

U. S. GENERAL ACCOUNTING OFFICE

REPORT ON

REVIEW OF SELECTED ASPECTS OF THE C-5A PROGRAM

JUNE 11, 1969

INTRODUCTION

The General Accounting Office has examined into selected aspects of the procurement of the C-5A airplane. The C-5A is a large jet airplane designed to airlift military supplies and equipment over long distances. The airplane is being manufactured by the Lockheed-Georgia Company, Marietta, Georgia, and the engines by the General Electric Company, Evendale, Ohio. DLG04557
DLG013800

Our review was made pursuant to the Budget and Accounting Act 1921 (31 U.S.C. 53); the Accounting and Auditing Act of 1950 (31 U.S.C. 67); and the authority of the Comptroller General to examine contractors' records, as set forth in contract clauses prescribed by the United States Code (10 U.S.C. 2313 (b)).

Our examination was directed primarily to ascertaining the cost elements in which the projected cost increases occurred, inquiring into the reasons for the cost increases, and determining when the increases should have first been recognized. We also examined into procedures used to assure the proper distribution of cost between design, development, test and evaluation effort and the initial production effort.

Our review work was initiated in February 1969 and field work was completed in May 1969.

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BACKGROUND

In October 1964 the Air Force prepared a technical development plan for the heavy logistics system which included an estimate of program cost of \$3.116 billion for 120 airplanes, engines, preparation of technical and cost proposals for the manufacture of the system and some miscellaneous items. This plan was submitted to the Department of Defense and approval was received to proceed with the program.

In December 1964 the Air Force requested that The Boeing Company, Douglas Aircraft Corporation, and Lockheed-Georgia Company, prepare detailed technical and cost proposals for the manufacture of the system, by then identified as the C-5A program. Each contract was a fixed-price contract in the amount of \$7.125 million to perform this work. Similar contracts were awarded to General Electric and Pratt & Whitney to prepare proposals for the engines.

Incorporated in these requests for proposals was a requirement that the competitors submit bids under a new concept of contracting called total package procurement. Under this concept the Air Force envisioned that both development and production of the system, together with as much support as feasible, be procured under a single contract containing a ceiling price as well as performance commitments. This would permit the Government to make a choice between competitors for the development and production units. Hopefully, cost savings would be achieved and the Government would benefit by acquiring a reliable product, at the lowest price, through competition for a major portion of its requirements.

This concept, however, requires that much more of the cost and technical aspects of the system be defined early in the program, placing on the competitors a burden of estimating cost of design and production several years in the future.

These technical and cost proposals were submitted to the Air Force in April 1965. They were evaluated by the Air Force and in October 1965 contracts were awarded to Lockheed and General Electric for development and production of the airplane and engines.

The contracts awarded to Lockheed and General Electric were of the incentive type and included some unusual features. Among these were a "correction of deficiencies" clause which required each contractor to meet or exceed performance criteria included in their proposals, the placing of full systems responsibility on Lockheed, and options for future productions which, if exercised, would cover a 10-year period.

Although the Air Force 1964 estimate was based on 120 airplanes, Lockheed's contract covered the design, development, test and evaluation (DDT&E) of five airplanes, the production of 53 airplanes identified as run A, and certain spare parts and aerospace ground equipment (AGE). The contract also contained options to produce an additional 57 airplanes which were identified as run B and 85 airplanes identified as run C. The estimated, or target price of the Lockheed contract for 115 airplanes in DDT&E, run A and run B was \$1.945 billion.

General Electric had a similar contract for the engines and the target price was \$624 million including \$165 million for the run B option. According to the contract, the prices for run C option would be based on projections of run B costs.

The target prices included a 10 percent profit and the contractors were to share with the Government in any underrun or overrun of the target cost. Each contract included a sharing arrangement whereby if actual cost was less than target cost, the contractor's profit would increase by 15 percent of the amount of this underrun. If actual cost was higher than

target cost, the profit of each contractor would be reduced by 15 percent of the amount of this overrun. The contract also provided for a ceiling price of 130 percent of target cost.

The contract with Lockheed included a clause whereby the Government had the right to adjust the sharing ratio to increase Lockheed's participation in any underrun or overrun to 50 percent and 30 percent respectively with the stipulation that target cost, target price and ceiling price would be increased by about 3.2 percent. The sharing arrangement and the targets were changed soon after contract award in accordance with this clause.

Each contract also contains a clause permitting a revision to the target cost and ceiling price each year beginning with calendar year 1968 to recognize abnormal fluctuations in the price levels of labor, materials, equipment and subcontracts. In the event that abnormal fluctuations in the economy occurred in calendar year 1968 or in subsequent years, the target cost and ceiling amounts may be adjusted upward upon request of the contractor. To date, the contractor has not made such a request.

Each contract contains a clause which permits the option price of run B to be adjusted upward if actual costs of producing run A exceed the target cost run A by 30 percent. A formula is included in the contract to compute the amount of this adjustment. This also required each contractor to segregate costs as they are incurred between DDT&E and run A.

The contract with Lockheed required that the option for run B airplanes be exercised 24 months prior to the scheduled delivery of the first run B unit. This required the Air Force to exercise the option prior to February 1969. Actual costs for the selected segments of run A,

for use in determining any revision in the target price of run B, will not be known until after delivery of the last run A units scheduled for 1970. However, in October 1968, the Air Force prepared an estimate of DDT&E and run A costs for both airplanes and engines to estimate what the adjustment to run B target prices would be.

Following is a schedule which compares the estimate of program costs prepared by the Air Force in 1964 with the target prices on contract and the latest available Air Force estimate of total program costs dated October 1968.

COMPARISON OF C-5A PROGRAM COST ESTIMATES WITH
CONTRACT TARGET PRICES
(Amounts in 000's)

	<u>Air Force estimate of program costs Oct. 1964</u>	<u>Contract target prices Oct. 1965</u>	<u>Air Force estimate of program costs Oct. 1968</u>
115 airplanes including DDT&E, run A and run B			
Airplanes	\$2,240,300	\$1,945,384	\$3,168,700
Engines	<u>577,500</u>	<u>624,000</u>	<u>754,000</u>
Total	\$2,817,800	\$2,569,384	\$3,922,700
Additions			
5 airplanes, support engineering change orders, etc.	<u>297,700</u>		<u>425,000</u>
Subtotal	\$3,115,500		\$4,347,700
Spare parts	307,000	<u>1/</u>	840,000
Facilities			<u>15,000</u>
Totals			<u>\$5,202,700</u>

Note: The 1964 estimate prepared by the Air Force contemplated an airplane with a gross take-off weight of 645,000 lbs. Subsequently, the Air Force requested the contractors to bid on a somewhat larger airplane. Lockheed's proposal which was accepted provided for an airplane weighing 728,000 lbs. and this larger airplane is included in the contract prices above and in the current Air Force estimate of cost.

1/ The contract price for spare parts will not be known until the type and quantities of parts are decided and prices for these items are negotiated. However, the prices for airplanes include about \$26 million in spare parts to support the flight test program.

In response to an Air Force request Lockheed prepared an estimate of actual cost for DDT&E and run A as of September 1968. We examined into Lockheed's costs incurred and its estimate of costs to complete production run A in relation to the estimated costs included in Lockheed's proposal. In a further section of this report we have outlined the effect the costs of the production run A will have on the costs of production run B.

COST INCREASES

In September 1968, at the request of the Air Force, the contractor estimated that actual cost for DDT&E and run A effort would be about \$2.335 billion or \$1.057 billion higher than target cost. The Air Force estimate of DDT&E and run A, prepared by the Systems Program Office at about the same time, indicated that costs would be about \$2.436 billion or about \$101 million higher than the contractor's estimate. The major difference between the estimates was that the Air Force expected that more direct labor hours would be incurred and that subcontract costs would be higher. In March 1969, the contractor's status report indicated estimated costs had risen to \$2.346 billion or \$11 million higher than the September 1968 study. In recent testimony before the Senate Armed Services Committee on June 4, 1969, the contractor estimated this cost at \$2.316 billion. To facilitate our analysis of the causes of the cost increase, we used the contractor's more detailed estimate of September 1968 rather than the Air Force estimate or the contractor's later status report estimate.

Our review of the expected cost increase on the DDT&E and run A portion of the C-5A program indicates that cost increases have occurred in all elements of cost -- labor, materials, overhead, and subcontracts.

A major area in which costs increased was refining the original design to control weight, eliminate drag, and redesign the wing. As the program progressed it was necessary to make design changes to meet the contract performance specifications. These refinements

materially contributed to increased cost. For example, the design refinement of the wing, together with the redesign to reduce drag and the changes made to control weight, all contributed to late release of engineering data to subcontractors and to the contractor's manufacturing branch. This late release of engineering data disrupted the production schedule and additional costs were incurred to recover schedule. New tools had to be made, items had to be installed out of sequence, and more overtime was required. Also, the weight control program contributed to greater use of materials such as titanium, beryllium, and honeycomb which, in addition to costing more, also required changes in the manufacturing process, finer tolerances, and increased labor costs.

Another major contributing factor was the general increases in labor and material costs.

In the area of wages, we found that increases occurred in all skills. The contractor projected that the average factory direct labor rate in 1967 would be \$3.298 an hour, but the actual factory rate was \$3.706 an hour. For example, in 1965 a general machinist earned \$3.77 an hour compared to the current rate of \$4.66 an hour. A tool and die maker earned \$3.77 an hour in 1965 and currently earns \$4.69 an hour.

A major portion of the overhead incurred at the Lockheed plant is allocated to the C-5A program. An analysis of the overhead of this plant indicates that rates have increased because of an increase in the number of indirect employees and increases in overhead costs

such as fringe benefits, indirect salaries, and depreciation. The contractor projected that the factory overhead rate in 1967 would be \$4.105 per direct labor hour, but the actual factory overhead was \$4.763 per hour. One of the primary reasons for the increase in overhead was fringe benefits which increased from \$34 million in 1965 to \$62 million in 1968. These fringe benefits, such as vacation, holiday, sick pay and retirement plan, increased primarily because of an increase in the number of employees and additional benefits added by union agreement in 1968. Also, we found the average salary of an indirect employee increased from \$8,132 in 1965 to \$10,259 in 1968.

We found that depreciation charged to overhead increased from \$3 million in 1965 to \$10.9 million in 1968. This increase was due primarily to an increase in the contractor's investment in facilities and equipment which occurred during this period.

The following schedule shows the increase in contractor's costs by major functional categories.

SCHEDULE OF CONTRACTOR'S COST
FOR THE C-5A AIRFRAME - DDT&E AND RUN A
(in 000's)

	Target cost Contract Award <u>Oct. 1, 1965</u>	Lockheed Estimate <u>Sept. 30, 1968</u>	<u>Difference</u>
Engineering	\$ 286,542	\$ 416,242	\$ 129,700
Tooling	158,908	236,372	77,464
Production	509,417	1,121,967	612,550
Subcontracts	245,527	424,948	179,421
Quality Assurance	30,282	54,447	24,165
Other	<u>47,927</u>	<u>81,516</u>	<u>33,589</u>
 TOTAL	 <u>\$1,278,603</u>	 <u>\$2,335,492</u>	 <u>\$1,056,889</u>

Engineering

Our analysis of the \$130 million increase in engineering cost indicates that about \$47 million is due to the contractor incurring or expecting to incur about 4.9 million more direct labor hours than originally planned, \$24 million is due to higher labor and overhead rates than proposed, and \$48 million is due to increases in the cost of material and other charges. The remaining \$11 million is attributable to numerous less significant factors.

Discussion with contractor officials indicates that the primary reason for the expected increase in engineering direct labor hours was because of design refinements necessary to control weight, reduce drag and redesign the wing. We found that increased cost of materials and other charges is attributable to increased use of computers, flight simulator program cost increases and increased cost of reliability and qualification test programs.

Tooling

Our analysis of the \$77 million increases in tooling costs indicates that about \$20 million of this increase is due to the contractor incurring or expecting to incur about 2 million more direct labor tooling hours than originally planned; about \$22 million is due to increased cost of labor and overhead, and about \$35 million is due to increased material and other costs.

The contractor stated that tooling costs increased primarily because of schedule problems generated by late release of engineering data and increased costs of material and labor. This late release of engineering data was primarily due to the design refinements which occurred in the program.

Production

Our analysis of the \$613 million increase in production costs indicates that about \$239 million of the increase in production costs is due to the contractor incurring or expecting to incur about 45 million direct labor production hours or 21 million more than originally planned; about \$58 million is due to increased cost of labor and overhead; and \$130 million is due to increased cost of materials and other charges. We were unable to determine the reasons for the remaining \$186 million increase. However, we believe a major part of the remainder is due to increases in cost of work performed by other divisions of the contractor, increased costs for components and other direct charges.

The contractor stated that the primary reason for increased direct labor production hours and material costs was because of changes in the manufacturing processes which resulted from design refinements. These manufacturing process changes included greater use of chemical milling processes, unique metal to metal bonding, and changes resulting from the use of titanium, beryllium, honeycomb, and other less commonly used materials. Also, lead time for the manufacture of forgings, castings, and extrusions increased in 1965 and 1966 which delayed receipt of these items causing out of sequence installation and multiple set-up costs.

Contractor officials told us the use of less commonly used materials also contributed to the cost increase because of the higher cost of these materials and an increase in fabrication costs because of the new procedures used to handle and work these materials.

Subcontracts

Estimated subcontract costs increased about \$179 million over the adjusted target costs. Our analysis indicates that approximately \$17 million of this increase represents the difference between the subcontract costs included in the contractor's proposed price and the amounts of the subcontracts awarded; about \$20 million represents negotiated changes subsequent to award; about \$4 million represents an estimate of additional changes; about \$98 million represents an amount the contractor expects to pay out of a total of \$149 million the subcontractors have requested for design changes, schedule recovery and scope changes; about \$36 million represents the contractor's estimated share of subcontractor projected overruns; and about \$4 million represents miscellaneous changes.

Our analysis of the amounts requested by subcontractors for design changes, schedule recovery and scope changes indicates that five of these subcontractors estimated schedule recovery costs at a total of about \$47 million. These costs represent amounts incurred or expected to be incurred by these subcontractors to bring their programs back on schedule. One subcontractor told us that schedule slippages occurred because preliminary design drawings furnished by Lockheed were subsequently changed which resulted in program delays. Another subcontractor reported that schedule slippages occurred because of late receipt of engineering data, receipt of defective engineering data and major redesign which resulted in disruption of normal work planning, out of sequence installation, and the need for changes in tooling. Contractor officials indicated that the reason for subcontractor schedule slippages can be attributed primarily to the design refinements mentioned above.

Quality assurance

Our analysis of the \$24 million increase in quality assurance costs indicates the primary cause is an estimated increase of 2 million quality assurance direct labor hours over the amount originally planned. This increase in hours is attributed to related increases in direct labor hours in engineering, tooling and production.

Other costs

Other costs, such as customer service, reproduction of data, and spares and administrative expenses, are estimated to be about \$34 million higher than originally planned. Although we did not make a thorough analysis of the reasons for the individual cost increases, we believe that higher costs of labor and material are also being experienced in these cost elements.

CONTRACTOR SEGREGATION OF COSTS

The contractor is required by the contract to segregate DDT&E and run A costs. This is important because certain run A costs are to be used in determining the price of run B.

In order to assure that there is proper distribution of costs, the Defense Contract Audit Agency (DCAA) makes continuous reviews of the contractor's accounting system, including the procedures for distributing labor and material costs. DCAA also examines into the contractor's classification of C-5A cost accounts to ascertain if the accounts are established to distinguish between DDT&E and run A costs. In addition, both the DCAA and the contractor make periodic floor checks to test the accuracy of labor as recorded against these accounts.

Also, Lockheed requires that major subcontractors record costs by DDT&E and run A effort through the issuance of separate purchase orders for each phase of the subcontract work. Both DCAA and Lockheed make periodic examinations of these subcontractors' records to insure the accuracy of the recording of costs.

While the above control procedures appear to be satisfactory if properly implemented, we noted that the Air Force has questioned the distribution of \$15 million of costs to run A which may have been more properly allocable to DDT&E effort. This question is currently under discussion and has not yet been resolved. We plan to examine into this matter at a later date.

In 1966, the Air Force made a change to the contract, shifting \$104 million in estimated tooling costs from DDT&E to run A. The amount

represented the estimate of costs to manufacture most of the basic tools that were to be used in the program and were to be paid from research and development funds. The balance, and relatively smaller amount, of the estimate of cost to make the tools were included in run A and to be paid from production funds.

We were told by officials of the Air Force C-5A Systems Program Office that this shift was necessary because there were insufficient Government research and development funds with which to continue making payments to the contractor under the DDT&E phase. The change permitted the Government to continue to make payments for tooling but from production funds rather than research and development funds as was originally planned. However, Headquarters, Air Force officials advised us that this shift was made to charge production tooling to the procurement appropriation in accordance with Department of Defense practices.

The Air Force did not require the contractor to segregate recorded tooling costs between the amount shifted to run A and the amount already in run A. Therefore, we could not determine if the contractor incurred more or less cost for tooling than the target amount shifted from DDT&E for such cost. Consequently, we are unable to determine whether or not the shift will have the effect of increasing or decreasing the price to the Government for run B.

EFFECT OF ACTUAL COSTS ON RUN B PROCUREMENT

In October 1968 the Air Force estimated that the actual costs which will be incurred by Lockheed for DDT&E and run A will be about \$2.436 billion or \$1.030 billion higher than the contract target price of \$1.406 billion. To arrive at the target price of the run B airplanes the repricing formula

is applied to certain segments of the actual costs under run A. The Air Force estimated the target price of \$539 million included in the contract for production run B would be adjusted to \$1.149 billion or an increase in the target price of \$610 million.

The Air Force estimates that the cost of the engines will be \$754 million or \$130 million higher than target price. The result of the application of the formula is that the Air Force currently estimates that 115 airplanes and engines will cost \$3.923 billion or \$1.354 billion higher than the target price established in 1965. Also, the Air Force estimates that Lockheed will incur a loss of \$285 million in the C-5A program. However, Lockheed testified before the Senate Armed Services Committee on June 4, 1969, that they expect their loss to be about \$13 million. The principal difference between the Air Force and Lockheed's estimate of the loss is that Lockheed is of the opinion the adjustment for abnormal escalation is not considered part of the target cost for the purpose of pricing run B. The Air Force, on the other hand, considers that the target cost should be adjusted for abnormal escalation in pricing run B.

SPARE PARTS

In October 1964 the Air Force estimated that the cost of initial spares would be \$307 million. This amount was not a part of the \$3.116 billion computed by the Air Force as the estimated cost for 120 C-5A airplanes since spares were considered an operating cost rather than an investment cost.

Varying amounts have been estimated for spares. However, the current Air Force Logistics Command estimate for spares and support costs amounts to \$840 million. In addition to increasing the 1964 estimate for initial spares to \$488 million--an increase of \$181 million primarily for additional spares to provide a wartime capability and spares for the larger aircraft--the Air Force has also included \$257 million for replenishment spares and \$95 million for support costs for common aerospace ground equipment and modifications. In recent testimony Air Force officials indicated that a more current estimate would be available by June 30, 1969.

REPORTING OF PROGRAM COSTS AND ESTIMATES AT COMPLETION

Our analysis of actual costs incurred and estimated costs to complete at various dates indicates the Air Force could reasonably have predicted as early as December 1967 that actual costs would exceed the ceiling price. We found that by December 1967 the contractor had incurred about 10 million more direct labor hours than originally planned, had experienced increases in labor, materials, and subcontracts not contemplated, and had experienced changes in types of

materials which would increase cost. We estimate these known cost increases, together with the negotiated projections of how much labor and overhead rates would increase through 1973, total about \$352 million. Our analysis shows that as of December 1967 the contractor had incurred or would incur \$165 million in additional labor and overhead costs, material cost indices showed material costs had increased by \$15 million, reports from subcontractors at that time showed costs would be \$128 million higher than the contractor proposed initially, and a minimum of \$44 million in additional costs would be incurred due to material changes.

These known cost increases, when added to the contractor's target cost, placed the probable cost of DDT&E and run A at that time at \$1.630 billion or within \$32 million of ceiling price. The addition of projections of increased direct labor hours and increased material cost beyond 1967 would have given sufficient indication that the ceiling price would be exceeded. The contractor, in cost information reports prepared about the same time, indicated that probable cost would be \$1.6 billion or within \$62 million of ceiling price .

We noted that certain reports prepared by the Air Force did not include current information on estimated costs at completion. Beginning in June 1968, the Cost Performance Report (R-225) and Contract Summary Report (R-32) contained estimates of cost at completion which were within the contract ceiling price even though an Air Force study completed in May 1968 indicated that costs at completion would be in excess of ceiling price. The R-225 report indicated by footnote that the results of the May study were not included by direction of higher headquarters but that all parties having a need for the results of the study had been

informed of the expected overrun.

We believe that current, complete, and accurate information on cost, schedule, and technical performance, contemplated with respect to major procurements, should be maintained in the Department of Defense. Also, the Congress and interested Congressional Committees should be kept currently advised of significant changes in major programs. We are currently examining into how this can best be accomplished.

TOTAL PACKAGE PROCUREMENT

It should be recognized that the C-5A program was the first major weapon system procurement on which the total package concept was used. Our preliminary conclusion indicates that this method may be best suited for the procurement of those systems requiring only limited additional development effort and where it is reasonable to break down the Government's requirement into manageable segments and where commitments for contractor performance will not extend over too long a period of time.

It seems clear that the Government prior to contracting for significant production units under a fixed pricing arrangement should have real assurance that the item can be produced and the costs can be predicted with reasonable accuracy. We are, however, giving further consideration to the alternative methods of procurement of weapon systems and expect to have further comments on this matter in the near future.