U.S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

ADVANCED MEDIUM STOL TRANSPORT PROTOTYPES

upper case

DEPARTMENT OF THE AIR FORCE

MARCH 1974

BOEING AMST PROTOTYPE - YC-14

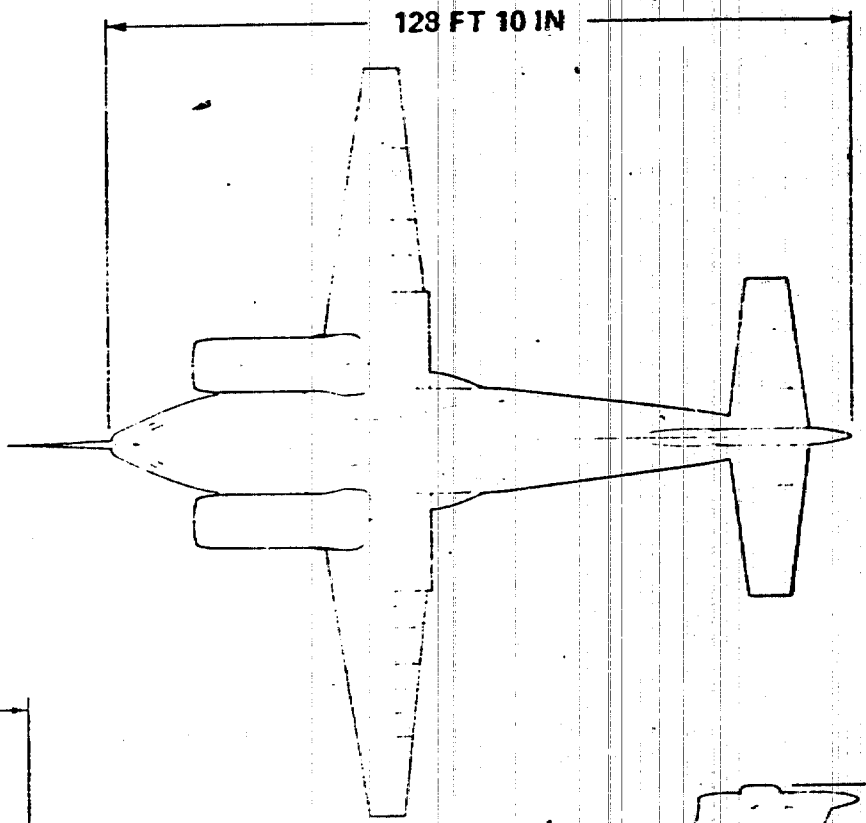
WING SWEEP, C/4: 4.9 DEG

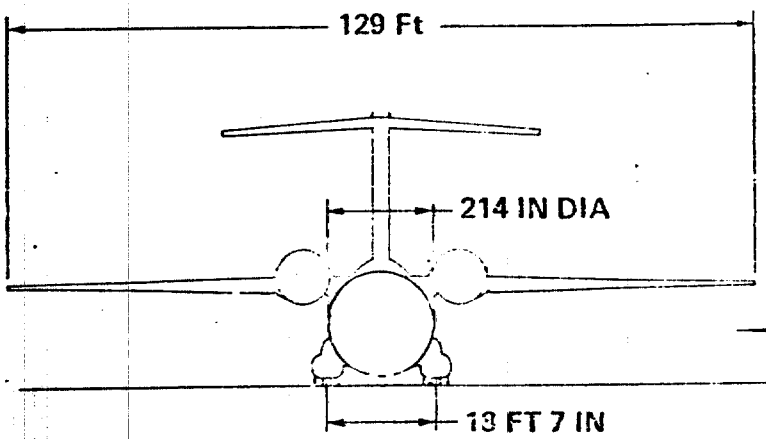
WING AREA: 1,762 SQ FT

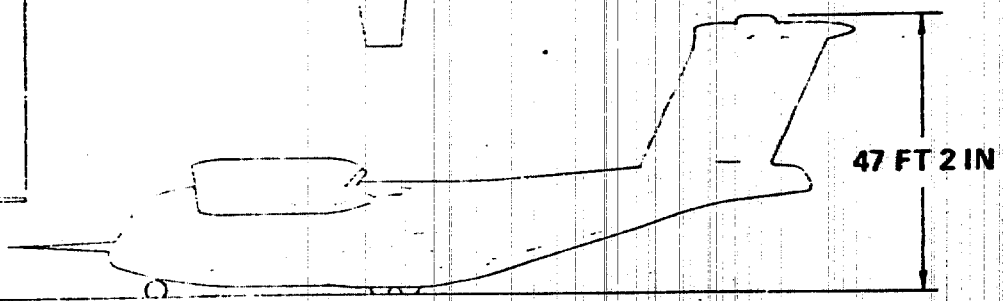
CARGO COMPARTMENT SIZE:

- **47 FT LENGTH**
- **11.7 FT WIDTH**
- **11.3 FT HEIGHT (MIN)**

ENGINES: CF6-50D, 48,300 LB SLS THRUST







MCDONNELL DOUGLAS AMST PROTOTYPE - YC-15

WING SWEEP, C/4: 5.9 DEG

WING AREA: 1,740 SQ FT

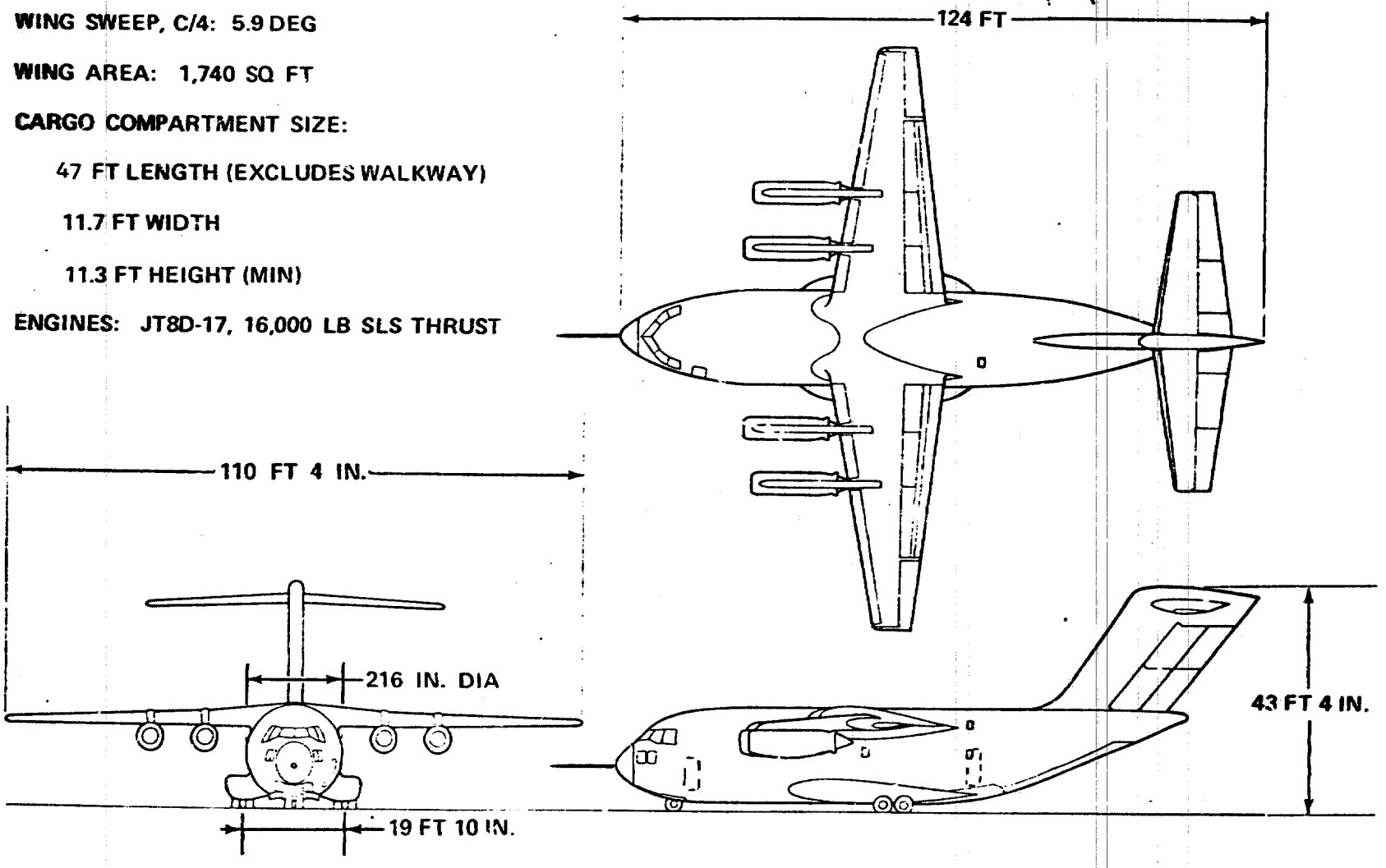
CARGO COMPARTMENT SIZE:

47 FT LENGTH (EXCLUDES WALKWAY)

11.7 FT WIDTH

11.3 FT HEIGHT (MIN)

ENGINES: JT8D-17, 16,000 LB SLS THRUST



PREFACE

In December 1973 the Advanced Medium STOL[1/] Transport (AMST) prototype program's fiscal year 1974 budget request was reduced by the Congress from $65.4 to $25 million--about 60 percent. The Air Force has requested $55.8 million for fiscal year 1975. Officials in the Prototype Program Office said the reduction in fiscal year 1974 funds left them with the following three options:

--terminate the total program,

--select one of the two contractors and continue the development of one design, or

--keep both contractors and stretch out the program over a longer period.

According to Prototype Program Officials, each of these options represented a substantial change in the cost and schedule of the AMST Program. In considering these options, these officials believed that, if the program was to continue, the system description, design-to-cost goals, and the performance goals as presented in this staff study would essentially remain the same.

In February 1974, the Air Force decided upon the third option--to keep both contractors and to stretch-out the program over a longer period. While schedules will be stretched-out with attendant cost increases, the advantages of maintaining competition appear to the Air Force to outweigh the reasons for eliminating one contractor. The program was not terminated in order to retain the option for modernizing the tactical airlift force.

1/ STOL - Short take-off and landing

The impact of this February 1974, decision on the cost and schedule of the AMST program has not been completely defined. The following staff study presents the status of the AMST prototype program at November 30, 1973--immediately preceding the December 1973 funding reduction.

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ABBREVIATIONS

AMST	Advanced Medium STOL Transport
CAR	Command Assessment Review
GE	General Electric
NM	Nautical Mile
PPO	Prototyp· Program Office
P&W	Pratt & Whitney, Division of United Aircraft Corporation
RDT&E	Research, Development, Test and Evaluation
ROC	Required Operational Capability
SAR	Selected Acquisition Report
STOL	Short Take-off and Landing
TAC	Tactical Air Command
TOL	Take-off and Landing

STATUS OF ADVANCED MEDIUM STOL TRANSPORT PROTOTYPES

The U.S. General Accounting Office has reviewed the AMST prototype program status as of November 30, 1973. Information on this program was obtained by reviewing plans, reports, correspondence, and other records and by interviewing officials at the Prototype Program Office (PPO), Aeronautical Systems Division, Air Force Systems Command. Our review did not include detailed analyses or audits of the basic data supporting program documents. We made no attempt to evaluate technological approaches or to involve ourselves in decisions while they were being made.

According to the Air Force, a requirement has existed since May 6, 1970, for the replacement of the Tactical Air Command (TAC) C-130 class of military transport. The results of the AMST prototype program could provide information on the type of follow-on development needed for such a replacement. If tactical airlift modernization is undertaken, the AMST could also provide a replacement for the STOL capable C-7 and C-123 aircraft in addition to the C-130. As of November 30, 1973, no commitment for development beyond the prototype phase had been made.

The AMST prototypes may benefit commercial derivatives of the aircraft, but to date the Secretary of the Air Force has not given approval for the inclusion of the domestic commercial sales clause in the contracts. This clause requires a contractor to reimburse the Government for a pro rata share of its nonrecurring costs in the event the contractor enters into domestic sales of the items on contract.

The AMST program is not on the Selected Acquisition Report (SAR) system even though significant funds are being spent in the prototype effort and the program has potential for further development and production. The following sections present the cost, schedule, and technical status of the AMST program as of November 30, 1973, and other pertinent program information.

SYSTEM DESCRIPTION AND STATUS

The AMST prototype program, which originated from a 1971 Air Force study, was approved by the Deputy Secretary of Defense in September 1972. The objectives of this prototype program are to:

--advance technology,

--reduce technical and strategic uncertainties

--provide a variety of hardware options in anticipation of future military needs, demonstrate operational utility, and

--demonstrate new technologies in powered lift capabilities at a minimum of cost.

Achievement of these objectives could provide a potential short take-off and landing replacement for the C-130, C-123, and C-7 military transports. The need for a medium STOL transport to replace the C-130 aircraft was documented by a Tactical Air Command Required Operational Capability (ROC) document dated May 6, 1970.

In November 1972 two contractors, Boeing and McDonnell Douglas, were selected to design, develop, fabricate and flight-test two aircraft each from a common set of cost and performance goals. The YC-14, Boeing's prototype, is a twin engine transport with two General

Electric CF6 turbofan engines mounted above the wings. Powered lift is supplied by the upper surface blowing technique which diverts the engines exhaust over the wing and rear flaps to provide the additional lift required for short take-offs, approaches, and landings. According to the AF, other feature include an improved straight wing to allow for lower cost, better STOL performance and decreased drag at cruise speeds, and an improved flight control system for better response at the low airspeeds at which the aircraft will be flown.

The YC-15, the McDonnell Douglas prototype, is a four engine AMST with Pratt & Whitney (P&W) JT8D turbofan engines mounted beneath the wing. The externally blown flaps method is used to provide powered lift on this prototype. This technique blows the engine's exhaust under the wing instead of over the wing. The exhaust is diverted downward by the wing's rear flaps to provide the additional lift necessary for short take-offs, approaches, and landings. As with the YC-14, the YC-15 will also include the improved wing, and an improved flight control system.

The design freeze for the YC-14 and YC-15 occurred in October and February 1973, respectively. The AMSTs are now being fabricated and assembled for their first flights scheduled for mid-to-late 1975.

COMING EVENTS

As of November 30, 1973, the completion of aircraft fabrication and assembly were the only events scheduled during the next 12-18 months for the AMST program. Wing and fuselage mating of the YC-15 was scheduled to

begin in August 1974, while final assembly of the YC-14 was scheduled to begin in December 1974. There were also no Air Force or Office of the Secretary of Defense (OSD) decision points remaining in the prototype program.

The matters discussed in the PREFACE to this staff study have a direct impact on the "COMING EVENTS" for the AMST program. The decision by the Air Force to keep both contractors and to stretch the schedule will substantially change the cost as well as the schedule for the program. The definition of the impact of this decision is the immediate coming event.

COST

The current AMST cost estimate ($200 million) for research, development, test and evaluation (RDT&E) has not changed from the August 31, 1972 initial estimate. Since no commitments have been made beyond the prototyping of the AMST, no official cost estimates have been made beyond the prototype phase. The prototype program's RDT&E costs to the Government are as follows:

AMST RDT&E Estimates

Item	Initial estimate August 31, 1972	Current estimate November 30, 1973
	(in millions)	
YC-14 contract (2 aircraft)	-	$ 96.2
YC-15 contract (2 aircraft)	-	86.1
Total prototype contracts	$180.0	$ 182.3
Other Government costs	20.0	17.7
Total prototype cost	$200.0	$ 200.0

The estimates do not include an allowance for inflation because both contracts have limited performance periods and both contain a clause which limits the Government's maximum obligation to the amounts shown. Further, any escalation in support costs will be included in the "Other Government Costs" category shown above.

The engines are contractor-furnished equipment in both contracts. The current estimated amounts for each prototype includes only the cost for leasing the engines from General Electric and Pratt & Whitney for the YC-14 and YC-15 respectively. Because of this leasing arrangement, if the flight test program runs longer than the scheduled one year the engines will have to be purchased or the lease will have to be extended. Air Force officials said that purchasing the engines is only a remote possibility; the leasing arrangement would probably be extended. If the engines were to be purchased, however, these officials believe the cost of the then used engines would be less than the cost of the engines when they were new. The cost of a new YC-14 engine is about $700,000; whereas, the cost of a new YC-15 engine is about $375,000.

Status of Funding

The status of funding by fiscal year (FY) for the AMST program is shown below:

RDT&E FUNDING
November 30, 1973
(in millions)

Item	FY 1973 & prior	FY1974	FY1975	FY1976	FY1977	Total
YC-14 contract	$14.5	$31.2	$39.4	$10.8	$ .3	$ 96.2
YC-15 contract	13.4	32.8	30.3	9.0	.7	86.2
Other Government costs	.1	1.4	6.0	7.7	2.4	17.6
Totals	$28.0	$65.4	$75.7	$27.5	$ 3.4	$200.0

The 1974-1975 fiscal year funding levels are higher because the prototypes are scheduled to be fabricated and assembled during this period.

The AMST prototype program features a "design-to-cost" goal of $5 million recurring flyaway cost in fiscal year 1972 dollars for the 300th operational aircraft. This goal is equivalent to an average recurring flyaway cost of $7.0 million per aircraft in FY 72 dollars over a 300 aircraft procurement. Amortizing the cost of tooling--estimated at about $60 million--over the 300 aircraft procurement would increase the average flyaway cost from $7.0 million to $7.2 million and the 300th unit flyaway cost from $5.0 million to $5.2 million in FY 72 dollars.

CONTRACT DATA

In January 1972, proposals were solicited from nine sources for the AMST prototypes. On November 10, 1972, contracts were awarded to the Boeing Company and McDonnell Douglas Corporation for $96.2 and $119.4 million respectively. The Boeing contract is a cost-plus-fixed-fee contract with the fee being $6.3 million. The McDonnell Douglas contract is a cost-sharing contract with the Government's share being $86.1 million and the contractor's share being $33.3 million. McDonnell

Douglas received a cost-sharing contract because this is the type of an arrangement it proposed, since the firm believed commercial benefits would be derived from the program. Both contracts contain clauses on costs which set a maximum on the Government's obligation. The maximum in the Boeing contract is the amount of the contract, while the maximum in the McDonnell Douglas contract is the amount of the Government's share.

The amounts of the two contracts vary because the contractors' proposed different aircraft using different technical approaches. In selecting the two sources, costs were given a lower priority than the soundness of the contractor's technical approach and the cost realism of the contractor's proposal in terms of meeting the production design-to-cost goal. The ability of a contractor to accomplish the proposed effort within the amount quoted was deemed more important by the Air Force than the total price quoted. Industry was simply made aware that about $90 million was available for each successful airframe contractor.

Both contracts also contain a foreign commercial sales clause which requires a contractor to reimburse the Government for a pro rata share of its nonrecurring costs in the event the contractor enters into foreign sales or license agreements for the items on contract. The domestic commerical sales clause, which covers sales to domestic buyers, is not part of the contracts. The inclusion of this clause in a contract, unlike the foreign commercial sales clause, is subject to approval by the Secretary of the Air Force. As of November 30, 1973,

approval by the Secretary had not been given, but PPO officials believe this will be forthcoming. The Prototype Program Office and Air Force Systems Command have both recommended the Secretary approv· the inclusion of this clause.

Both contracts require the design, development, flight test, and logistics support of two AMST prototypes. No commitment for development beyond the prototype phase has been made t either contractor.

The prototype development efforts of each contractor are divided into two phases. Phase I efforts were limited to a 90-day period in which each contractor analyzed possible design/performance tradeoffs to achieve a reduction in its baseline airplane flyaway cost for the 300th production unit. In addition, each contractor was authorized to continue preliminary design efforts which were not dependent upon specified performance/design goals and to evaluate potential civil application of their designs.

The cost of Phase I was limited to $2.5 million for each contractor and the contractors' efforts were completed in December 1972. The Air Force evaluated the contractors' analyses and authorized Phase II efforts in January 1973.

Phase II allows the two contractors to proceed with their best efforts to develop the AMST prototype aircraft. The current contract effort is reported to be on schedule with first flights planned for June and November 1975 for the YC-15 and YC-14, respectively. The flight tests will end a year later in June and November of 1976.

SCHEDULE

The AMST program is reported to be currently on schedule for both the Boeing Company and McDonnell Douglas Corporation. Scheduled key events for each company and current estimated completion dates are:

Boeing YC-14	Program goal November 10, 1972	Current estimate November 30, 1973 (accomplished)
Complete Phase I of contract	February 1973	(January 1973)
Design freeze	-	(October 1973)
25% structural design completed	-	May 1974
Begin final assembly	-	December 1974
First flight	November 1975	November 1975
Completion of flight test	October 1976	November 1976
Douglas YC-15		
Complete Phase I of contract	February 1973	(January 1973)
Design freeze	-	(February 1973)
Start first aircraft wing assembly	-	(December 1973)
Begin first aircraft wing and fuselage mating	-	August 1974
First flight	June 1975	June 1975
Completion of flight test	June 1976	June 1976

PERFORMANCE

The AMST performance goals are based essentially on the Tactical Air Command ROC which requires the replacement of the C-130 transport with a high speed STOL aircraft. The following shows the program's performance goals and the performance status of each prototype as of November 30, 1973.

Characteristics	November 10, 1972	Current estimate Boeing YC-14	Douglas YC-15
STOL mission			
Range	400 NM	400 NM	400 NM
Payload	27,000 lbs.	27,000 lbs.	27,000 lbs.
Critical field length	2,000 ft.	2,300 ft.	2,000 ft.
Speed	normal turbofan/jet	normal turbofan/jet	normal turbofan/jet
Conventional TOL[1/] payload	53,000 lbs.	53,000 lbs.	53,000 lbs.
Cargo compartment size	height 11.3ft. width 11.7ft. length 47.0ft.	height 11.3ft. width 11.7ft. length 47.0ft.	height 11.3ft. width 11.7ft. length 47.0ft.
Ferry range	2,600 NM	2,600 NM	2,600 NM

PPO officials do not consider the 300 foot critical field length variance for the YC-14 significant because the variance is due to the selection of a less expensive engine during the Phase I performance tradeoff study. This performance factor is calculated at 103°F air temperature and performance improves as the outside air temperature is lowered. Hence, 2,000 ft. critical field length is currently obtainable at 77°F.

1/ Take-off and Landing

The payload radius and field length capabilities for the AMST are interrelated. The transport's STOL payload goal is to land and take off with a 27,000 pound payload from a 2,000 foot unimproved airstrip with at least one-half internal fuel on board. For operations from improved airfields a payload goal of 53,000 pounds was established. Performance estimates indicate that the AMST prototypes will be capable of carrying payloads of over 60,000 pounds into and out of airfields approximately 3500 feet in length.

The speed goal for the AMST was delineated as the normal cruise speeds associated with turbofan or turbojet powered transports which is around 0.7 mach. The speed goal was not specified further because it was intended to be a design fallout.

The AMST cargo compartment size allows the aircraft to hold 40 troops seated beside six pallets. Existing cargo loading and handling equipment is used. The cargo compartment will also accommodate 80 paratroopers, or bare base shelters[1/] or military/commercial van cargo containers, as well as vehicles currently too large to be transported by the C-130.

Other goals not shown above include controllability at the low speeds required for STOL operations, an avionics subsystem providing the minimum capability for communications and navigation during the test period, and landing gears capable of operating from improved landing zones.

1/ Base base shelters are a series of prefabricated buildings which can be easily assembled at forward locations.

The prototype program also includes a goal that any operationally configured AMST should be designed for reliability and ease of maintenance.

MANAGEMENT REPORTING SYSTEM

The contractors' internal management reporting systems are used for reporting data to the AMST Program Office. The Director of the PPO monitors the contractors and manages the program, and keeps the Air Force Systems Command advised by quarterly Command Assessment Reviews (CAR's). These briefings are to provide information on the cost, schedule, and technical status of the program, as well as, any associated problems. The AMST program is not under the Selected Acquisition Report system.

Selected Acquisition Reporting

Department of Defense Instruction 7000.3 requires that all acquisition programs designated as major by the Secretary of Defense be on the SAR system. The AMST program has not been so designated, but it does meet the criteria for such a designation--i.e., an RDT&E expenditure in excess of $50 million. As shown on page 6 of this staff study the estimated RDT&E cost of the AMST program is $200 million. We believe the program should be on the SAR system to provide greater visibility of the program to the Congressional committees and to top management officials in DOD.

RELATIONSHIP TO OTHER SYSTEMS

The AMST prototype aircraft are primarily being built for test and evaluation purposes to define a possible replacement program for the C-130 aircraft. If tactical airlift modernization is undertaken,

however, the AMST could also provide a replacement for the STOL capable C-7 and C-123 aircraft. Before the AMST can enter the production phase, additional engineering effort must be performed.

STATUS OF TESTING

The flight test programs are scheduled to begin in June 1975 for the YC-15 and November 1975 for the YC-14. The test program will evaluate the incorporated technology features and each design's potential operational utility. Proof of powered lift concepts, flight control response characteristics, and application of the prototypes' exhibited characteristics to the tactical airlift mission will be emphasized.

Since the aircraft are prototypes, no formal operational testing and evaluation per Section 506,Public Law 92-156 is evisioned or planned. However, testing of the AMST prototypes will be conducted by a joint team which will include both contractors, the Air Force Flight Test Center, Tactical Air Command, Air Force Logistics Command and National Aeronautics and Space Administration. The United States Army and Marine Corps will also provide input concerning troop and equipment airdrops and other data in relation to troop and battlefield activity.

MATTERS FOR CONSIDERATION

The Congress may wish to inquire further into the status of the Secretary of the Air Force's approval of the domestic commercial sales clause. Exclusion of this caluse from the AMST prototype contracts would forfeit the Government's right to reimbursement for its pro rata share of nonrecurring costs if the contractors decide to sell the AMST to domestic commercial buyers.

Further, due to the significant estimated cost of the AMST program, we suggest that DOD include it in the SAR system. This would provide the Congress information on a regular basis concerning the cost, schedule, and technical status of the prototype program, as well as, any plans for further development and production.

The inclusion of the AMST program on the SAR system is essential in view of the matters discussed in the PREFACE to this staff study. As stated in the PREFACE, the impact of the February 1974, decision on the cost and schedule of the AMST program has not been completely defined. While schedules will be stretched-out with attendant cost increases, the advantages of maintaining competition appear to the Air Force to outweigh the reasons for eliminating one contractor. The inclusion of the program on the SAR system would provide the Congress better visibility on the impact of this decision on the cost and schedule once this is defined, and also would provide recurring information on the status of the program.

AGENCY COMMENTS

A draft of this study was reviewed by DOD officials associated with the management of the AMST program, and their comments are incorporated in the report as we believe appropriate. We know of no residual differences with respect to the factual material presented herein.