

NASA LEWIS RESEARCH CENTER
ALTITUDE WIND TUNNEL PROJECT

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PROJECT MANAGEMENT REPORT
OCTOBER 1985



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ALTITUDE WIND TUNNEL PROJECT

PROJECT MANAGEMENT REPORT

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DATE:

11-14-85

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ALTITUDE WIND TUNNEL PROJECT

STATUS AS OF: November 1, 1985

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MONTHLY PROJECT MANAGEMENT REPORT

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I. INTRODUCTION

The National Aeronautics and Space Administration, through the work conducted by the Lewis Research Center in Cleveland, Ohio is committed to the continued advancement of technology for new and improved aircraft propulsion systems. A national assessment of the future outlook for aeronautics concluded that major advances in aircraft capabilities are yet to be made. To achieve these advances aggressive programs must be pursued in propulsion and in the integration of the propulsion system with the total aircraft. It will also be essential that these advanced systems have expanded capabilities for adverse weather operation, primarily icing and heavy rain.

Examples of some new propulsion systems which will be more highly integrated with airframe external flow include advanced high-speed turboprop propulsion, highly survivable military aircraft, V/STOL, and high-speed rotorcraft with adverse weather capability such as icing. The technical challenges associated with these new systems will require continued advances in computational capabilities and the availability of a particular type of test facility with unique characteristics which currently does not exist. These characteristics include a wind tunnel configuration with large-scale test article capability, high subsonic speeds, concurrent pressure and temperature simulation of altitude, weather capability (e.g. icing and heavy rain), and also sizeable ancillary services for propulsion system operation and simulation (high pressure air sources and exhaust flow scavenging). The rehabilitation of the existing and unused Altitude Wind Tunnel (AWT) at the NASA Lewis Research Center, supported by already existing high pressure and high flow rate air systems, will provide in a cost effective manner the needed National Altitude Wind Tunnel propulsion system and icing test facility.

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The organizational units within the AWT Project Office are performing all the activities associated with the planning, advocacy, management, budgeting, and conduct of required contractual and in-house efforts to provide for the successful design, and fabrication, and checkout of the modified Altitude Wind Tunnel. The AWT Engineering Office will conduct the CoF elements and supporting work for the AWT Project. These efforts include the Preliminary Engineering Report (PER), the Final Design, studies and construction management. The AWT Research Office will conduct analytical, experimental, and study efforts to assure that the AWT meets the research needs as established in the requirements document. These efforts include component and system performance analysis and verification by analytically and physically modeling the individual components and eventually the complete tunnel loop. The AWT Systems Office will conduct the necessary analysis and studies to ensure that the AWT can be operated efficiently and safely. These efforts include an institutional impact and safety analysis, an integrated systems test plan, dynamic systems analysis and the development of a complete system real-time simulator.

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II. EXECUTIVE SUMMARY

The AWT Project Office has developed a plan for completion of current activities in view of the failure of the AWT CoF initiative to be approved for FY 1987. In this plan, the Engineering and Systems Offices will essentially terminate all activities and will close down each activity by preparing reports on those efforts where reportable information has been developed. The Research Office will terminate some activities and continue others thru completion. This revised plan has been approved by Lewis senior management and by NASA Headquarters Code R. The revised plan and schedule are described in this report.

The Engineering Office will complete its activities by preparing a supplemental report to the PER. This report will be completed by the end of CY85 and the Office will then be disbanded.

In the Research Office work continued on the physical modeling activities. High-speed leg testing has resumed following Lewis facility maintenance shut-down. Tests of ice accretion on screens and honeycomb flow straighteners were conducted in the Icing Research Tunnel. The result was that very little ice collected on these surfaces because the AWT type heat exchanger ahead of them was an efficient remover of ice cloud drops. Improvements to the Time Delay Spectrometry technique for measuring acoustic treatment performance have been identified and are being incorporated into this measuring system.

The Systems Office activity included the following. An informal report concerning an operational assessment of the AWT PER configuration has been completed. This completes the work in this area. In the Systems Simulation, Controls, and Real-Time Digital Simulator areas informal and formal reports are being prepared which covers the work accomplished to date. With the completion of these reporting activities, the Office will be disbanded.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
ENGINEERING OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

III. AWT ENGINEERING OFFICE ACTIVITIES

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
ENGINEERING OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

INTRODUCTION

The AWT Engineering Office will perform all the functions necessary to manage and direct contracted and in-house efforts to:

- establish an initial design and current cost estimate in the Preliminary Engineering Report (PER),
- accomplish a final design,
- provide construction management services, and
- provide an environmental assessment.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
ENGINEERING OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

PROJECT: CoF Project #2286
Altitude Wind Tunnel (AWT)
FY 1987, 1988, 1989 and 1990

CENTER: LeRC

FACILITY PROJECT MANAGER: Robert L. Allen

I. NARRATIVE STATUS ANALYSES

1.0 PROJECT DESCRIPTION

This project provides for the Modification of the Altitude Wind Tunnel at the Lewis Research Center for propulsion and icing research. The new tunnel shall combine the existing Altitude Wind Tunnel pressure shell, office and shop buildings, and refrigeration plan with additional new features developed in a Special Study completed in June 1982. The resulting configuration shall have a 20' octagonal test section capable of MACH .8 velocities at 32,000 feet altitude, 55,000 feet maximum altitude, a minimum stagnation temperature of -40 degrees F, and icing conditions. A complete compilation of the facility requirements and criteria is contained in the Requirements and Criteria Document dated July 1983, and the costed configuration is defined in the PER dated December 1984.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
ENGINEERING OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

2.0 SIGNIFICANT PROGRESS

The work package managers have started drafts of a supplement report to the PER. This supplement will document the Engineering Office's activities on the various facility systems since the completion of the PER. Completion of the supplement report and closing of the Engineering Office is expected by the end of calendar year 1985. This is the final report for the Engineering Office.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
RESEARCH OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

IV. AWT RESEARCH OFFICE ACTIVITIES

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
RESEARCH OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

INTRODUCTION

The AWT Research Office will conduct the necessary studies and experimental programs to establish the specific research applications of the AWT and therefore the necessary facility capabilities; and also to determine, analyze, and enhance the actual performance of the proposed facility design. The functions of this office are subdivided into two areas:

RESEARCH PROGRAM PLANNING

The objective of the Research Planning function is to identify future aero/propulsion research needs and establish program plans to develop the technologies to satisfy these needs.

PERFORMANCE ASSESSMENT AND MODELING

The objective of the AWT Performance Assessment and Modeling program is to execute the analytical and physical modeling activities needed to ensure a technically sound AWT design.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
RESEARCH OFFICE ACTIVITIES

WORK BREAKDOWN STRUCTURE

W.B.S. 1.0 RESEARCH PROGRAM PLANNING

- 1.1 Research Need and Program Identification
- 1.2 AWT Testing Requirements and Capabilities Identification

W.B.S. 2.0 PERFORMANCE ASSESSMENT AND MODELING

- 2.1 Circuit Aerothermodynamics
- 2.2 Drive System
- 2.3 Icing Systems
- 2.4 Acoustics

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
RESEARCH OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

STATUS

W.B.S. 1.0 RESEARCH PLANNING

1.1 Research Need and Program Identification

Effort terminated.

1.2 AWT Testing Requirements and Capabilities

Effort terminated.

W.B.S. 2.0 PERFORMANCE ASSESSMENT AND MODELING

2.1 Circuit Aerothermodynamics

Modifications to the aerothermodynamic modeling plan include; 1) elimination of the complete AWT model loop testing; 2) elimination of the aero tests of corners 3 and 4 in the high-speed leg; and 3) elimination of some of the analytical modeling effort. The high-speed leg experimental evaluation, including testing of a series of blockage models, is the main effort remaining in this area.

Work on aerodynamic modeling of the test section with slot-bleed and the transition from the circular settling chamber to the octagonal test section has been eliminated because of the considerable effort still required to complete these models.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
RESEARCH OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

Experimental evaluation of the high-speed leg has resumed following the Lewis facilities maintenance shutdown. Design and fabrication of blockage models for the high-speed leg continues.

2.2 Drive System

Changes to the drive system modeling plan include the elimination of the aero testing of the rapid diffuser downstream of the fan. In addition, the model fan installation will be changed to allow for clean inlet testing by removing corner #2 from in front of the fan and replacing it with a bellmouth. Flow distortions representative of the upstream corner will now be investigated using screens to simulate the corner flow distortions. This change is being implemented in order to be able to use the fan as a research tool after the AWT modeling effort is completed.

With the availability of FY86 funding, machining of the model fan blades has been resumed.

2.3 Icing Systems

Modifications to the icing modeling plan include; 1) the elimination of the high-speed leg icing tests in PSL; and 2) the elimination of the remaining research on spray nozzles and drop-sizing instruments. Work on the latter item may be transferred and continued in other organizational areas outside of the AWT.

Testing to establish ice accretion on AWT type screens and honeycomb flow straighteners was performed in October. The test duct was mounted downstream of the model AWT heat exchanger. Because the heat exchanger is such an efficient collector, few droplets survive to accrete on the screens or honeycomb. The conclusion is that screen and honeycomb flow straighteners can be left in place in the AWT during icing tests with no significant ice accretion to affect their performance.

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NARRATIVE ANALYSIS
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RESEARCH OFFICE ACTIVITIES

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Hardware for both the turning vane electrothermal and steam deicing tests and the prototype spraybar tests has been fabricated, and instrumenting the hardware is proceeding. These tests will be performed in the IRT in November and December, respectively.

2.4 Acoustic Systems

Modification of the acoustic modeling plan includes; 1) eliminating all acoustic activity associated with the fan; and 2) elimination of the acoustic effort that was to be done in the full AWT model loop. The work associated with providing an anechoic test section will be completed.

A layout of the high-speed leg in CW-22 was made in order to determine the minimum modifications necessary to complete the anechoic test section work. Cost effectiveness of the modifications is currently being evaluated.

Discussions have been completed with the manufacturer of the Time Delay Spectrometry (TDS) system for purposes of improving its capability of making acoustic measurements at high test section Mach numbers. A signal enhancement process has been identified which is expected to improve the TDS system such that it can be effective at the higher Mach numbers. Modifications to the existing system will be implemented after the first of the year.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
RESEARCH OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

PROBLEMS

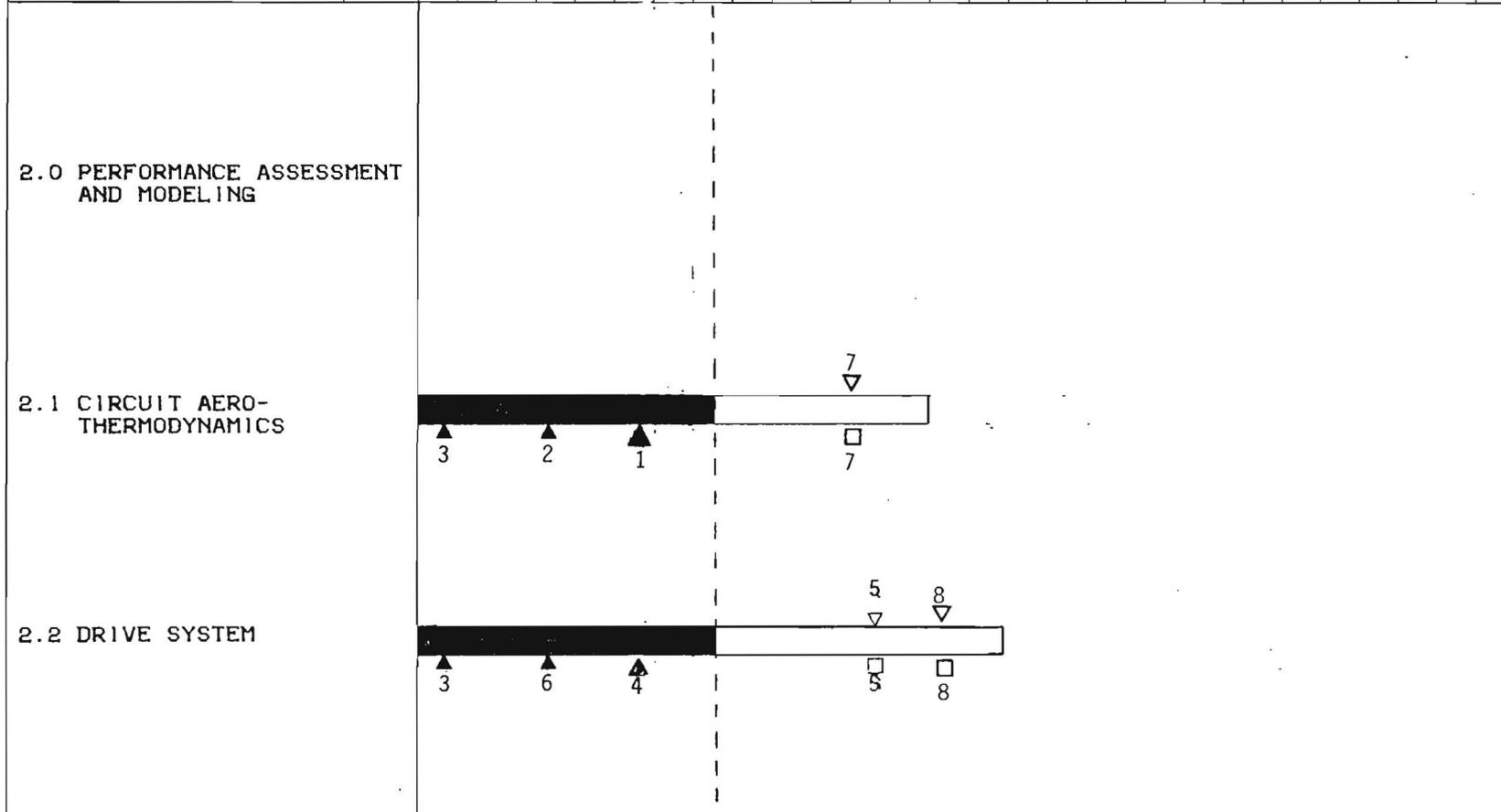
None.

CHANGE IN PLANS

A revised AWT modeling plan has been developed as a result of AWT CoF new start not being approved. The revised plan and the major deletions are described in this report.

LEWIS	MASTER PROGRAM SCHEDULE	
RESEARCH CENTER	ALTITUDE WIND TUNNEL PROJECT	STATUS AS OF <u>NOVEMBER 1, 1985</u>
	RESEARCH OFFICE ACTIVITIES	

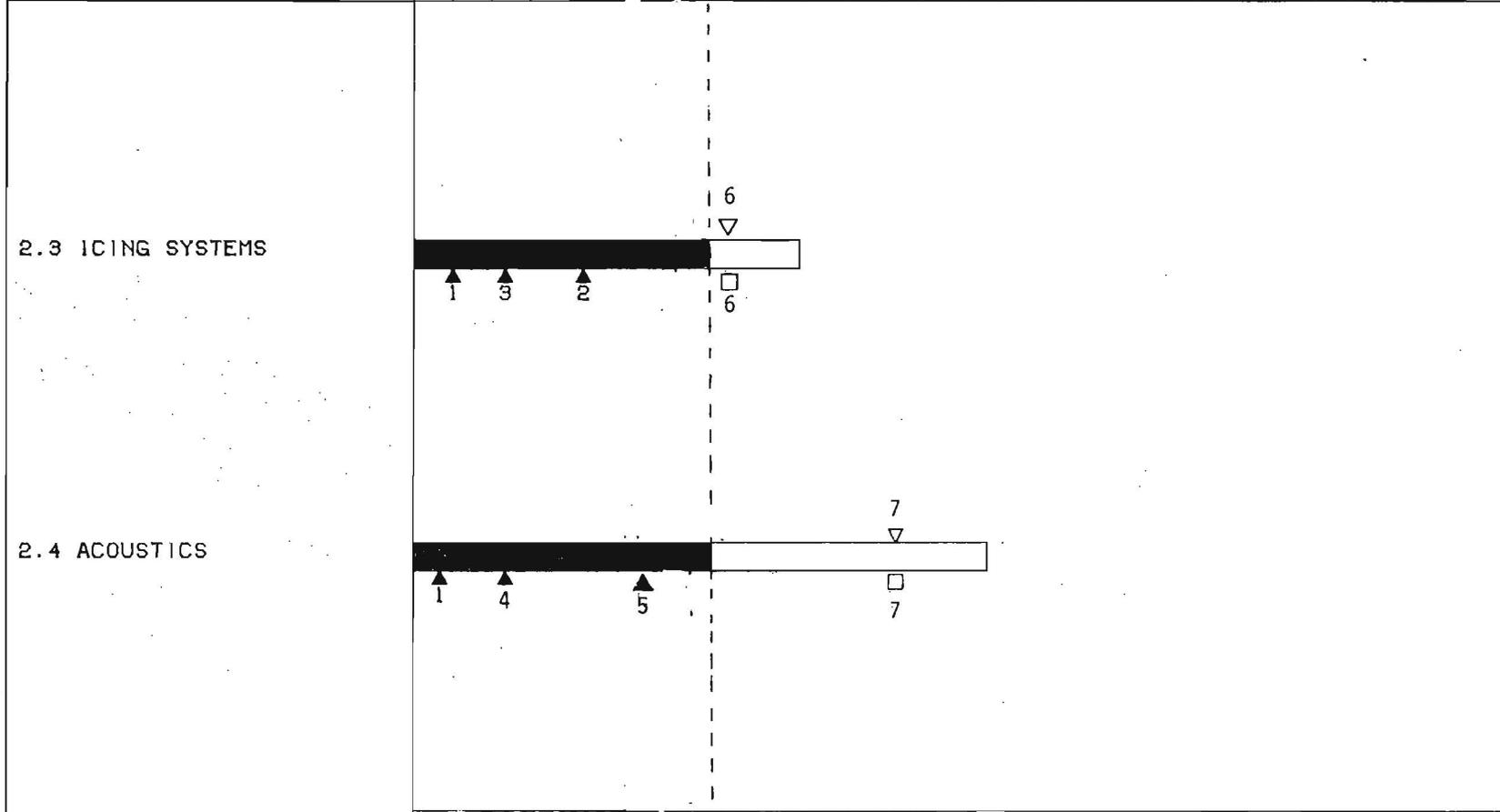
WBS ACTIVITY	CY	1984				1985				1986				1987				1988				1989				1990			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4



KEY	1. INITIATE HI. SPD. LEG TEST	5. INITIATE FAN TEST
▽ Scheduled Milestone	2. INITIATE HEAT EXCH. TEST	6. INITIATE CORNER #1 TEST
▲ Completed Milestone	3. INITIATE ANAL. & MODEL DESIGN	7. COMPLETE HIGH-SPEED LEG TESTS
□ Expected Completion	4. INITIATE CORNER #2 TEST	8. COMPLETED FAN TESTS

LEWIS RESEARCH CENTER	MASTER PROGRAM SCHEDULE ALTITUDE WIND TUNNEL PROJECT RESEARCH OFFICE ACTIVITIES	STATUS AS OF <u>NOVEMBER 1, 1985</u>
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WBS ACTIVITY	CY	1984				1985				1986				1987				1988				1989				1990			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4				



KEY		
▽ Scheduled Milestone	1. INITIATE ANAL. & MODEL DES.	5. INITIATE HI. SPD. LEG TEST
▲ Completed Milestone	2. INITIATE SINGLE NOZ. RIG TEST	6. COMPLETE AWT TESTS IN IRT
□ Expected Completion	3. INITIATE AWT TESTS IN IRT	7. COMPLETE HSL TESTS
	4. INT. TRTMT. TEST IN 8X6	

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
SYSTEMS OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

V. AWT SYSTEMS OFFICE ACTIVITIES

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ALTITUDE WIND TUNNEL PROJECT

STATUS AS OF November 1, 1985

INTRODUCTION

The Altitude Wind Tunnel Systems Office will conduct analyses and studies and will plan tests to ensure that the AWT can be operated efficiently and safely. The activities of the AWT Systems Office have been subdivided into two major areas of responsibility. These are:

OPERATIONS/UTILIZATION ASSESSMENT AND PLANNING

The objectives of the Operations/Utilization Assessment and Planning activities are to assess the suitability of the AWT design for satisfying functional requirements, to assess the institutional impact (costs, power, staffing) of the AWT on the Center, to plan for the integrated systems tests and the integration of the AWT with other Lewis facilities, to perform analyses and studies to assure safe operation of the AWT, to provide integrated schedules for the project, and to support the AWT Project from the preliminary design phase (PER) through Final Design, Construction, and the eventual start-up and checkout.

SYSTEMS ANALYSIS AND TEST

The objectives of the Systems Analysis and Test activities are to develop mathematical models and computer simulations of the AWT, to use the simulations to evaluate the steady-state and transient performance of proposed control system designs, and to develop a real-time simulator system that can be used to checkout control system hardware and software prior to tunnel runs.

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
SYSTEMS OFFICE ACTIVITIES

WORK BREAKDOWN STRUCTURE

STATUS AS OF November 1, 1985

W. B. S. 3.0 AWT Operation/Utilization Assessment and Planning

- 3.1 AWT Design Assessment
- 3.2 Institutional Impact Assessment
- 3.3 Integrated System Test (IST) Plans
- 3.4 Safety Assessment
- 3.5 Integrated Schedule

W. B. S. 4.0 Systems Analysis and Test

- 4.1 Systems Simulation
- 4.2 Controls
- 4.3 Real-Time Digital Simulator

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NARRATIVE ANALYSIS
ALTITUDE WIND TUNNEL PROJECT
SYSTEMS OFFICE ACTIVITIES

STATUS AS OF November 1, 1985

STATUS

W.B.S. 3.0 AWT OPERATION/UTILIZATION ASSESSMENT AND PLANNING

A Preliminary Information Report, summarizing the results of the operational assessment of the PER configuration, was completed. Since the AWT Project was not included in the FY87 CoF budget, the operations assessment has been terminated. This will be the final report on this WBS element.

W.B.S. 4.0 SYSTEMS ANALYSIS AND TEST

4.1 Systems Simulation

Checkout of the exhaust subsystem coding was completed. All subsystem simulations are operational and being used to complete the controls assessment. A Preliminary Information Report, describing the refrigeration subsystem model is 50 percent complete. A NASA Technical Memorandum on the circuit model has been initiated. Both IBM 370 and hybrid computer versions of the circuit model (with simplified subsystem models) are being used to obtain data for the TM. Work on this element of the WBS will end with the completion of the documentation.

4.2 Controls

Preliminary Information Reports on the controls assessment plan and the fan drive control were completed. A draft of a PIR on the PES control assessment is now being reviewed. The assessments of the refrigeration and supply/exhaust controls are still in progress. All documentation will be completed by the end of CY85. A paper, describing the system analysis (i.e. simulation and controls

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NARRATIVE ANALYSIS
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SYSTEMS OFFICE ACTIVITIES

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assessment) process has been submitted to the AIAA 14th Aerodynamic Testing Conference to be held March 5-7, 1986 in West Palm Beach, Florida. Work on this element of the WBS will end with the completion of the documentation. A plan is now being formulated to modify and apply the AWT refrigeration model to the analysis of the Icing Research Tunnel.

4.3 Real-Time Digital Simulator

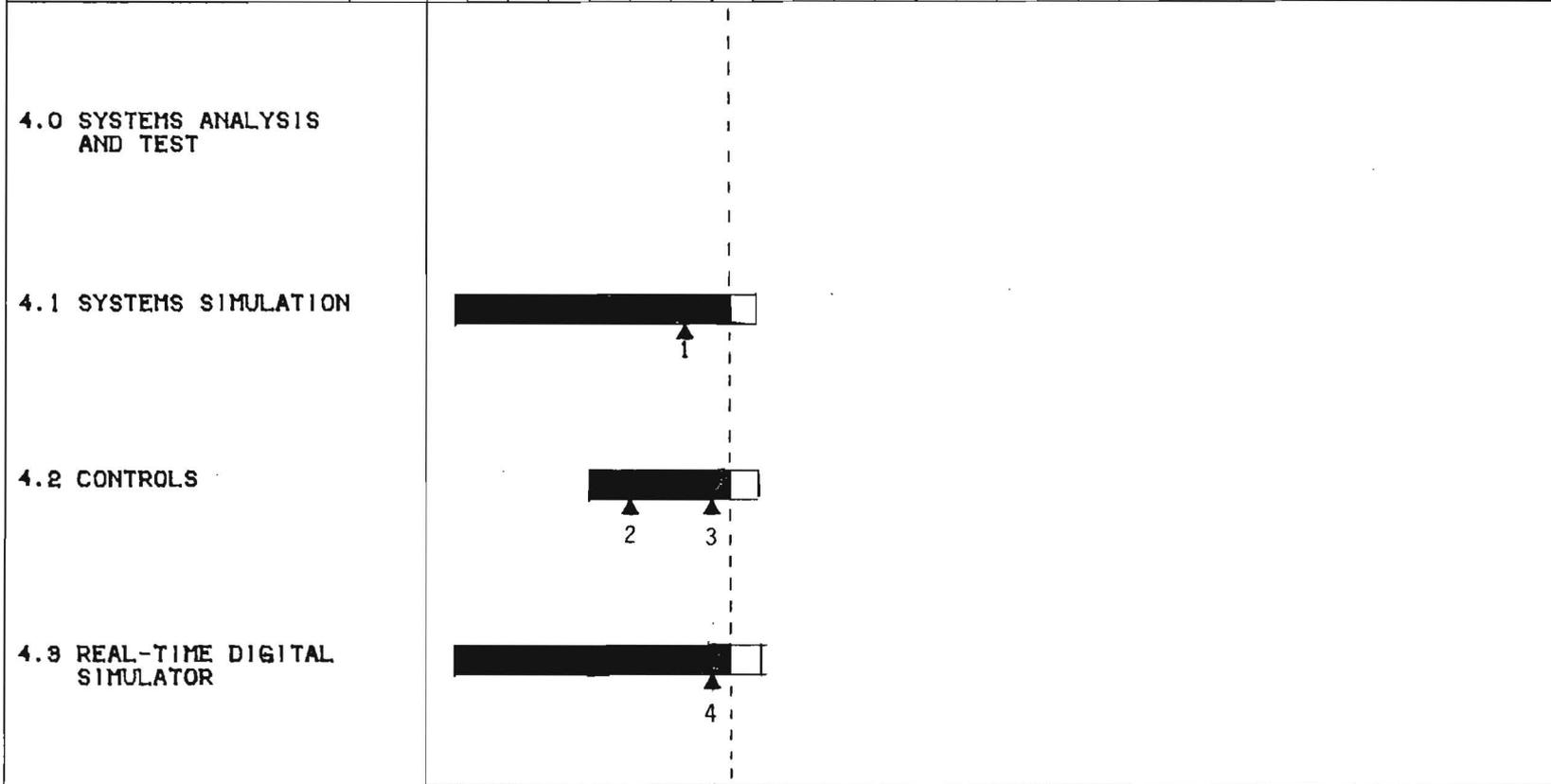
Work on the development of a dedicated, real-time simulator for the AWT has been terminated. Work on generic, parallel-processing technology continues with the adaptation of the programming and operational software utilities to accommodate a floating-point data type and the new, more powerful floating-point processors. Future work in this area will depend on the outcome of personnel reassignments and availability of resources.

LEWIS		MASTER PROGRAM SCHEDULE																											
RESEARCH		ALTITUDE WIND TUNNEL PROJECT												STATUS AS OF <u>NOVEMBER 1, 1985</u>															
CENTER		SYSTEMS OFFICE ACTIVITIES																											
WBS ACTIVITY	CY	1984				1985				1986				1987				1988				1989				1990			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
9.0 OPERATIONS/UTILIZATION ASSESSMENT AND PLANNING																													
9.1 DESIGN ASSESSMENT																													
9.2 INSTITUTIONAL IMPACT ASSESSMENT																													
KEY		1. PER DESIGN PREVIEW 2. BEGIN OPER & CONTROL ASSESSMENT 3. COMPLETE STUDY 4. PRELIMINARY ESTIMATES																											
▽ Scheduled Milestone																													
▲ Completed Milestone																													
□ Expected Completion																													

LEWIS		MASTER PROGRAM SCHEDULE																											
RESEARCH		ALTITUDE WIND TUNNEL PROJECT												STATUS AS OF <u>NOVEMBER 1, 1985</u>															
CENTER		SYSTEMS OFFICE ACTIVITIES																											
WBS ACTIVITY	CY	1984				1985				1986				1987				1988				1989				1990			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
9.9 INTEGRATED SYSTEMS TEST (1ST) PLANS		[Gantt bar spanning 1984 Q1 to 1985 Q1]																											
9.4 SAFETY ASSESSMENT		[Gantt bar spanning 1984 Q3 to 1985 Q1]																											
9.5 INTEGRATED SCHEDULE.		[Gantt bar spanning 1984 Q3 to 1985 Q1 with a triangle marker at the end]																											
KEY		1. INITIATE CPM SYSTEM																											
▽ Scheduled Milestone																													
▲ Completed Milestone																													
□ Expected Completion																													

LEWIS RESEARCH CENTER	MASTER PROGRAM SCHEDULE ALTITUDE WIND TUNNEL PROJECT SYSTEMS OFFICE ACTIVITIES	STATUS AS OF <u>NOVEMBER 1, 1985</u>
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WBS ACTIVITY	CY	1984				1985				1986				1987				1988				1989				1990			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4				



KEY	
▽ Scheduled Milestone	1. PRELIMINARY SYSTEMS MODEL
▲ Completed Milestone	2. CONTROLS ASSESSMENT PLAN
□ Expected Completion	3. SUBSYSTEM CONTROLS ASSESSED
	4. SIMULATOR REQUIREMENTS DEFINED

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ALTITUDE WIND TUNNEL PROJECT

STATUS AS OF November 1, 1985

VI. RESOURCES ANALYSIS

1.0 FINANCIAL STATUS

- 1.1 Commitments
- 1.2 Obligations
- 1.3 Costs
- 1.4 Master Schedule

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RESOURCES ANALYSIS
AWT FINANCIAL STATUS
COMMITMENTS

STATUS AS OF 11-1-85

CURRENT FISCAL YEAR 1986

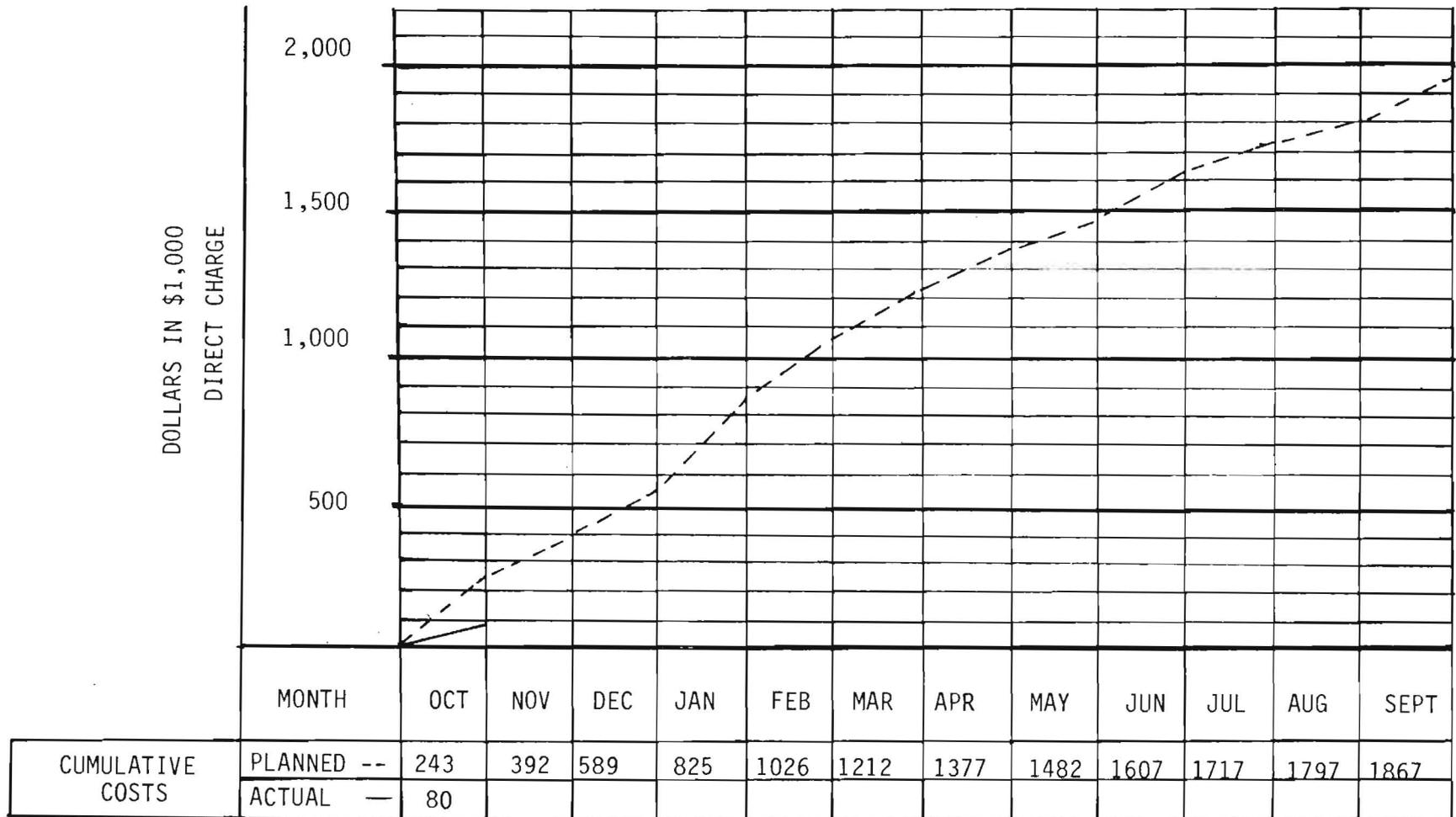


FIGURE 1.1

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RESOURCES ANALYSIS
AWT FINANCIAL STATUS
OBLIGATIONS

STATUS AS OF 11-1-85

CURRENT FISCAL YEAR 1986

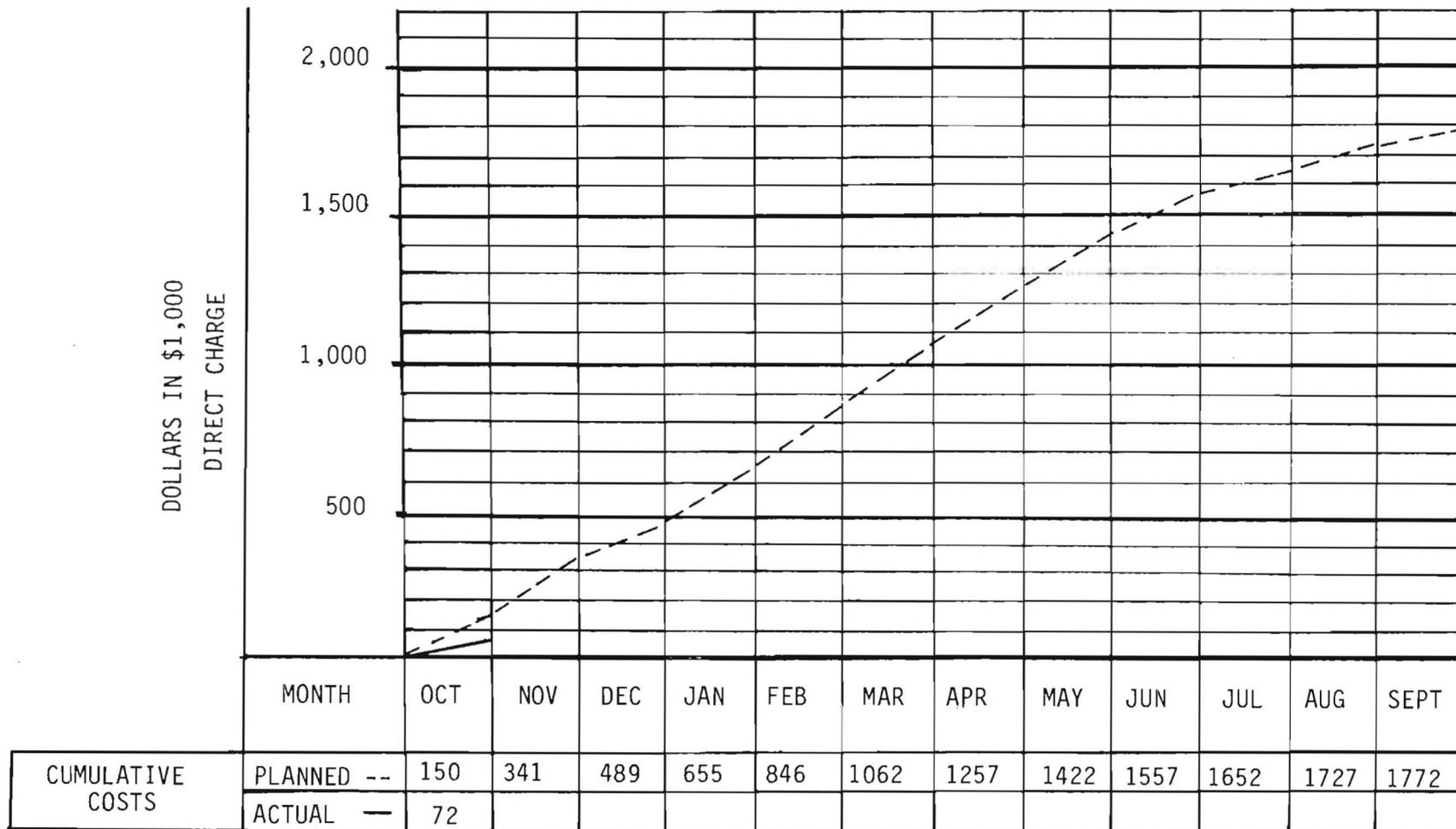


FIGURE 1.2

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RESOURCE ANALYSIS
AWT FINANCIAL STATUS
COSTS

STATUS AS OF 11-1-85

CURRENT FISCAL YEAR 1986

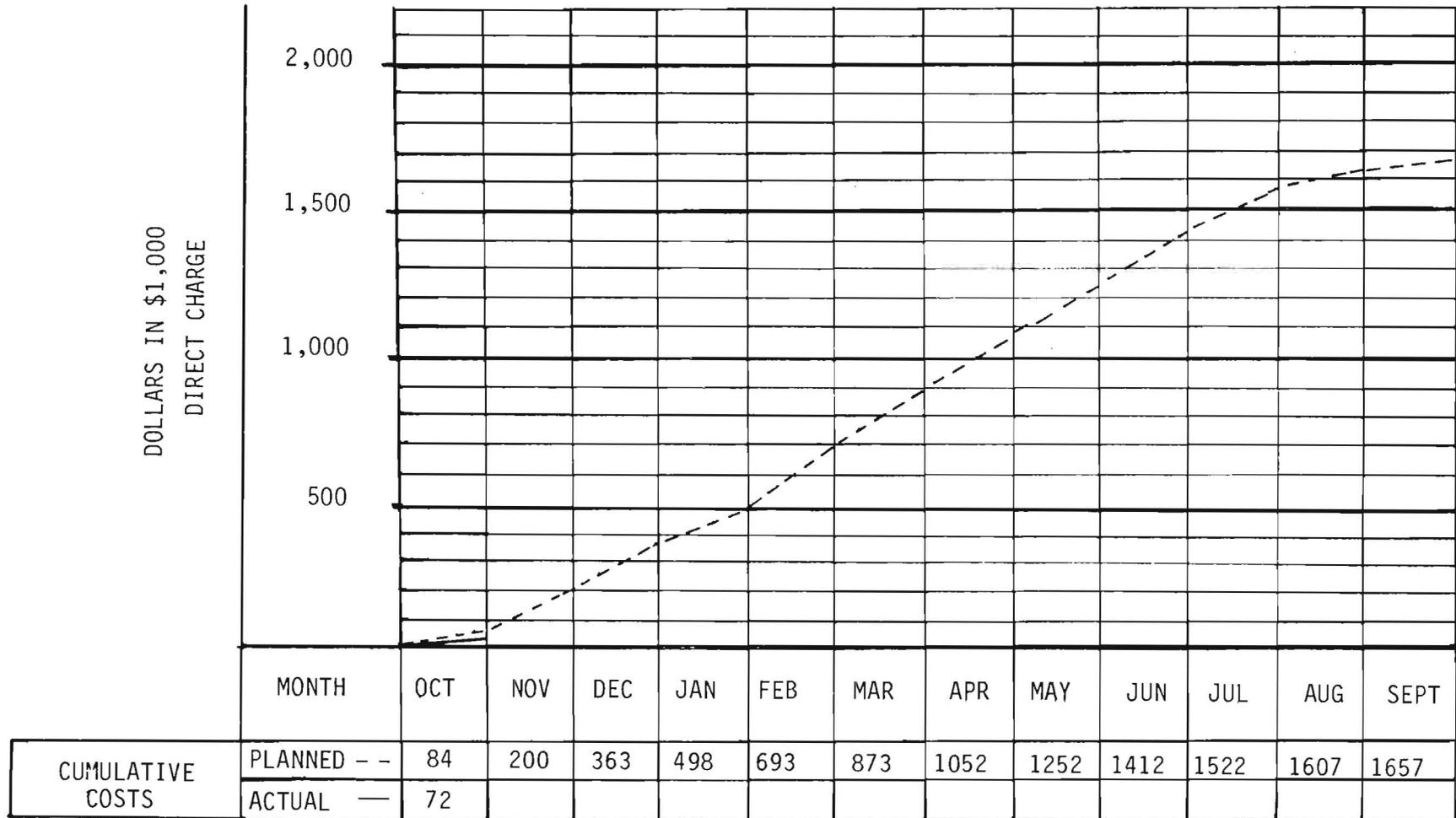


FIGURE 1.3

1.4 MASTER SCHEDULE
 ALTITUDE WIND TUNNEL PROJECT

STATUS AS OF 11-1-85

		FISCAL YEARS								
		1982 & PRIOR	1983	1984	1985	1986	1987	1988		
1	CONCEPT DEVELOPMENT									
	STUDY	██████████								
	ADVOCACY		██████████	██████████	██████████					
	PRELIMINARY ENGR' REPORT			██████████						
2	ENGINEERING OFFICE									
	PER UPDATE				██████████					
	STRUCTURAL CERTIFICATION				██████████					
3	RESEARCH OFFICE									
	CORNER AERODYNAMICS			██████████	██████████	██████████				
	HIGH SPEED LEG AERO.			██████████	██████████	██████████	██████████			
	ANECHOIC TEST SECTION			██████████	██████████	██████████	██████████			
	FAN AERODYNAMICS			██████████	██████████	██████████	██████████			
	COMPONENT PROTECTION (DEICING)			██████████	██████████	██████████				
	SPRAY BAR PERFORMANCE			██████████	██████████	██████████				
	ACOUSTIC ABSORBER PERFORM.			██████████	██████████	██████████				
4	SYSTEMS OFFICE									
	LOOP MODELING				██████████					

PROJECT MANAGEMENT REPORT
ALTITUDE WIND TUNNEL PROJECT

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2720/J. J. Reinmann (2)	M.S. 86-7	7500/L. J. Kaszubinski	M.S. 86-2
2740/G. K. Sievers	M.S. 86-7	7500/J. A. Yuska	M.S. 86-2
2743/J. F. Groeneweg (2)	M.S. 5-7	7510/D. W. Drier	M.S. 86-2
2750/P. G. Batterton	M.S. 86-7	7520/W. E. McKissock	M.S. 86-2
2753/R. E. Coltrin	M.S. 86-7	7530/G. S. Sarvay	M.S. 86-2
2760/C. L. Ball	M.S. 5-9	7600/D. J. Keliher	M.S. 86-9
2800/D. N. Bowditch	M.S. 6-8	7610/W. D. Guthrie	M.S. 86-9
2800/L. E. Macioce	M.S. 6-8	7620/H. A. Schoeffler	M.S. 86-9
2810/H. B. Block	M.S. 6-8	7630/D. F. Larson	M.S. 86-9
2810/H. E. Zager	M.S. 6-8	7650/E. C. Boitel	M.S. 86-8