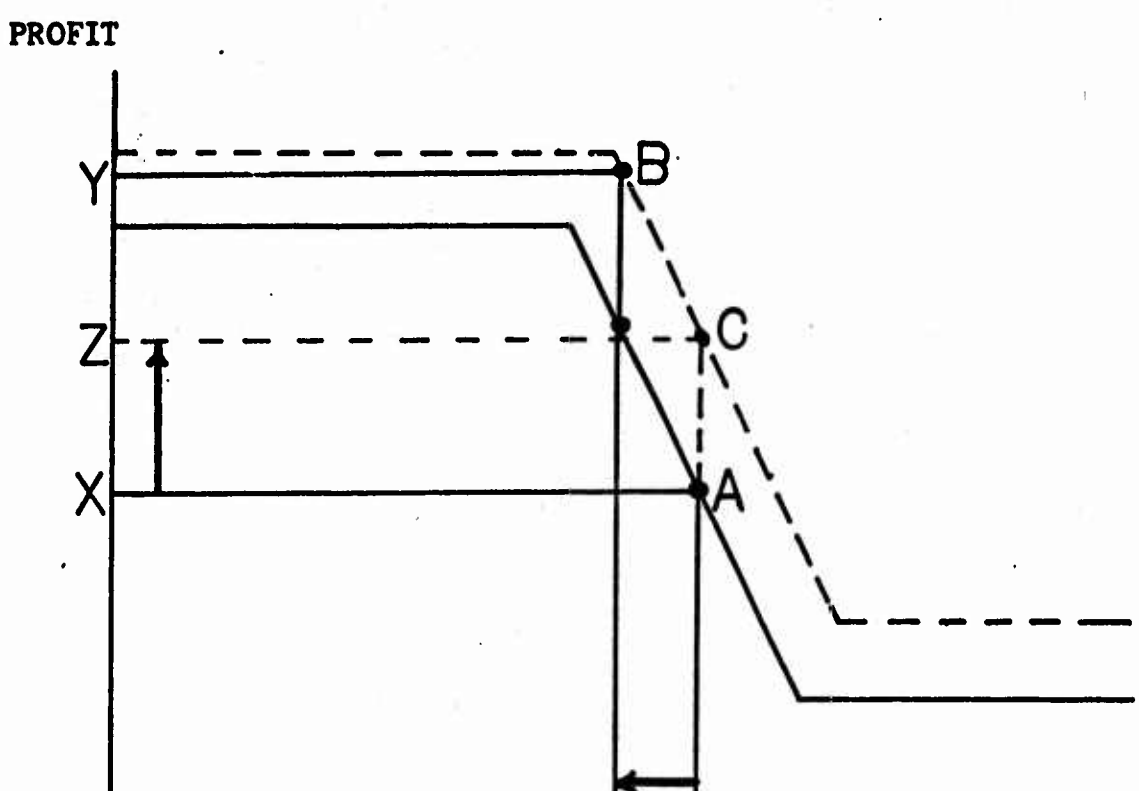


Figure 11-1
50:50 Share Line

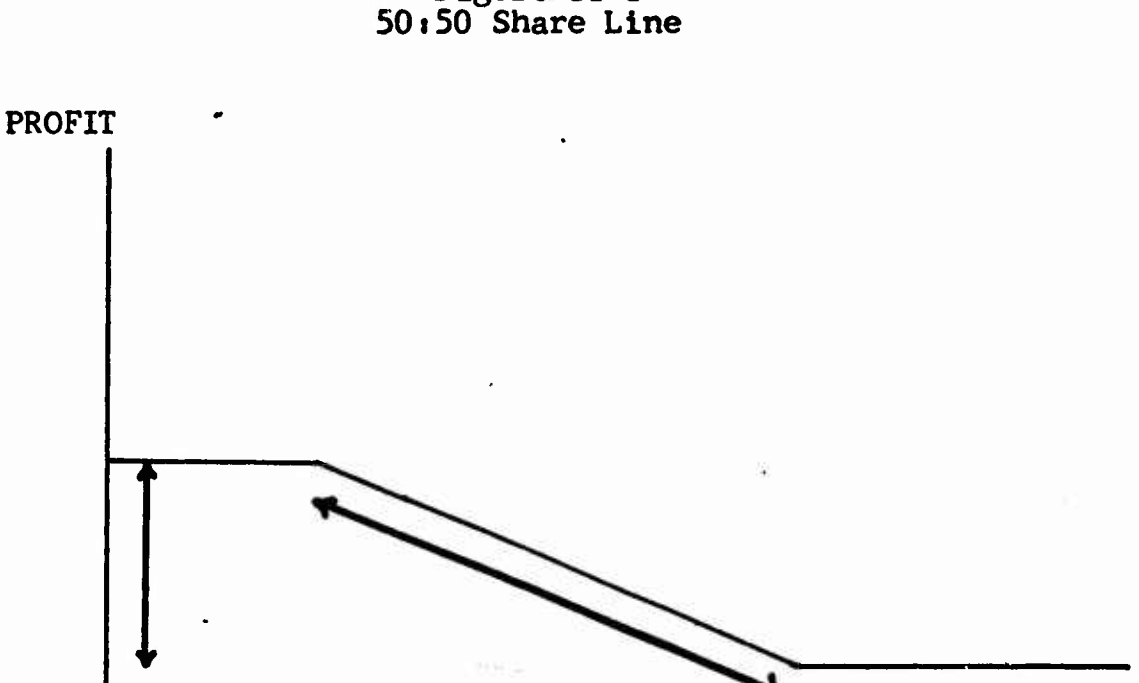


Figure 11-2
90:10 Share Line

several years later, actual costs are 200. The VECP did not appear to have worked. However, the contractor's profit is now Z amount, which is quite an increase from the original X amount.

In the F-15 contract there is only one incentive share line for value engineering and the development portion of the program. This share line has a 90:10 share ratio and is shown in Figure 11-2. The contractor can move anywhere along the share number line. If he moves to the left and undershoots target costs, he saves the Government money and is rewarded by extra profit.

This approach provides the contractor with maximum motivation to fully utilize the value engineering cost reduction sharing arrangement outlined in the F-15 contract and does, in fact, make for maximum positive motivation of the contractor as well as his subcontractors. By holding in suspense the money saved until the end of the program and not directly adjusting targets, the contractor(s) are constructively motivated to avoid the target figures in order to create a management reserve of funds with which to further refine their approach to program completion. The contractor thus motivated will expend every effort to organize a viable value engineering effort with respect to the submission of quality Value Engineering Change Proposals (VECPs).

Some of the most recent and significant F-15 VECPs which have been approved by the Configuration Control Board

(CCB) and incorporated under the "changes" clause of the contract are as follows: deletion of non-essential parts of static and fatigue tests ($392,000); use of off-the-shelf parts for the bleed valve leak detection system in the F-15 ($316,000); reduction in the scope of transparency qualification procedures ($1,490,000); and improvement of radar reliability test criteria ($3,443,000); and realignment of the Eglin AFB Category I Test Program, ($2,075,000).

The F-15 Value Engineering Program has been highly successful. Total savings of $29,741,895 have been estimated from VECPs approved as of July 15, 1972. Out of a total of forty-one VECPs received from the contractor for fiscal year 1971, twenty-five were approved for implementation. Seventy-one per cent of all VECPs processed were approved, which indicates a highly accurate filtering system for proposals. The number of VECPs approved exceeded the established goal by 166 per cent. The number of VECPs received has exceeded the goal by 195 per cent. This latter figure gives an indication of the degree to which the contractor has been motivated toward exceptional value engineering management, interest, and effort through a well incentivized contract supplemented by the individual efforts of military managers directly charged with the responsive implementation of the value engineering potential of the F-15 system.

The degree of success attained by the program in FY 71 was recognized by Department of Defense officials. Major John E. Baer, Configuration Management Officer, F-15 VE Monitor,

received the Air Force Systems Command (AFSC) Special Value Engineering Award for his efforts in behalf of the program. Also, MCAIR received a similar award from AFSC for its individual inputs to the program as well as its active program to train and motivate subcontractors and suppliers in the performance of value engineering.[9]

Proposed VE Changes

The high degree of success attained by the F-15 Value Engineering Program and other extensive testing by Aeronautical Systems Division has prompted the Air Force to recommend a different VE instant contract sharing provision for incorporation into the ASPR.

The proposed change will apply to major systems acquisition contracts and its use will be optional.[10] The content of the new VE clauses is quite similar to those presently incorporated in the F-15 contract. A VECP which results in an anticipated decrease in the cost of performance of the contract will be accepted by the Government. The new proposal will be incorporated into the contract by a contract modification. There will be no adjustment in the target cost, target profit or ceiling price.

---

[9]Major John E. Baer, F-15 System Program Office, Aeronautical System Division, Wright Patterson AFB, Ohio, Personal Interview, November, 1971.

[10]Letter from the Air Staff, Colonel T. L. Keheley, Chief, Contract Management Division, Procurement Policy, DCS Systems and Logistics, June 30, 1972.

In the event the proposal results in an increase in the overall cost of contract performance, the increase will be negotiated and incorporated under the "changes" clause of the contract. In this case the target cost, target profit and ceiling price are adjusted.[11]

The proposed ASPR changes by the Air Force cover Fixed Price Incentive (Firm Target), Fixed Price Incentive (Successive Targets) and Cost Plus Incentive contracts and may be included in the final revision of the VE section of the ASPR presently under consideration by the ASPR committee.[12]

A VE incentive clause very similar to the one being used in the F-15 contract is being proposed by the Air Force for incorporation into the ASPR. The F-15 VE clause, when used in conjunction with other contract clauses, is very effective. The clause, therefore, is worthy of consideration for other systems contracts. It should be pointed out, however, that the clause should not be lifted out and used in isolation. There is a great deal of planned interaction between the VE clause, the LOGO, the CPIF and the FPIS portions of the contract. To disrupt this interaction would reduce the effectiveness of any one of the contract clauses.

---

[11]Captain Arthur R. Charles, USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS). F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio, Personal interviews, November 17, 1971, December 23, 1971, and July 29, 1972.

[12]Air Staff Letter, June 30, 1972.

CHAPTER XII

OTHER SIGNIFICANT SPECIAL CLAUSES

The F-15 contract contains three other special provisions which are designed to assist in effective program management. These are a total system performance responsibility clause, correction of deficiency clause, and an option to adjust quantities clause.

Total System Performance Responsibility (TPSR)[1]

MCAIR, by signing the contract, accepted full responsibility for the successful integration of all systems and subsystems of the F-15 to achieve total system performance under system specification No. SS76301A328A001.[2]

This clause also requires MCAIR to assure integration of Government furnished aeronautical equipment (GFAE) produced by companies with which MCAIR has no privity of contract.[3] MCAIR is also required to witness the inspection and acceptance

---

[1]U.S. Department of Defense, "Acquisition Contract (Phase II) for F-15 Systems Support Service and Data Therefor," Contract F33657-70-C-0300, Dec. 31, 1969, p. 25-30.

[2]This is the overall performance specification the F-15 is required to meet before the aircraft is accepted by the Government.

[3]The Government presently has contracts with Pratt-Whitney for the engine, Hughes Aircraft Co. for the radar and Philco Ford for the guns.

testing of the aircraft engines and must give its written concurrence that the engines meet the engine specifications or enter into a written agreement with Pratt-Whitney with regard to what corrective action will be taken to assure that engine specifications have been met and acceptance test procedures have been satisfied. The Government has taken a further step to assure schedule compliance by stating that MCAIR is not relieved of its obligation of timely delivery of the aircraft because of failure to agree with Pratt-Whitney on the course or extent of corrective action to be taken in the event of a deficiency.

While MCAIR has responsibility for the engine integration, they are not penalized for any increase in costs due to changes agreed upon between the Government and the engine contractor. In addition, MCAIR is compensated for any time expended in the performance of work required for total system integration.

The contractor indicates that he believed the integration effort would be improved by having the engine as Contractor Furnished Equipment. Evidence offered in support of his claim is the task of integrating the system radar contractor which he feels is technically quite complex. That complex integration effort is considerably eased by the radar contractor's appreciation of the airframer's final authority as the ultimate contracting agent with whom he must deal.

The contractor's position has merit. If it is desirable that one source (such as an airframer) be responsible for the system integration effort, he (the airframer) should be allowed authority to accomplish that task. That authority should extend to being able to literally force each member of the system to solutions that the integrator feels to be in the system's best interest. As it is, the Government desires that a contractor be the integrator, and have "total responsibility, but seems to select-out parts of the total system for Government procurement on such grounds as "commonality."

In instances where it is desirable that one contractor be the integrator, his authority should be absolute. If for considerations such as commonality or the savings of a prime's add-ons (overhead, profit, etc.) one part of a particular system is excluded from the contractor's CFE list, notions of TSPR are lessened by that degree. The associate contractor seems ultimately to look to who controls his contract--the Government or the prime, to determine to what extent he will cooperate in a particularly complex integration effort.

Under this clause, MCAIR has agreed to furnish F-15 system cost, schedule and performance impact statements on all engine change proposals.[4] They have also agreed to accept any changes in the engine specification directed by the Government.

---

[4]"Acquisition Contract," p. 49.

This acceptance will in no way relieve MCAIR of their total system performance responsibility. Lastly, the clause requires MCAIR, in order to properly fulfill its obligation, to enter into an agreement with Pratt-Whitney to apportion liability between the two prime contractors.

The total system performance responsibility clause greatly aided the administration of the development program by assuring that all systems were compatible when it was time for the first flight test.

While this clause is specifically tailored to the requirements of the F-15 program, it represents a feasible way of reducing the risk of system-subsystem incompatibility and is worthy of consideration for inclusion in other future DOD weapon systems contracts.

Correction Of Deficiencies (COD)

The problem of quality and conformance to specification is of paramount importance in Government procurement. Many disputes can arise from interpretation of a contract. These disputes arise either from difficulties with specifications or from whether the products or services meet the required contractual specifications.[5]

The correction of deficiencies clause in the F-15

---

[5]John A. McCann, ed., Government Contract Law. The Ohio State University Research Foundation, 1970, p. 158.

contract was greatly strengthened in language and content, when compared with earlier DOD contracts, to delineate as clearly as possible the contractor's responsibilities with regard to correction of deficiencies.[6]

The correction of deficiencies clause not only applies to the item in which the deficiency was discovered, but also to any supplies which are affected as a result of the correction of a deficiency in the prime item. This includes spare parts, aeronautical ground equipment (AGE), AGE spare parts, training equipment and related technical data.

This effort by the SPO was an attempt to preclude any excessive costs on the part of the Government to repair failed secondary equipment caused by the "domino effect" of prime equipment deficiencies. This particular wording was not used in the C-5 contract and consequently the contractor denied this specific responsibility under the contract.[7]

MCAIR agreed to correct any deficiencies discovered within eighteen months after delivery of the last Category II test aircraft with respect to supplies and services (aircraft not included).

---

[6]Edwin C. Eads, Master's Thesis, "The F-15 Air Superiority Aircraft--A Study of the Weapons System Acquisition Process. Industrial College of the Armed Forces, Washington, D.C., March 1971, p. 7.

[7]Major Norm Patterson, Judge Advocate General's Office, Aeronautical Systems Division, Wright Patterson AFB, Ohio. Personal interview, June 9, 1972.

The correction of deficiencies clause applies to aircraft for a period of eighteen months after delivery of the last Category II test aircraft or six months after delivery of an aircraft whichever is later.

With regard to time extensions and contract price, the contract further specifies:

> "In no event shall the Government be responsible for extension or delays in the scheduled deliveries or periods of performance under this contract as a result of the contractor's obligation to correct deficiencies, nor shall there be any adjustment of the delivery schedule or period of performance as a result of such correction of deficiencies, except as may be agreed to by the Government in a supplemental agreement with adequate consideration."[8]

> "It is hereby specifically recognized and agreed by the parties hereto that this clause shall not be construed as obligating the Government to increase the contract target cost/fee/price or ceiling."[9]

To date, no situation has developed which would require the SPO to take any action under the correction of deficiencies clause of the F-15 Systems Contract.

---

[8] Acquisition Contract, p. 46.

[9] Ibid.

While the Government has never had to invoke the correction of deficiencies clause, it appears that the existence of the clause in the contract has had a persuasive influence on the conduct of business between the contractor and the Government.

To state that this clause should be incorporated into future weapons systems is a very difficult task. The clause appears to have a positive influence in assuring a type of warranty for the complex F-15 weapon system. If the COD clause is incorporated into other acquisition contracts, it should be done only after appropriate modifications have been made.

Option To Adjust Quantities

The F-15 contract contains a clause which allows the Government to adjust the quantities procured under production portion of the contract (item 3). Specifically the contract states:

> "The Government shall have the option hereunder to adjust quantities of production aircraft procured under item 3 and under the options granted by part XXIV, from 50 to 150 per cent of the quantities specified in this contract . . .."[10]

---

[10]"Acquisition Contract", p. 50a.

This clause provides the Government the right to adjust the production quantities of aircraft once each fiscal year in the following manner:

Fiscal Year	Low	Contract Quantity	High
1973	15	30	45
1974	39	77	116
1975	72	144	216
1976	35	70	105

Since Congress is not a party to the F-15 contract and has been known to revise its appropriations from time to time, this clause is primarily a hedge against changes in funding levels. In addition, the clause provides for changes in force composition due to altered operational requirements.

While this clause is not entirely a new innovation in Government contracting[11] its structure and application in the F-15 contract make it the most comprehensive clause of this nature devised to date.[12] There are only three factors contained in the repricing algorithm: (1) the quantity purchased, (2) the economic factor and (3) the additional tooling factor.[13]

---

[11]A similar clause was used in the Air Force C-5 contract and the Navy F-14 contract.

[12]Patterson interview.

[13]A mathematical relationship used to price the production run if the option to adjust quantities is exercised.

The option to adjust quantities clause is supported by a predetermined set of procedures and formulae for computing the revised prices for the quantity selected. Once the new quantity to be procured is determined, its proper sequence in the cumulative production price schedule is selected from Table 12-1. The proper price for the new production is determined by subtracting the cumulative price of the number of production aircraft procured in previous fiscal years from the cumulative price of the number of production aircraft procured in the previous and current fiscal years.

Next, the quantity factor is determined for the new production by selecting the appropriate factor from Table 12-2.

After having determined the quantity factor, the economic factor must be found. The economic factor is selected from the appropriate row in Table 12-3.

The final factor which goes into this repricing model is the tooling factor. The tooling factor is based upon the peak production rate per month. These rates are shown in Table 12-4. Additional tooling is required only if the delivery rate is greater than three aircraft per month.

After the prices and factors have been determined, the contract target price, target cost, and ceiling price must be computed. To show how these prices are computed and

TOTAL AIR VEHICLE (WBS 1000) AND SYSTEM PROJECT MANAGEMENT (WBS 5000) (Ap)

FOLLOWING 20 CAT I & II AIRCRAFT

(FY 1973 DOLLARS)

DATE 12/08/69
F15 FLAT ECONOMICS PRICE CURVE

UNIT	CUM TOTAL	UNIT	CUM TOTAL	UNIT	CUM TOTAL	UNIT	CUM TOTAL	UNIT	CUM TOTAL	UNIT	CUM TOTAL
01	15 317 358	51	340 457 309	101	583 620 950	151	797 034 245	201	987 150 816	251	1 162 887 583
02	26 462 248	52	345 712 024	102	588 174 046	152	801 030 864	202	990 775 150	252	1 166 315 529
03	34 435 306	53	350 945 436	103	592 717 724	153	805 018 459	203	994 393 338	253	1 169 740 379
04	45 716 214	54	356 158 030	104	597 252 092	154	808 997 129	204	998 005 422	254	1 173 162 221
05	54 514 231	55	361 350 273	105	601 777 261	155	812 966 952	205	1 001 611 449	255	1 176 581 097
06	62 945 635	56	366 522 611	106	606 293 335	156	816 928 005	206	1 005 211 433	256	1 179 997 012
07	71 093 890	57	371 675 476	107	610 800 418	157	820 880 342	207	1 008 805 449	257	1 183 409 940
08	78 979 331	58	376 809 279	108	615 295 857	158	824 824 099	208	1 012 393 499	258	1 186 820 015
09	86 648 441	59	381 924 418	109	619 777 049	159	828 759 288	209	1 015 975 650	259	1 190 227 130
10	94 178 785	60	387 021 276	110	624 244 169	160	832 686 002	210	1 019 551 930	260	1 193 631 341
11	101 531 864	61	392 100 221	111	628 697 389	161	836 604 311	211	1 023 122 377	261	1 197 032 669
12	108 744 879	62	397 161 608	112	633 136 876	162	840 514 286	212	1 026 687 027	262	1 200 431 133
13	115 831 877	63	402 205 780	113	637 562 795	163	844 415 995	213	1 030 245 918	263	1 203 826 676
14	122 804 528	64	407 233 067	114	641 975 307	164	848 309 507	214	1 033 800 100	264	1 207 219 421
15	129 672 669	65	412 243 798	115	646 374 569	165	852 194 888	215	1 037 350 614	265	1 210 609 287
16	136 444 692	66	417 238 251	116	650 760 737	166	856 072 205	216	1 040 897 481	266	1 213 996 347
17	143 127 835	67	422 216 755	117	655 133 961	167	859 941 523	217	1 044 440 723	267	1 217 380 596
18	149 724 399	68	427 179 587	118	659 494 289	168	863 802 906	218	1 047 980 358	268	1 220 762 045
19	156 251 914	69	432 127 026	119	663 842 169	169	867 656 418	219	1 051 516 407	269	1 224 140 707
20	162 703 269	70	437 059 342	120	668 177 439	170	871 502 121	220	1 055 049 891	270	1 227 516 595
21	169 086 816	71	441 976 796	121	672 500 343	171	875 340 076	221	1 058 577 928	271	1 230 889 723
22	175 406 449	72	446 879 642	122	676 811 017	172	879 170 345	222	1 062 103 240	272	1 234 260 131
23	181 665 671	73	451 768 124	123	681 109 506	173	882 992 947	223	1 065 625 144	273	1 237 627 742
24	187 867 653	74	456 642 482	124	685 396 207	174	886 809 062	224	1 069 143 563	274	1 240 992 659
25	194 015 271	75	461 502 944	125	689 670 986	175	890 615 627	225	1 072 658 509	275	1 244 354 853
26	200 111 151	76	466 349 737	126	693 934 056	176	894 415 741	226	1 076 170 006	276	1 247 714 367
27	206 157 693	77	471 183 077	127	698 185 544	177	898 208 460	227	1 079 678 072	277	1 251 071 193
28	212 157 103	78	476 003 175	128	702 425 570	178	901 993 841	228	1 083 182 725	278	1 254 425 322
29	218 111 414	79	480 810 238	129	706 654 256	179	905 771 937	229	1 086 683 996	279	1 257 776 744
30	224 022 503	80	485 604 464	130	710 871 718	180	909 542 905	230	1 090 181 866	280	1 261 125 613
31	229 892 109	81	490 386 048	131	715 078 074	181	913 306 499	231	1 093 676 389	281	1 264 471 797
32	235 721 849	82	495 155 179	132	719 273 434	182	917 063 070	232	1 097 167 572	282	1 267 815 347
33	241 513 227	83	499 912 040	133	723 457 916	183	920 812 572	233	1 100 655 431	283	1 271 156 278
34	247 267 647	84	504 656 809	134	727 631 624	184	924 555 056	234	1 104 139 984	284	1 274 494 622
35	252 986 422	85	509 389 662	135	731 794 648	185	928 290 574	235	1 107 621 249	285	1 277 830 329
36	258 670 781	86	514 110 768	136	735 947 154	186	932 019 177	236	1 111 099 242	286	1 281 163 471
37	264 321 881	87	518 820 292	137	740 089 186	187	935 740 913	237	1 114 573 980	287	1 284 494 040
38	269 940 806	88	523 518 396	138	744 220 865	188	939 455 833	238	1 118 045 481	288	1 287 822 045
39	275 528 580	89	528 205 235	139	748 342 294	189	943 163 985	239	1 121 513 760	289	1 291 147 498
40	281 086 168	90	532 880 964	140	752 453 570	190	946 865 416	240	1 124 978 834	290	1 294 470 409
41	286 614 482	91	537 545 731	141	756 554 791	191	950 560 176	241	1 128 440 719	291	1 297 790 792
42	292 114 384	92	542 199 683	142	760 646 053	192	954 248 309	242	1 131 899 432	292	1 301 108 650
43	297 586 692	93	546 842 961	143	764 727 449	193	957 929 844	243	1 135 354 989	293	1 304 424 001
44	303 032 181	94	551 475 705	144	768 799 073	194	961 604 884	244	1 138 807 405	294	1 307 736 853
45	308 451 588	95	556 098 049	145	772 861 015	195	965 273 416	245	1 142 256 696	295	1 311 047 214
46	313 845 614	96	560 710 128	146	776 913 364	196	968 935 505	246	1 145 702 878	296	1 314 355 101
47	319 214 925	97	565 312 069	147	780 956 210	197	972 591 104	247	1 149 145 966	297	1 317 660 517
48	324 560 157	98	569 903 999	148	784 989 638	198	976 240 526	248	1 152 585 976	298	1 320 963 475
49	327 881 917	99	574 486 043	149	789 013 734	199	979 883 546	249	1 156 022 922	299	1 324 263 985
50	335 180 783	100	579 058 320	150	793 028 582	200	983 520 295	250	1 159 456 819	300	1 327 562 057

Table 12-1

QUANTITY ADJUSTMENT FACTORS (Q_F)

Item 3 1973 Segment

Quantity	Adjustment Factor (Q_F)
15	1.2742
30	1.000
45	.9293

Formula for Quantities from 15 - 45 (n = new FY quantity)

15 to 30 $Q_F = 1 + .01828\ (30-n)$
30 to 45 $Q_F = 1 + .00471\ (30-n)$

Item 3 1974 Segment

Quantity	Adjustment Factor (Q_F)
39	1.1946
77	1.000
116	.9517

Formula for Quantities from 39 - 116 (n = new FY quantity)

39 to 77 $Q_F = 1 + .00512\ (77-n)$
77 to 115 $Q_F = 1 + .00127\ (77-n)$

Option Quantity - FY 1975

Quantity	Adjustment Factor (Q_F)
72	1.1526
144	1.000
216	.9647

Formula for Quantities from 72 - 216 (n = new FY quantity)

72 to 144 $Q_F = 1 + .00212\ (144-n)$
144 to 216 $Q_F = 1 + .00049\ (144-n)$

Option Quantity - FY 1976

Quantity	Adjustment Factor (Q_F)
35	1.1295
70	1.000
105	.9681

Formula for Quantities from 35 to 105 (n = new FY quantity)
35 to 70 $Q_F = 1 + .00180\ (70-n)$
70 to 105 $Q_F = 1 + .00091\ (70-n)$

Table 12-2

ECONOMIC FACTORS (E_F)

Fiscal Year	Delivery Period	Economic Factor
1973	November 1974 to September 1975	1.000
1974	October 1975 to July 1976	1.0339
1975	July 1976 to June 1977	1.0684
1976	July 1977 to December 1977	1.1081

Table 12-3

ADDITIONAL RATE TOOLING (AT_R)
(FY 1973 Dollars)

	Additional Rate Tooling (AT_R)
From 3 Aircraft Per Month to 4 Aircraft Per Month	$ 6,137,000
5 Aircraft Per Month	11,952,000
6 Aircraft Per Month	15,505,000
7 Aircraft Per Month	19,381,000
8 Aircraft Per Month	22,935,000
9 Aircraft Per Month	26,003,000
10 Aircraft Per Month	29,072,000
11 Aircraft Per Month	31,656,000
12 Aircraft Per Month	34,240,601
13 Aircraft Per Month	37,170,000
14 Aircraft Per Month	39,986,000
15 Aircraft Per Month	42,704,000
16 Aircraft Per Month	45,335,000
17 Aircraft Per Month	47,886,000
18 Aircraft Per Month	50,367,000

Table 12-4

the interrelationship of the factors, the following notation will be used:

E_F is the economic factor from Table 12-3.

Q_F is the quantity factor from Table 12-2.

AT_R is the additional rate tooling from Table 12-4.

AT_C is the adjusted target cost.

AC_P is the adjusted ceiling price.

AT_P is the adjusted target price.

A_P is the selected quantity price from Table 12-1.

For the contract production effort under Item 3 of the contract the following formula is used to adjust the target price, cost and ceiling price:

$$AT_P = (A_P \times Q_F \times E_F) + (AT_R \times E_F)$$

$$AT_C = \frac{AT_P}{1.09}$$

$$AC_P = AT_C \times 1.45$$

Only the ceiling price is computed for the option quantities for fiscal years 1975 and 1976. This ceiling price is computed in the following manner:

FY 1975

$$AC_P = \left[(AP \times Q_F \times E_F) + (AT_R \times E_F)\right] 1.204$$

FY 1976

$$AC_P = \left[(AP \times Q_F \times E_F) + (AT_R \times E_F)\right] 1.254$$

To demonstrate the ease with which the algorithm is applied, the following example is provided:

ASSUMPTIONS:

- FY 1973 quantity is changed to 40 aircraft. Peak monthly delivery rate is 4 aircraft per month.
- FY 1974 quantity is 77 aircraft. Peak monthly delivery rate is 12 aircraft per month.
- FY 1975 option quantity is changed to 168 aircraft. Peak monthly delivery rate is 14 aircraft per month.
- FY 1976 option quantity is changed to 90 aircraft. Peak monthly delivery rate is 15 aircraft per month.

CALCULATIONS:

- FY 1973 adjusted target price (AT_P) is determined as follows:

  $$AT_P = (A_P \times Q_F \times E_F) + (AT_R \times E_F)$$

  A_P is the value for the first 40 aircraft from Table 1 or $281,086,168

  $Q_F = 1 + .00471\ (30 - 40)$ from Table 2

  $= 1 - .0471$

  $= 0.9529$

E_F = 1.0000 from Table 3

AT_R = $6,137,000 from Table 4

Substituting in the above equation therefore:

$$AT_P = (\$281,086,168 \times 0.9529 \times 1.0000) + (\$6,137,000 \times 1.0000)$$

$$= \$267,847,009 + \$6,137,000$$

$$= \$273,984,009$$

- FY 1974 adjusted target price (AT_P) is determined as follows:

$$AT_P = (A_P \times Q_F \times E_F) + (AT_R \times E_F)$$

A_P is the value for 77 aircraft following the FY 1973 quantity of 40. This value from Table 1 is selected at the 117 aircraft, less the value through the first 40 from FY 1973.

Cum thru Aircraft No. 117 = $655,133,961, less
Cum thru Aircraft No. 40 of $281,086,168 = $374,047,793

Q_F = 1.000 from Table 2

E_F = 1.0339 from Table 3

AT_R = $34,240,601 (12 aircraft/month) - $6,137,000 (4 aircraft/month from FY 1973) = $28,103,601 from Table 4.

Substituting in the formula:

$$AT_P = (\$374,047,793 \times 1.000 \times 1.0339) + (\$28,103,601 \times 1.0339)$$

$$= \$386,728,013 + \$29,056,313$$

$$= \$415,784,326$$

- FY 1975 adjusted ceiling price (AC_P) is determined as follows:

$$AC_P = [(A_P \times Q_F \times E_F) + (AT_R \times E_F)] \times 1.204$$

A_P is the value for 168 aircraft following the FY 1973 and 1974 quantities (Cum 117). This value from Table 1 is as follows:

Cum thru Aircraft No. 285 = $1,277,830,329, less the cum thru Aircraft No. 117 of $655,133,961 = $622,696,368

Q_F = 1 + .00049 (144-168)

= 1 - .01176

= .98824

E_F = 1.0684

AT_R = $39,986,000 (14 aircraft/month) - $34,240,601 (12 aircraft/month from FY 1974) = $5,745,399

Substituting in the formula:

$$AC_P = \left[(\$622,696,369 \times .98824 \times 1.0684) + (\$5,745,399 \times 1.0684)\right] \times 1.204$$

$$= \left[\$657,465,004 + \$6,138,384\right] \times 1.204$$

$$= \left[\$663,603,388\right] \times 1.204$$

$$= \$798,978,479$$

o FY 1976 adjusted ceiling price (AC_P) is determined as follows:

$$AC_P = \left[(A_P \times Q_F \times E_F) + (AT_R \times E_F)\right] \times 1.254$$

A_P is the value for 90 aircraft following the FY 1973, FY 1974, and FY 1975 quantities (Cum 285). This value from Table 1 is as follows:

Cum thru Aircraft No. 375 = $1,568,608,751, less the cum thru Aircraft No. 168 of $1,277,830,329 = $290,778,422

Q_F = 1 + .00091 (70 - 90)

= 1 - .0182

= .98180

E_F = 1.1081

AT_R = $42,704,000 (15 aircraft/month) - $39,986,000 (14 aircraft/month from FY 1975) = $2,718,000.

Substituting in the formula:

$$AC_P = [(\$290,778,422 \times .98180 \times 1.1081) + (\$2,718,000 \times 1.1081)] \times 1.254$$

$$= [\$316,347,319 + \$3,011,816] \times 1.254$$

$$= \$319,359,135 \times 1.254$$

$$= \$400,476,355$$

CALCULATION OF OPTION TO ADJUST QUANTITIES FROM 50 TO 150 PERCENT

The validity of the adjustment formula may be tested by applying the formula provisions to determine the current contract prices. The Fiscal Year 1974 and Fiscal Year 1975 procurements have been used as examples.

- The Fiscal Year 1974 procurement includes 77 aircraft, or a cum total (including Fiscal Year 1973) of 107 aircraft. The target price may be calculated as follows:

  $$AT_P = (A_P \times Q_F \times E_F) + (AT_R \times E_F)$$

  A_P is the target price from Table 1 of cum aircraft No. 117, which is $610,800,418, less the cum aircraft thru FY 1973 or cum No. 30, which is $224,022,503, or an FY 1974 T_P of $386,777,915

  Q_F = 1.000 from Table 2

  E_F = 1.0339 from Table 3

  AT_R = $34,240,601 from Table 4 (tooling for the 12 aircraft per month rate of FY 1974)

Substituting in the formula, the following applies:

$$AT_P = (\$386,777,915 \times 1.000 \times 1.0339) + (\$34,240,601 \times 1.0339)$$

$$= \$399,889,686 + \$35,401,357$$

$$= \$435,291,043$$

Current Contract Prices	Total Price
Item 3AJ - Single-Place Aircraft	$383,210,000
Item 3AK - Two-Place Aircraft	45,237,000
Item 3AM - System Project Management	6,010,000
Total	$434,457,000
Variance	834,043
Variance	00.2%

o The Fiscal Year 1975 procurement includes 144 aircraft, or a cum total (thru Fiscal Year 1975) of 251 aircraft. The ceiling price may be calculated as follows:

$$AC_P = \left[(A_P \times Q_F \times E_F) + (AT_R \times E_F)\right] \times 1.204$$

A_P is the target price from Table 1 of cum aircraft No. 251, which is $1,162,887,683 less the cum aircraft thru FY 1974 or cum No. 107, which is $610,800,418, or an FY 1975 T_P of $552,087,265.

Q_F = 1.000 from Table 2

E_F = 1.0684 from Table 3

AT_R = Not applicable

Substituting in the formula, the following applies:

$$AC_P = \left[(\$552,087,265 \times 1.000 \times 1.0684) + (N/A \times 1.0684)\right] \times 1.204$$

$$= \left[\$589,850,034\right] \times 1.204$$

$$= \$710,179,441$$

Current FY 1975 Ceiling Price	$710,709,000

Anyone familiar with the weapon systems pricing process when there is a change in quantity will readily appreciate this simplistic approach to repricing the production quantity.

To date, there has been no situation where the repricing formula has been called into play. The case where it would have been useful is when the Navy decided against a joint engine procurement for the F-15 and F-14. When the Navy decided not to use the Pratt-Whitney engine for the F-14, the procurement quantity dropped to below the fifty per cent of the original production quantity; therefore, the option to adjust quantities did not apply. The new F-15 engine quantity had to be completely repriced which resulted in a higher unit price.

This clause appears to have a wide range of application and should probably be considered for inclusion in other contracts. While getting the contractor to agree to produce 150 per cent of the contract quantity would be no problem, the fifty per cent quantity is another matter. The contractor will be more reluctant to speculate on the costs and risks involved when the actual production quantity required is far below that originally negotiated.

CHAPTER XIII

SUMMARY AND CONCLUSIONS

Thesis Objectives

The authors of this thesis have provided a study of the F-15 program with a threefold objective; (1) to describe the contract clauses that were considered by the authors to be unique in structure or application, (2) to analyze how these clauses are presently working, and (3) to determine the feasibility of applying these contract clauses to other development programs. Chapters VI through XII contained the clauses considered to be unique by the authors.

A brief F-15 program overview was provided in Chapter IV to acquaint the reader with the general provisions of the contract. Chapter V outlined the philosophy from which the contract evolved and which continues to influence the DOD management of the program.

The following summary has been provided to draw the previously described clauses together and emphasize the interrelationships that exist. The conceptual scheme of this summary has been shown in Figure 13-1.

Summary

Figure 13-1 depicts the F-15 program as an open system which is impacted upon by numerous external factors. Although

the authors did not treat each of these factors separately in previous chapters of this thesis, it is important to point out that each of them has influenced the final contract structure.

Procurement history provided the basic data and information which allowed the contract authors and negotiators to attempt an innovative and highly detailed procurement approach. Past mistakes were studied and analyzed. Successful techniques were modified so that they could be incorporated into the F-15 contract. The adequacy of past performance was measured in terms of current procurement benchmarks and new goals were established. (The primary concept which surfaced after the study and analysis of acquisition procurement history was "the F-15 Procurement Approach".)

Political interests were not referred to in the text of this thesis. It would be naive to believe that these interests had no impact upon the F-15 program, however. The wide and injurious publicity showered upon DOD procurement programs, such as the C-5A and the Main Battle Tank (MBT), placed formidable pressure upon all personnel (contractor and Government) to right the wrongs of the past and provide a "successful" procurement program for the F-15.

Economic factors such as the unprecedented inflationary trends which had developed in the United States and the sharp decline of employment within the aerospace industry most assuredly impacted upon the decisions which were made with

THE F-15 PROCUREMENT APPROACH

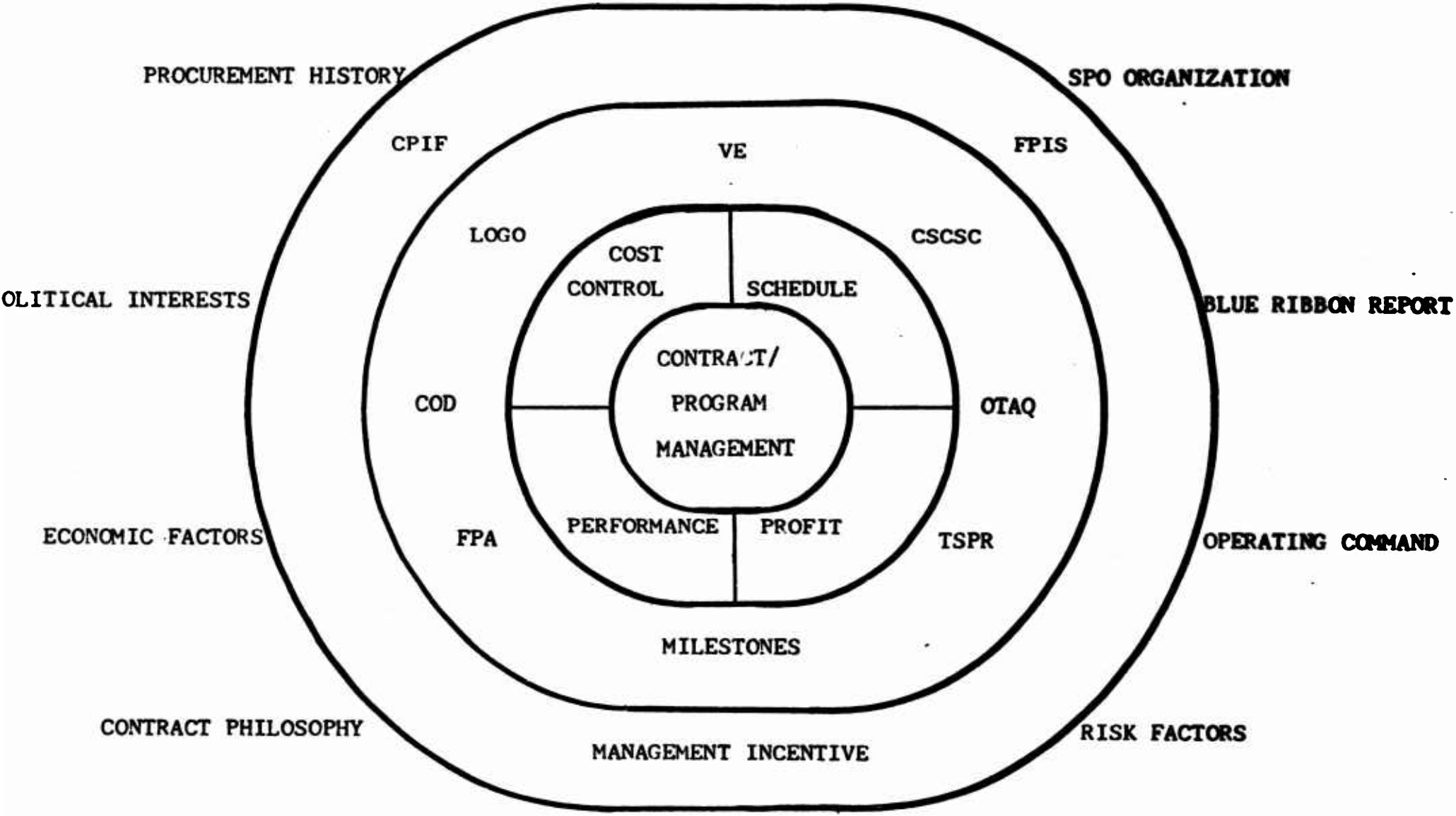


Figure 13-1

respect to the F-15. The development of a major DOD system (the C-5A) during such a period of inflation had just been dubbed a "failure". This type of "failure" could not be repeated.

The contract philosophy established was based upon the recognition of many factors. It was recognized by DOD that previous development contracts had been plagued by numerous design changes, poorly stated specifications, flexible pricing arrangements, a low degree of system definition, lack of Government influence on contractor management, high costs-yet low "coming out" profits for contractors, poor Government/contractor interface of management information systems, etc. The philosophy which prevailed over the structuring of the F-15 contract was one which endeavored to rectify those undesireable factors.

The System Program Office (SPO) organizational structure was modified in an attempt to facilitate rapid communication, low level responsibility with comensurate authority, and high visibility of program costs/schedule progression. This structure was considered to be an external influence because the contract structure was not designed to facilitate the organization's existence and growth - the organization was structured to guide and direct contractual obligations.

The Blue Ribbon Panel Report specified numerous recommended changes within DOD. The ensuing directive issued

by Mr. Packard had little direct effect on the F-15 SPO. The major changes directed by Mr. Packard after the Blue Ribbon Report had been introduced to the F-15 program during its initial organization. This would indicate that a liaison between the Panel and DOD existed prior to the time the recommendations were published.

The operating command (TAC) exerted direct influence upon the F-15 program prior to contract award. Specifications were structured to satisfy known and anticipated performance requirements. The schedule established via the demonstration milestones in the contract was one which was required to serve the purposes of the operating command and contractor as well. A concentrated effort was required to assure that the original stated performance requirements would not change (upward) significantly during the life of the contract and thereby cause cost and schedule adjustments.

Numerous risk factors came into consideration early in the program and continue to exert influence upon the acquisition/development contract. When speaking of risk, one must consider the entire spectrum wherein risk might be found. Increased enemy threat, labor disputes, reliability of estimates, probability of design adequacy, contractor stability, and unknown unknowns all have distinct risk factors associated with them.

The contractual approach which formed the resultant compendium of all the considerations and influences cited

above has been dubbed "The F-15 Procurement Approach" by the authors of this thesis. The cited factors do not, in and of themselves, make the F-15 approach unique. These considerations are not dissimilar to those made during the conceptual and planning phases of any major weapon system. The unique F-15 procurement approach that the authors wish to emphasize is that approach which tailored not only the contract but the entire program management system to the criteria established via the early systematic in-depth analysis and definition performed by DOD and contractor personnel.

Upon entering the closed circle which depicts the F-15 procurement approach, it is important to visualize the cost plus incentive fee (CPIF), fixed price incentive with successive targets (FPIS), and the management incentive ($2 million over a five year period) portions of the F-15 contract as revolving around and permeating through the inner layers of the system and ultimately reaching the core of the nucleus-the "successful" contract and "effective" program management area.[1] It is too early to tell whether or not the F-15 approach will be a total success throughout the life of the contract. At the time this thesis was written (July 31, 1972 was used as the data cut-off point) all criteria had been met to term the

---

[1]Successful and effective are difficult terms to define. Success has been defined by the authors as "on time, under cost, and within performance specifications". Effective will be the term applied to a management program which brings about success.

program a "success" to date with positive indications that this trend would continue.

In Chapter VI it was pointed out that the CPIF portion of the contract was written and structured in a manner which (1) reduced contractor risk early in the program, (2) encouraged technical innovation, (3) provided a realistic and visible profit for the contractor, (4) encouraged contractor efficiency, and (5) provided flexibility for the Government in the event major unforeseen factors entered into the program.

The objectives met through the use of the CPIF provisions should not be limited to those above, however. By meeting the objectives previously stated, interrelationships were established which are intended to lead the program into the nucleus of the system. The Cost-Schedule Control System Criteria (CSCSC) were enhanced through, no fewer than, 180 performance specifications and nonhardware plans furnished to the contractor by DOD.

Reporting systems evolved that established a near real time interface between the contractor and SPO management information systems. The Forward Pricing Agreement (FPA) established in September 1971 was more easily introduced because of the pre-established compatible computer interfaces between the contractor and the SPO.

The value engineering program has projected a possible $29 million cost saving. The demonstration milestone schedule and the funding schedule met and passed the test of time

thereby increasing contractor confidence in their feasibility and reliability.

The provisions of the Total System Performance Responsibility (TSPR) agreement make the prime contractor responsible for the total and complete integration of all Government furnished equipment (GFE) and components supplied by secondary contracts (CFE and GFE). This clause allows the prime and secondary contractors to work directly with each other to achieve total system integration. Since the prime contractor has a vested interest in cost control, weight control, schedule (milestones), and performance this clause provides an increase in the total control the Government has over the secondary contractors. The prime contractor is motivated to keep close surveillance over the progress and performance of the sub-contractors.

The Correction of Deficiencies (COD) clause of the contract binds the contractor to a responsibility for correcting any deficiencies discovered within an eighteen month period after delivery of test aircraft or a six month period after delivery of production aircraft. This provision motivates the contractor to build the aircraft properly the first time and to identify areas to the Government whose adequacy may be questionable. This facilitates early correction of deficiencies when the cost of correction is considerably lower than that which would be experienced if a deficiency were allowed to go uncorrected into the

production phase of the contract.

An Option to Adjust Quantities (OTAQ) provision in the contract was included to protect the Government in the event fluctuations occurred in appropriations or total production requirements. This provision contained a repricing algorithm to be used for quantities up to fifty per cent above and below the anticipated production quantity. An option such as this forces both the contractor and the Government to study the ramifications of adjusted quantities far in advance of an actual change. The OTAQ provision is another protective device which guards against unwarranted or unanticipated cost growth.

The Limitation of Government Obligation (LOGO) clause applies across the entire spectrum of the contract. This clause is a significant motivation factor for the contractor to control costs. Because the contractor knows that if his costs exceed scheduled incremental appropriations he must provide the capital necessary for him to continue contract execution on schedule and within performance specifications, he is definitely motivated to provide an early (seventeen months) notification to the Government that he is encountering or projecting a cost growth.

The factors listed within the second ring of the system revolve around the inner ring which contains cost control, schedule, performance, and profit. Each clause has an influence on the ultimate goals which lead to an

"effective" contract and "successful" program management.

The third inner-most ring of the conceptual scheme depicts four segmented areas. Three of the subdivisions represent the areas in which the Government has placed primary emphasis with respect to the F-15 program. The authors believe that DOD has recognized the need for and provided more structured and definitive profit objectives in the F-15 program than has been the practice in past weapon system procurements, hence profit was also included.

The contract clauses which the authors considered to be unique in structure or application have been described. These clauses have been analyzed and the manner in which the clauses contribute to effective program management has been recorded. The interrelatedness of the F-15 contract clauses has been emphasized. The authors have stated their opinion, based upon this study, concerning the feasibility of future use of these contract clauses to other acquisition programs.

Conclusions

The success of a weapon system acquisition, as defined in this study, cannot be assured merely by following a checklist of contractual clauses. Success is the culmination of: (1) detailed planning and definition, (2) a well structured contract tailored to the specific needs of an individual system, (3) a planned interface of DOD and contractor information systems, (4) a contractor motivated by competition, realistic "coming out" profits, and Government influence,

(5) a highly proficient, motivated, and stable System Program Office managed by professionals, and (6) a degree of good luck.

This thesis has established that the above factors are present in the F-15 program. Because the program is proceeding on schedule, under cost, and within performance specifications, it must be considered a success to date.

The contract clauses or scheme for one weapon system should not be extracted and placed directly into the contract of another system without modification. This study has determined that a successful program is dependent upon how well the unique qualities of that program have been defined and planned for.

The authors have recognized that there are many factors other than contract structure which bear directly upon program success. It is concluded that the degree of success enjoyed by the F-15 program to date has been enhanced by: (1) the low number of requirements to go beyond current state-of-the art technology, (2) the length of system program time allotted (nine years from the conceptual through the production phase), and (3) the operating command's adherence to the performance standards established early in the program.

APPENDIX A

Interview Guide

INTERVIEW GUIDE

1. Do you consider the inclusion of the (insert clause here) in the F-15 contract a new innovation? In what respects?

2. Specifically, what is the clause supposed to accomplish?

3. In your opinion, is the clause functioning as intended?

4. How does the clause support the overall program objective?

5. If you could unilaterally change the clause at this time, would you do so? In what way?

6. Do you think this clause should be adopted by DOD for inclusion into other programs? Why or why not?

7. Should the clause as presently structured be an ASPR required clause for other programs?

APPENDIX B

Deputy Secretary of Defense's Memorandum entitled "Policy Guidance on Major Weapon System Acquisition"

THE DEPUTY SECRETARY OF DEFENSE
Washington, D. C. 20301

May 28, 1970

MEMORANDUM FOR Secretaries of the Military Departments
Director of Defense Research & Engineering
Assistant Secretaries of Defense
The General Counsel
Assistants to the Secretary of Defense
Directors of Defense Agencies

SUBJECT: Policy Guidance on Major Weapon System Acquisition

We have been considering within the Department, for over a year, ways by which we can improve acquisition programs for major weapon systems. Some steps have been taken which I believe are in the right direction (reference my July 31, 1969 memorandum), and it is now appropriate to move ahead in a concerted effort to firmly establish additional new policies and to implement them.

The prime objective of the new policy guidance is to enable the Services to improve their management of programs. Improvement in the execution of those programs will be made to the extent the Services are willing and able to improve their management practices. The Services have the responsibility to get the job done. It is imperative that they do the job better in the future than it has been done in the past.

It is the responsibility of the OSD to approve the policies which the Services are to follow, to evaluate the performance of the Services in implementing the approved policies and to make decisions on proceeding into the next phase in each major acquisition program.

The purpose of this memorandum is to issue broad policy guidance which is to be translated into appropriate action by all Services and Agencies in new major weapon system acquisitions.

Management

Management in the Services will be improved only to the extent that capable people with the right kind of experience and training are designated to manage these major

programs -- in fact all programs. In order to be effective, program managers must be given adequate authority to make decisions on major questions relating to the program both in the conceptual development stage and in the full-scale development stage. If capable people are going to be willing to undertake these important program management assignments, ways must be found to give them some incentive to do so. Program managers must be given more recognition toward career advancement in all of the Services, and good managers must be rewarded just as good operational people are rewarded.

If our people are to develop the experiences necessary for program management and are to utilize their experience, they must be assigned to a given program long enough to be effective.

The overall structure of the program management function in all Services needs to be considered. Changes must be made to minimize the numerous layers of authority between the program manager and the Service Secretary.

The entire management problem needs to be addressed under these simple guidelines: put more capable people into program management, give them the responsibility and the authority and keep them there long enough to get the job done right.

Development

The cost of developing and acquiring new weapon systems is more dependent upon making practical trade-offs between the stated operating requirements and engineering design than upon any other factor. This must be the key consideration at every step in development from the conceptual stage until the new weapon goes into the force.

The program schedule (structure) is another very key consideration. It must make sense. It must allow time for accomplishing important task objectives without unnecessary overlapping or concurrency. The ideal schedule is sequential with enough slack time for resolution of those problems which inevitably arise in any development program.

Conceptual Development

It is crucial that the right decisions be made during the conceptual stage. If wrong decisions are made during this period the problems that are generated cannot easily be overcome later in the program.

Any new program will contain some risk that the technology involved cannot, within reasonable time and cost constraints, be converted into practical engineering design which meets the desired operating requirements. There are three ways in which this technical risk can be minimized:

1. Risk Assessment. The first is to make a careful assessment of the technical problems involved and a judgment as to how much effort is likely to be necessary in finding a solution that is practical. A careful look at the consequence of failure, even of "low risk" program elements, is also critical.

2. System and Hardware Proofing. The second and only sure way to minimize the technical risk is to do enough actual engineering design and component testing in the conceptual development stage to demonstrate that the technical risks have been eliminated or reduced to a reasonable level. Component or complete system prototyping, or backup development, are examples of this.

3. Trade-offs (risk avoidance). Since program risk and cost are dependent on practical trade-offs between stated operating requirements and engineering design, trade-offs must be considered not only at the beginning of the program but continually throughout the development stage.

Proposals for OSD approval of development programs shall include a description of how the Service or Agency intends to manage the program to include appropriate attention to (1) Risk Assessment; (2) System and Hardware Proofing; (3) Tradeoffs. When a DCP is prepared, it shall reflect these in the management plan.

Small development projects which do not require specific OSD approval shall also be structured to reflect these considerations.

All new programs will be kept in the conceptual development stages until the responsible Service secretary and the OSD can be assured that the program is actually in the proper shape to proceed into full-scale development.

Full-Scale Development

Authorization to proceed into full-scale development will be given by OSD based upon a DCP and the recommendation of the DSARC. In making this recommendation, the DSARC shall consider in particular whether adequate risk reduction has been accomplished.

Even though risk has been adequately addressed during the conceptual development stages, full-scale development will uncover technical and engineering problems that need to be solved. Procedures shall be established in the development program by which these problems will be continually addressed in view of possible trade-offs with stated operating requirements, cost, and operational readiness date.

Furthermore, it is essential to have assurance that those problems encountered during the earlier development stages have in fact been solved. This requires that milestones be established to demonstrate achievement of objectives at appropriate points in the development program. These milestones shall include such things as completion of appropriate stages in the overall system design and testing of critical items of hardware, e.g., subsystems and components.

Consideration must be given in development to all matters necessary in a full operating system. This will include such things as maintenance, logistic support, training, etc. However, where these matters are dependent on the final production design, as much of this work as possible should be delayed until the production stage. In general, RFPs for the development stage should be carefully reviewed to eliminate demands for reports, documentation and work tasks which are not absolutely necessary for the efficient accomplishment of the actual development work. These considerations and demands must be limited to those which directly contribute to the design of the system itself.

Production

The most important consideration before moving into full-scale production on a new weapon system is to have assurance that the engineering design is completed, that all major problems have been resolved, and this has been demonstrated to the extent practical by actual performance testing.

At the DSARC review when the decision is made as to whether to proceed into full production, I want the responsible Service to certify that the following actions have been taken:

1. All of the milestones which demonstrate the achievement of a practical engineering design have been met.

2. All important engineering problems encountered during the development have been resolved with appropriate trade-offs with stated operating requirements so that the production, maintenance and operating costs are optimized.

The start up of production must be scheduled to minimize financial commitments until it has been demonstrated that all major development problems have been resolved. In most cases production engineering and production tooling are necessary to demonstrate that the engineering has been satisfactorily accomplished. It may also be necessary to develop and demonstrate new production processes, methods and procedures. Thus, some limited expenditure may have to overlap development.

Contracts

In all our contracting, the type of contract must be tailored to the risks involved. Cost plus incentive contracts are preferred for both advanced development and full scale development contracts for major systems. When the assessment of technical risk permits, such contracts should include provisions for competitive fixed price subcontracts for subsystems, components and materials. In many cases this will enable a major portion of the program to benefit from competition. When risks have been reduced to the extent that realistic pricing can take place, fixed-price type contracts should be used. But the contracting officer should have the flexibility to consider the technical capability of the contractor and other factors in selection of contract type. When fixed-price type contracts are used for development programs, the contractor's financial ability to absorb losses that might be incurred must be a factor in making the award.

It is, of course, desirable to award a fixed-price contract in a competitive environment. It has been proven to be difficult or impossible to achieve effective competition in a fixed-price contract for production for a major weapon system before full-scale development has been undertaken. Consideration should therefore be given to the use of a negotiated fixed-price contract after the development has progressed to the point that the production design can be realistically specified. To the extent possible, a contract negotiated under these circumstances should encourage competition for subsystems, components, and materials. In this way a substantial part of the cost can be established in a competitive environment.

The use of letter contracts should be minimized. Change orders should not be authorized until they have been contractually priced, or until contractual ceilings have been established.

This guidance is provided to the Services with the understanding that it is to be implemented within the established DCP and DSARC policies. Other reports and reviews are to be kept to a minimum, but the lines of communication between OSD offices and Service components must be kept open to insure actual programs are being implemented under this guidance.

To the extent that the above guidance conflicts with existing DOD Directives and Instructions, the policies stated herein will govern. Since these policies should be applied immediately, I would appreciate your distributing this memorandum to key personnel, including all program managers, involved in the acquisition of major weapon systems.

I want the appropriate regulations of OSD and the Services and Agencies to be changed or cancelled to reflect these policies. I have asked the DDR&E to take the leadership in accomplishing this and have suggested 1 September 1970 as the date for recommending changes to me.

BIBLIOGRAPHY

"Air Force Hopes for Approval of F-15 Buy." Aviation Week and Space Technology, January 5, 1970, pp. 18-19.

Baer, John E., Major. F-15 System Program Office, Aeronautical Systems Division, Wright-Patterson AFB, Ohio. Personal interview, November 29, 1971.

Baron, Paul A. "Current Problems and Developments In Contract Changes." NCMA News Letter Anthology, Vol. I (June, 1970).

Batchelder, C. A.; Boron, H. E.; Campbell, H. G.; Dei Rossi, J. A.; Large, J. P. An Introduction to Equipment Cost Estimating. Report No. RM-6103-SA. Santa Monica, California: The Rand Corporation, 1969.

Baur, F. Trowbridge von. "Fifty Years of Government Contract Law." The Federal Bar Journal, 352-358.

Bellis, Benjamin N. "For Air Superiority--The F-15." Ordinance, July-August 1970, pp. 65-67.

Brownlow, Cecil. "F-15 Deliveries Tied to Milestone Concept." Aviation Week and Space Technology, September 14, 1970, pp. 96-98.

Charles, Arthur R., Captain. USAF Procuring Contracting Officer, Chief of Contracts Branch (ASD-YFKS), F-15 SPO Aeronautical Systems Division, Wright-Patterson AFB, Ohio. Personal interviews, November 3 and 17, 1971; December 23, 1971; May 16, 1972; July 29, 1972; August 7 and 14, 1972.

Clawson, Robert H. Value Engineering for Management. New York: Auerbach Publishers, Inc., 1970.

Cox, Edward and Jarrett, C. C. Historical Development of Procurement Methods. Office of the Assistant Secretary of Defense, Washington, D. C.,1969.

Dobler, Donald W. and Lamar, Lee Jr. Purchasing and Materials Management. New York: McGraw Hill, Inc., 1971.

"Does the Air Force Really Want Value Engineering?" Defense Industry Bulletin, Vol. 5, No. 11 (November, 1969).

"The Dogfight Over the F-15." Business Week, December 20, 1969, pp. 20-22.

Drake, Hudson B. "Major DOD Procurements At War With Reality." Harvard Business Review, January-February, 1970.

DuLude, Lawrence V. "Incentive Contracting." National Contract Management Journal, (Spring, 1969), 115.

Eads, Edwin C. "The F-15 Air Superiority Aircraft - A Study of the Weapons System Acquisition Process." Unpublished Master's thesis, Industrial College of the Armed Forces, Washington, D.C., 1971.

"F-14 Vs. F-15: Will it Come to a Shootout?" Armed Forces Journal. February 28, 1970, 20-21.

Fallon, William D., ed. Value Analysis/Value Engineering. New York: American Management Association, 1964.

F-15 Program Office, Forward Pricing Agreement Briefing Charts, Wright-Patterson AFB, Ohio. November 3, 1971.

Gluck, Fred, ed. A Compendium of Authenticated Logistics Terms and Definitions. Maxwell AFB, Alabama: Air University, 1970.

Kaufmann, William W. The McNamara Strategy. New York: Harpers-Row, 1964.

Keheley, T. L., Colonel. Chief, Contract Management Division, Procurement Policy, DCS Systems and Logistics Office. Letter dated June 30, 1972.

Kintisch, Emanuel. "Value Engineering Contract Clauses." Defense Industry Bulletin. February, 1970, 13-14.

"Laird Takes Hard Line with Defense Complex." Business Week, May 10, 1969, pp. 82-84.

Logistics Management Institute. An Evaluation of the Foundation of Incentive Contracting Report, LMI Task 66-7. Washington, D.C., September, 1966.

Logistics Management Institute. Defense Industry Profit Review, LMI Task 66-25. Vol. 2 and 7. Washington D.C., November, 1967.

Logistics Management Institute. Defense Industry Profit Review, LMI Task 69-1. Washington D.C., March, 1969.

Lorette, R. J., Lt. Col. "Cost Estimate Growth in Air Force Weapons System Acquisition." National Contract Management Association Journal, Vol. 3 (Fall 1969).

McCann, John A., ed. Government Contract Law. Wright-Patterson AFB, Ohio: The Ohio State University Research Foundation, 1970.

McDonnell-Douglas Spirit. October, 1971.

"McDonnell Douglas Takes F-15 Contract." Armed Forces Journal, January 3, 1970, p. 10.

"Packard Guidelines on Major Weapon Systems Acquisitions." Armed Forces Journal, June 13, 1970, 22-23.

Patterson, Norm, Major. Judge Advocates General's Office, Wright-Patterson AFB, Ohio. Personal interview, June 9, 1972.

"A Plum for McDonnell Douglas." Business Week, December 27, 1969, p. 22.

Reece, James S. "'The Management of Change': A Catchword or An Opportunity?" National Contract Management Association, Vol. 5 (Spring 1971), 123-137.

Report to the President and the Secretary of Defense on the Department of Defense by the Blue Ribbon Defense Panel. Gilbert W. Fitzhugh, chairman. Washington, D.C.: Government Printing Office, 1970.

Riemer, W. H. Handbook of Government Contract Administration. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1968.

Robinson, Donald. Chief, Systems Division Procurement and Production Directorate, F-15 Systems Program Office Wright-Patterson AFB, Ohio. Personal interview, June 22, 1972.

Strube, Delbert H., Lt. Col. "Milestone Procurement." The Review (Defense Supply Association), September-October, 1970.

U.S. Army. Signal Corps Specification No. 486, December 23, 1907.

U.S. Department of Defense, Armed Services Procurement Regulation Committee. Report on Case 70-13 Value Engineering. Washington, D. C., 24 May 1972.

U.S. Department of Defense. Armed Services Procurement Regulation Section 1-17. Washington, D.C.: Government Printing Office, 30 June 1969.

U.S. Department of Defense. Armed Services Procurement Regulation Section 1-1701, Rev. 3. Washington, D. C.: Government Printing Office, 30 June 1969.

U.S. Department of Defense. Armed Services Procurement Regulation Section 1-201.2. Washington, D. C.: Government Printing Office, 30 April 1971.

U.S. Department of Defense. Armed Services Procurement Regulation Section 3-807.12. Washington, D. C.: Government Printing Office, 30 September 1970.

U.S. Department of Defense. Armed Services Procurement Regulation Section 3-808.1. Washington, D. C.: Government Printing Office, 1 January 1969.

U.S. Department of Defense. Armed Services Procurement Regulation Section 7-103.2. Washington, D. C.: Government Printing Office, 1 January 1969.

U.S. Department of Defense. Contract F33657-70C-0300. "Acquisition Contract (Phase II) for F-15 System Support Services and Data Therefor." 31 December 1969.

U.S. Department of Defense. Defense Procurement Circular #11. Washington, D. C.: Government Printing Office, 9 October 1964.

U.S. Department of Defense. F-15 Engineering Change Proposals and Flight Test Changes. ASX Operating Instruction 375-3, Wright-Patterson AFB, Ohio, 4 March 1970.

U.S. Department of Defense and National Security Industrial Association. Symposium Proceedings on Major Defense System Acquisition. Washington, D.C., 11-12 August 1971.

U.S. Department of Defense, Office of the Secretary of Defense. Profit Rates Negotiated on Selected Prime Contracts. 8 December 1967.

U.S. Department of Defense. Request for Proposal F-15 Air Superiority Fighter. December, 1968.

U.S. Government. Report to Congress by the Comptroller General of the U. S. Defense Industry Profit Study, 17 March 1971.

Versel, Barney M. "Some Thoughts on Estimating." National Contract Management Association Journal, Vol. 3 (Fall 1969).

Waks, Norman. Current Issues in Military Program Control. Report to the American Management Association Briefing Panel, September 9, 1969. Bedford, Massachusetts: Mitre Corporation, 1969.

Wall Street Journal. "Pentagon Set To Test New Profit Policy for Defense Jobs Tied to Capital Outlays," January 10, 1972.

Witze, Claude. "Declining Defense Profits--Government Economy, or a National Security Risk?" Air Force, April 1968, p. 31.