NASA

National Aeronautics and
Space Administration

Budget Estimates

FISCAL YEAR 1979

Volume II

Construction of Facilities

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

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VOLUME II

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

GENERAL STATEMENT

This appropriation provides for contractual services for the design, major rehabilitation, and modification of facilities; the construction of new facilities; minor construction; the purchase of related equipment and advance design related to facilities planned for future authorization.

The funds requested for 1979 provide for the continuation of prior years' endeavors in meeting the facilities requirements for the space shuttle program; construction and modification of large aeronautical research and development facilities; and construction, rehabilitation, and modification of other facilities to maintain, upgrade and improve the usefulness of the NASA physical plant; and facility planning and design activities.

The projects and amounts reflected in the budget estimate are time sensitive in order to meet the specific milestones established for the space shuttle development program and operational capability. The program for FY 1979 also includes the third increment of funding for two large aeronautical facilities, the construction of a National Transonic Facility at the Langley Research Center and modification of the 40- by 80-Foot Subsonic Wind Tunnel at the Ames Research Center. Requirements for these and other aeronautical research and technology facilities are outlined in detail in the enclosed justifications.

The Rehabilitation and Modification of Facilities program for FY 1979 continues to meet the objectives of preserving and enhancing the capabilities and usefulness of existing facilities, and to ensure continued safe, economical and efficient use of the NASA physical plant. The Minor Construction program provides the means to accomplish smaller facility projects which for the most part are to accommodate technical requirements stemming from research, development, test and similar activities.

Funds requested for Facility Planning and Design cover advance planning and design requirements for potential future projects, master, planning, facilities studies, and engineering reports and studies.

The request for FY 1979 is $152,500,000, a decrease of $9,840,000 below the adjusted appropriation for FY 1978. Outlays are estimated to be $154,000,000 in FY 1979, an increase of $21,500,000 over the estimate for FY 1978.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

CONSTRUCTION OF FACILITIES

For construction, rehabilitation and modification of facilities, minor construction of new facilities and additions to existjng facilities, and for facility planning and design not otherwise provided, for the National Aeronautics and Space Administration, and for the acquisition or condemnation of real property, as authorized hy law, [$160,940,000] *$152,500,000,* to remain available for ohligation until September 30, [1980] *1981*: ***Provided,*** That, notwithstanding the limitation on the availability of funds appropriated under this head by this appropriation Act, when any activity has been initiated by the incurrence of obligation.. therefor, the amount available for such activity shall remain available until expended, except that this provision shall not apply to the amounts appropriated pursuant to the authorization for rehabilitation and modification of facilities, minor construction of new facilities and additions to existing facilities, and facility planning and design. ***(42 U.S.C. 6461 et. seq.; Department of Ilousing and Urban Development—Zndependent Agencies Appropriation Act, 1978; additional authorizing legislation to be proposed.)***

CONSTRUCTION OF FACILITIES

Program and Financing (in thousands of dollars)

Identification code 80-0107-0-1-999

		Budget plan (amount. for construction of facilities actions programed)			Costs and obligations		
		1977 actual	1978 estimate	1979 estimate	1977 actual	1978 estimate	1979 estimate
	Program by activities:						
	Direct program:						
	1. Space transportation systems	30.695	64,880	31,070	56.977	49,900	51.203
	2. Scientific investigations in space	8, I20	6.410	----------	3,830	8.700	5.833
	3. Space and terrestrial applications	----------	3,100	----------	----------	600	1,933
	4. Space research and technology	680	----------	----------	549	700	200
	5. Aeronautical research and technology	34.950	38, 400	76.530	7.964	37,700	44,633
	7. Supporting activity	431645	49.550	44.900	37,788	45.000	43,930
	Total direct program costs, funded	118,090	162,340	152, 500	107,108	142.600	158, 600
	Reimbursable program:						
	7. Supporting activity (reimbursable program cost)	7.161	----------	----------	349	1, 700	3,000
	Total program costs. funded	125,251	162,340	152.500	107.457	144, 300	161, 600
	Change in selected resources (undelivered orders)	----------	----------	----------	23.970	33,142	-2,500
10.00	Total	125,251	162.340	152, 500	131.427	177,442	159.100
	Financing:						
	Offsetting collections from						
11.00	Federal funds	-2,073	----------		-2,073	----------	----------
14.00	Non-federal sources	-5.088	----------		-5,088	----------	
21.40	Unobligated balance available. start of year. For completion of prior year budget plans:						
	Direct.	----------	----------		-93,386	-80.353	—71, 893
	Reimbursable.	----------	----------		-114	-6.942	-300
24.40	Unobligated balance available, end of year: For completion of prior year budget plans.						
	Direct.	----------	----------		80,353	71.893	65.593
	Reimbursable	----------	----------		6.942	300	----------
25.40	Unobligated balance lapsing	----------	----------		29	----------	----------
	Budget authority	118,090	162,340	152, 500	118,090	162,340	152,500
	Budget authority:						
40.00	Appropriation	118,090	160,940	152, 500	118,090	160, 940	152, 500
42.M1	Transferred from other accounts.	----------	1,400	----------	----------	1,400	----------
43.00	**Appropriation (adjusted)**	118, 090	162.310	152, 500	118, 090	162, 340	152, 500
	Relation of obligations to outlays						
71.00	Obligations incurred, net.				124.266	177.442	159.100
72.40	Obligated balance. start of year				77,738	97.187	142.129
74.40	Obligated balance. end of year				-97.187	—142, 129	-147.229
77.40	Adjustments in expired accounts.	----------	----------	----------	153	----------	----------
90.00	Outlays				104, 970	132, 500	154,000

Note.—Reconciliation of budget plan to obligations:

	1977 actual	*1978 estimate*	*1979 estimate*
Total budget plan	125, 251	162, 340	152, 500
Deduct portion of budget plan to be obligated in subsequent years	56, 731	40, 340	38, 000
Add obligations of prior year budget plans	62, 907	55, 442	44, 600
Total obligations	131, 427	177.441	159,100

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

SUMMARY OF THE BUDGET PLAN BY LOCATION

Location	FY 1977	FY 1978 (In Dollars)	FY 1979
Ames Research Center	4,490,000	---	9,770,000
Hugh L. Dryden Flight Research Center	750,000	420,000	---
Goddard Space Flight Center	---	4,500,000	5,640,000
Jet Propulsion Laboratory	---	2,830,000	4,630,000
Lyndon B. Johnson Space Center	2,200,000	2,540,000	---
John F. Kennedy Space Center	2,805,000	2,130,000	---
Langley Research Center	6,185,000	1,770,000	6,500,000
Lewis Research Center	2,170,000	860,000	6,140,000
National Space Technology Laboratories	---	620,000	---
Large Aeronautical Facilities	31,000,000	37,000,000	56,100,000
Various Locations	---	1,750,000	---
Space Shuttle Facilities	30,695,000	64,880,000	31,070,000
Space Shuttle Payload Facilities	4,340,000	6,410,000	---
Rehabilitation and Modification	17,875,000	18,900,000	17,800,000
Minor Construction	2,925,000	5,950,000	4,200,000
Facility Planning and Design	12,655,000	11,780,000	10,650,000
Total Plan	118,090,000	162.340.000	152.500.000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

	FY 1977	FY 1978	FY 1979
		(In Dollars)	
SUMMARY OF THE BUDGET PLAN BY COGNIZANT OFFICE			
Office of Space Transportation Systems	34,625,000	71,290,000	31,070,000
Office of Space Sciences	2,970,000	---	---
Office of Space and Terrestrial Applications	---	3,100,000	---
Office of Aeronautics and Space Technology	36,850,000	37,980,000	76,530,000
Office of Space Tracking and Data Systems	750,000	3,150,000	---
Office of Management Operations	9,440,000	10,190,000	9,190,000
Office of the Comptroller	33,455,000	36,630,000	35,710,000
Total Plan	118,090,000	162,340,000	152.500.000
SUMMARY OF THE BUDGET PLAN BY SUBFUNCTION			
Code No. Title			
253 Space Flight	30,695,000	64,880,000	31,070,000
254 Space Science, Applications and Technology	8,800,000	9,510,000	---
255 Supporting Space Activities	43,645,000	49,550,000	44,900,000
(250) Subtotal, General Science, Space and Technology	83,140,000	123,940,000	75,970,000
405 Air Transportation	34,950,000	38,400,000	76,530,000
Total	118.090.000	162.340.000	152,500,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

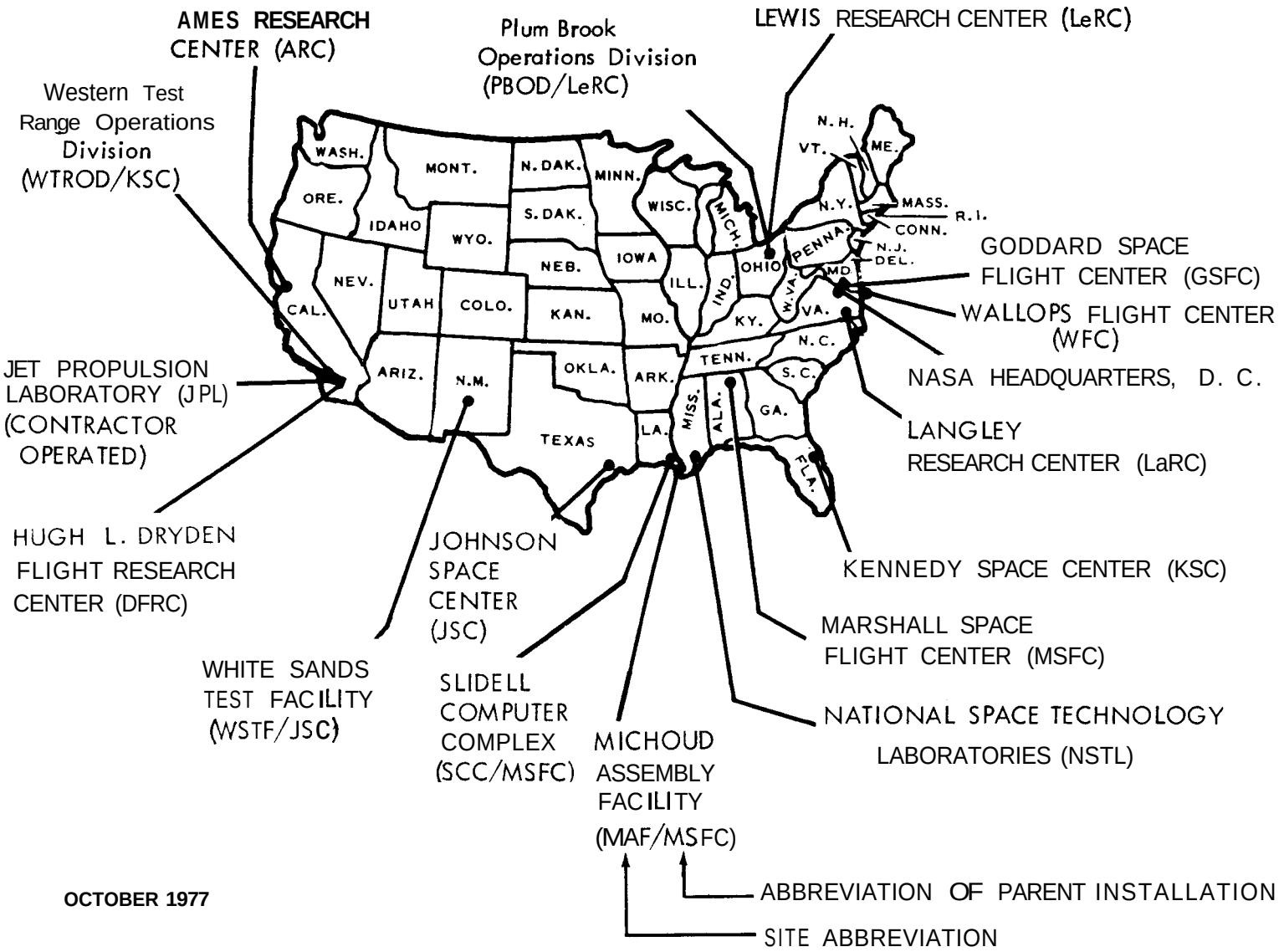
BUDGET PIAN BY LOCATION AND PROJECT

Cognizant Office	Budget Activity	Subfunction Code	Installation and Project	FY 1977	FY 1978	FY 1979	Page No.
				(In thousands of dollars)			
			Ames Research Center	4,490	---	9,770	
AST	5	405	Modification of Unitary Plan Wind Tunnel.....	---	---	5,390	CF 1-1
AST	5	405	Modification of 3.5-Foot Wind Tunnel.....	---	---	1,870	CF 1-10
AST	5	405	Modification of 12-Foot Pressure Wind Tunnel...	---	---	2,510	CF 1-16
AST	2	254	Modifications for High Enthalpy Entry Facility.....	1,220	---	---	
Mgmt Ops	7	255	Construction of Supply Support Facility.....	1,540	---	---	
AST	5	405	Modification of Flight Simulator for Advanced Aircraft..	1,730	---	---	
			Hugh L. Dryden Flight Research Center	750	420	---	
ST&DS	7	255	Construction of Addition to Flight Control Facility.....	750	---	---	
Mgmt Ops	5	405	Construction of Central Hydraulic System.....	---	420	---	
			Goddard Space Flight Center	---	4,500	5,640	
Mgmt Ops	7	255	Modifications and Additions for Logistic and Supply Functions...	---	---	5,640	CF 2-1
S&TA	3	254	Construction of Additional Technical Processing Facilities.....	---	3,100	---	
ST&DS	7	255	Construction of an Addition to Building 14 for a Network Operations Control Center.....	---	1,400	---	
			Jet Propulsion Laboratory	---	2,830	4,630	
Mgmt Ops	7	255	Modifications to Various Buildings for Seismic Protection	---	2,830	1,570	CF 3-1
COMP	7	255	Modifications and Addition to the Space Flight Operations Facility.....	---	---	3,060	CF 3-8
			Lyndon B. Johnson Space Center	2,200	2,540	---	
Mgmt Ops	7	255	Modification of Chillers in Central Heating and Cooling Plant.....	---	2,540	---	
SS	2	254	Construction of Addition to Lunar Sample Curatorial Facility.....	2,200	---	---	

Cognizant Office	Budget Activity	Subfunction Code	Installation and Project	FY 1977	N 1978	N 1979	Page No.
				(In thousands of dollars)			
			John F. Kennedy Space Center	2,805	2,130	---	
STS	2	254	Construction of Airlock to Spin Test Facility	360	---	---	
Mgmt Ops	7	255	Modifications for Utility Control System	2,445	2,130	---	
			Langley Research Center	6,185	1,770	6,500	
Mgmt Ops	7	255	Modifications for Utility Control System	---	---	1,980	CF 4-1
AST	5	405	Rehabilitation of Unitary Plan Wind Tunnel	---	980	4,520	CF 4-8
Mgmt Ops	7	255	Rehabilitation of Main Heating Plant	---	790	---	
Mgmt Ops	7	255	Construction of Data Reduction Center Annex	2,970	---	---	
Mgmt Ops	7	255	Construction of Refuse-Fired Steam Generating Facility	2,485	---	---	
AST	5	405	Construction of Addition for Aeroelastic Model Laboratory	730	---	---	
			Lewis Research Center	2,170	860	6,140	
AST	5	405	Construction of Research Analysis Center	---	---	6,140	CF 5-1
AST	5	405	Rehabilitation of Combustion Air Drying System, Engine Research Building	1,490	---	---	
Mgmt Ops	5	255	Modification of Central Chilled Water System	---	860	---	
AST	4	254	Modification of Refrigeration System, Electric Propulsion Laboratory	680	---	---	
			National Space Technology Laboratories	---	620	---	
Mgmt Ops	7	255	Modifications for Utility Control System	---	620	---	
			Large Aeronautical Facilities at Various Locations as Follows:	31,000	37,000	56,100	
AST	5	405	Construction of National Transonic Facility (LaRC)	25,000	23,500	24,500	CF 6-1
AST	5	405	Modification of 40- by 80-Foot Subsonic Wind Tunnel (ARC)	6,000	13,500	31,600	CF 6-17
			Various Locations	---	1,750	---	
ST&DS	7	255	Rehabilitation and Modification of 64-Meter Antenna Components	---	1,750	---	

Cognizant office	Budget Activity	Subfunction Code	Installation and Project	FY 1977	FY 1978	FY 1979	Page No.
				(In thousands of dollars)			
			Space Shuttle Facilities at Various Locations as Follows:	30,695	64,880	31,070	
STS	1	253	Modifications to Launch Complex 39, Pad B (KSC)	12,855	40,700	13,570	CF 7-4
STS	1	253	Modifications of Manufacturing and Final Assembly Facilities for External Tanks (MAF)	1,930	18,610	13,980	CF 7-13
STS	1	253	Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities, Thiokol Plant, Wasatch, Utah	---	---	1,920	CF 7-30
STS	1	253	Minor Shuttle-Unique Projects (Various Locations)	1,760	1,750	1,600	CF 7-42
STS	1	253	Modifications to SRB Processing Facilities (KSC)	8,700	1,730	---	
STS	1	253	Rehabilitation of Barge Channels (KSC)	---	2,090	---	
STS	1	253	Construction of Orbiter Processing Facility (KSC)	3,750	---	---	
STS	1	253	Construction of Shuttle/Carrier Aircraft Mating Facilities (DFRC, KSC, Palmdale)	1,700	---	---	
			Space Shuttle Payloads Facilities at Various Locations as Follows:	4,340	6,410	---	
STS	2	254	Modifications and Addition for Shuttle Payload Vertical Processing (KSC)	---	6,410	---	
STS	2	254	Modifications to Operations and Checkout Building for Spacelab (KSC)	3,570	---	---	
SS	2	254	Modification and Addition for Shuttle Payload Development (GSFC)	770	---	---	
COMP	7	255	Rehabilitation and Modification of Facilities at Various Locations, Not in Excess of $500,000 per Project	17,875	18,900	17,a00	CF 8-1
COMP	7	255	Minor Construction of New Facilities and Additions to Existing Facilities at Various Locations, Not in Excess of $250,000 per Project	2,925	5,950	4,200	CF 9-1
COMP	7	255	Facility Planning and Design	12,655	11,780	10,650	CF 10-1
			TOTAL	118.090	162.340	152.500	

LOCATION OF NASA MAJOR AND COMPONENT INSTALLATIONS



OCTOBER 1977

RECORDED VALUE OF CAPITAL TYPE PROPERTY
IN-HOUSE AND CONTRACTOR-HELD
AS OF SEPTEMBER 30, 1977
(DOLLARS IN THOUSANDS)

Reporting Installation	Real Property					Plant Equipment	Fixed Assets in Progress	Grand Total
	Land	Buildings	Other Structures and Facilities	Leasehold Improvements	Total			
Ames Research Center	$ 2,928	$ 204,998	$ 7,922	$ -	$ 215,848	$ 132,782	$ 9,553	$ 358,183
ARC - Moffett Field, CA	2.928	204,998	7.922		215,848	128,727	9.553	354,128
Varioua Locations (a)						4,055		4,055
Flight Research Center		11,972	3,562		15,534	61,370	2,039	78.943
FRC - Edwards AFB, CA		11.972	3.562		15,534	57,424	2,039	74,997
Various Locations (a)						3.946		3.946
Goddard Space Flight Center	1,675	98.377	56.169	176	156,397	493,580	17.613	667,590
GSPC - Greenbelt, MD	1,322	82.977	16,464	85	100,848	205,624	12,678	319,150
Tracking Stations (Network)	353	15.399	39.660	91	55,503	258,364	4.935	318,802
Various Locations (a)	-	1	45		46	29,592	-	29,638
Jet Propulsion Laboratory	1,067	85.498	69,238	537	156.340	222,923	20,955	400,218
JPL - Pasadena, CA	1,067	75,418	10,558	537	87,580	134,984	20,955	243.519
Deep Space Network		10,080	58,680		68,760	87,939		156,699
Johnson Space Center	9,107	194,275	60,684	53	264.119	460,438	19.702	744.259
JSC - Houston, TX	5,537	158,645	34,820		199,002	379,113	14.081	592,196
White Sands Teat Facility								
WSTF - Las Cruces, NM		9,458	20,828		30,286	22,350		52,636
Various Locations (a)	3,570	26.172	5.036	53	34,831	58,975	5,621	99,427
Kennedy Space Center	71,345	299,588	310,473		681,406	666,715	113.833	1,461,954
KSC - Cape Canaveral, FL	71,345	299,588	310.473		681,406	655,924	113.833	1,451,163
Western Test Range Operations Div.								
WTROD - Lompoc, CA						4,124	-	4,124
Various Locations (a)						6,667	-	6,667
Langley Research Center	162	139,340	165,445		304,947	157.707	20,479	483,133
LARC - Hampton, VA	156	123,936	165,369		289,461	143.303	20,479	453,243
Various Locations (a)	6	15,404	76		15,486	14,404		29.890
Lewis Research Center	3,662	214,690	76.034	139	294.525	123.465	10.263	428.253
LERC - Cleveland, OH	316	129,948	56.388	139	186,791	95,126	10,263	292,180
Plumbrook Operations Division								
PBOD - Sandusky, OH	3,346	84,742	19,646		107,734	11,764		119,498
Various Locations (a)						16,575		16.575
Marshall Space Flight Center	7,587	196.79 7	97.134		301,518	404.452	14,007	719.977
MSFC - Huntsville, AL	-	121,830	57,024		178,854	266.320	14,007	459,181
Michoud Assembly Facility								
MAF - New Orleans, LA	7,522	66,097	27.518		101,137	31,790		132,927
Slidell Computer Complex								
SCC - Slidell, LA	65	4,757	1.068		5,890	12.604		18,494
Various Locations (a)		4,113	11.524		15,637	93,738		109,375
National Space Technology Labs.	18,074	64.374	193,287		275.735	32,702		308,437
NSTL - Bay St. Louis, MS	18,074	64,374	193.207		275,735	32,702		308,437
Wallops Flight Center	1,277	24,042	52,440		77,759	51,265	4,906	133,930
WFC - Wallops Island, VA	1,277	24,042	52,440		77,759	49,075	4,906	131,740
Various Locations (a)						2,190		2,190
NASA Headquarters						12,421		12.421
Washington, DC						3.194		3,194
Various Locations (a)						9.227		9,227
TOTAL	$ 116,884	$ 1,533,951	$ 1,092,388	$ 905	$ 2,744,128	$ 2,819,820	$ 233,350	$ 5,797,298

(a) Includes Property in Possession of Contractors at Various Locations.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

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SUMMARY

AMES RESEARCH CENTER

	Amount	Page No.
Office of Aeronautics and Space Technology:		
Modification of unitary plan wind tunnel,...	5,390,000	CF 1-1
Modification of 3.5-foot wind tunnel..	1,870,000	CF 1-10
Modification of 12-foot pressure wind tunnel.....	2,510,000	CF 1-16
Total.....	9.770.000	

AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF UNITARY PLAN WIND TUNNEL
LOCATION PLAN

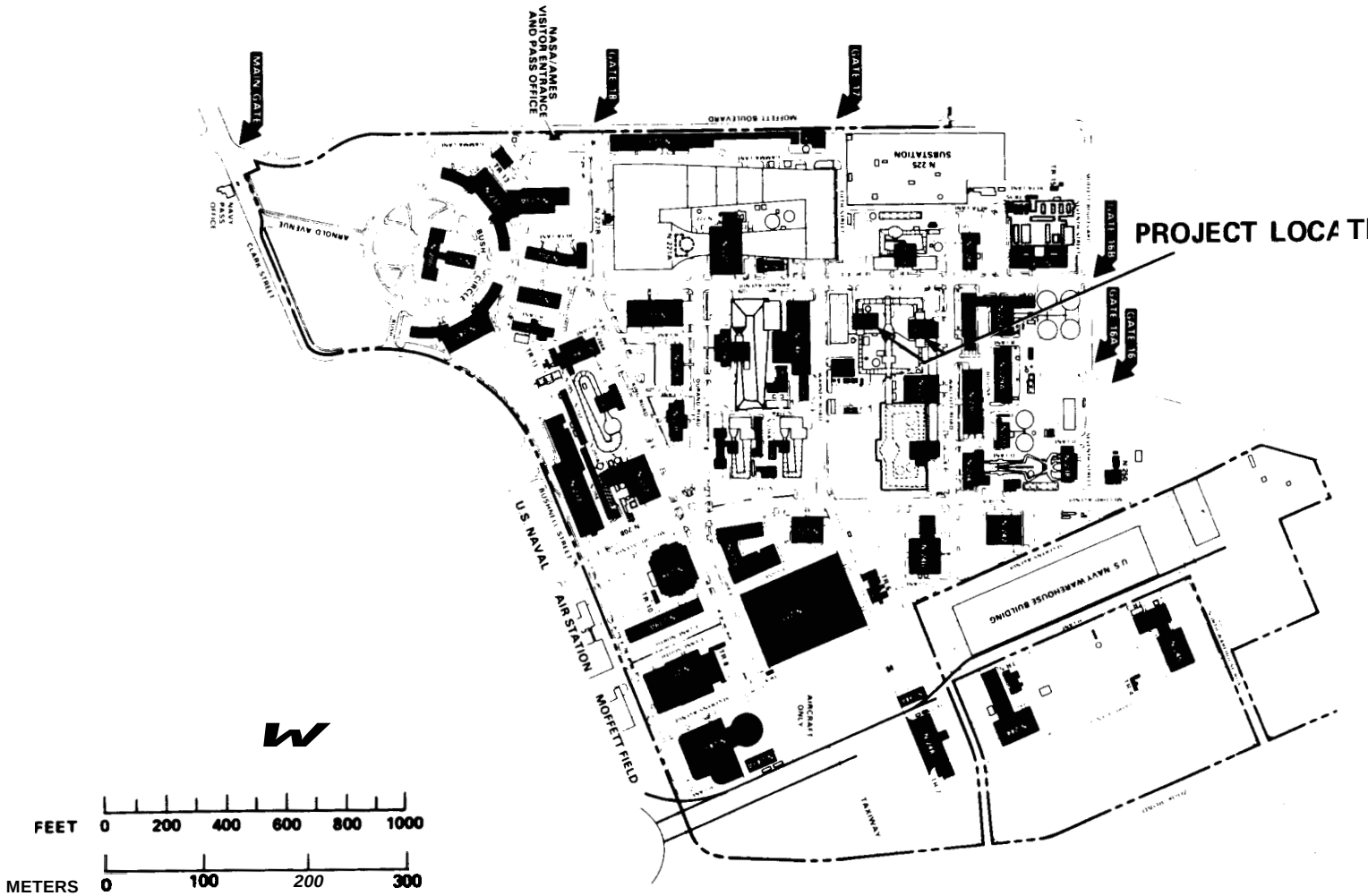


Figure 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE:	Modification of Unitary Plan Wind Tunnel
INSTALLATION:	Ames Research Center
FY 1979 CoF ESTIMATE:	$5,390,000

LOCATION OF PROJECT: Moffett Field, Santa Clara County, California

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project.

	Planning and Design	Construction	Total
Specific CoF funding	280,000	3,226,000	3,506,000
Other affiliated funding	---	35,374,600	35,374,600
Total.....	280.000	38.600.600	38.880.600

SUMMARY **PURPOSE** AND SCOPE:

The purpose of this project is to provide resources for the replacement of the two remaining data acquisition systems with the necessary area modifications in the Unitary Plan Wind Tunnel (UPWT) at Ames Research Center, Moffett Field, California. This will further increase the operational efficiency of the tunnel to better accommodate technical program requirements. It will also result in additional energy and manpower savings.

The location of the UPWT is shown in Figure 1. It consists of three separate and distinct test section legs: the 9x7-foot (2.7x2.1-meter) supersonic leg, the 8x7-foot (2.4x2.1-meter) supersonic leg, and the 11x11-foot (3.4x3.4-meter) transonic leg (Figure 2). All three "legs" are powered by a common set of drive motors. This project will involve the replacement and modification of data acquisition systems for the 9x7-foot leg

(Figure 3) and 8x7-foot leg (Figure 4). Modification of the 11x11-foot data acquisition system approved in the FY 1976 CoF authorization is well advanced and will be completed in the Fall of 1978. The data systems in the 9x7 and 8x7 legs of the UPWT will be similar to those provided in the earlier project.

Modification of the data acquisition systems will provide high speed data acquisition, improved data system accuracy, increased reliability, and a reduction in maintenance and energy consumption. Monitoring and display of tunnel conditions and aerodynamic parameters will be provided on a "real-time" user basis. Other advantages of the modification include the capability for controlling selected wind tunnel operations, a reduction in test setup time, and an opportunity for complete checkout of a model and its data sensors before the main drive and computer systems are tied into the test circuit.

PROJECT JUSTIFICATION:

The Unitary Plan Wind Tunnel has been in continuous operation since the facility was completed in 1955. This tunnel uses about 50 percent of the total energy used at Ames Research Center.

To meet growing technological requirements and to provide for a more efficient test operation, there is a pressing need to further improve the operational efficiency of the UPWT. The existing data acquisition systems have been in use since 1961; and are slow and technically restrictive when measured against the present and near term needs. It lacks the real-time data reduction and graphic display features essential to a more efficient operation. In short, the equipment is obsolete and spare parts are difficult to acquire since some are no longer manufactured. Reliability is rapidly deteriorating and maintenance is increasing, requiring more time to achieve test objectives.

The 9x7-foot leg, which has a Mach number range of 1.5 to 2.5, and the 8x7-foot leg, whose Mach capability is 2.5 to 3.5, have been used extensively in support of numerous major research and development programs involving assessments of high speed aerodynamics, inlet airframe interactions, engine inlet performance, and jet plume effects. Specific programs include the Space Shuttle, B-1, YF-12, F-111, F-14, F-15 Lightweight Fighter, F-16, Transonic Aircraft Technology, and the F-18. Future activity will include V/STOL fighter aircraft research and other high priority Department of Defense programs.

The 11x11-foot leg, whose Mach number range is *0.4* to 1.4, is the low speed circuit of the UPWT. It has been used extensively in support of a wide array of major aeronautical research and development programs for NASA, the Department of Defense, and the aerospace industry.

Initial efforts toward improving the UPWT's operational efficiency are in progress as covered above. Data acquisition systems proposed for this project are similar to the system now being installed for the 11x11-foot leg Transonic Wind Tunnel. They will provide the increased reliability, decreased maintenance, improved data system accuracy, increased data acquisition speed, test setup time and data reduction, and real-time monitoring required to achieve maximum operating efficiency.

At present the 9x7-foot and 8x7-foot legs of the UPWT, and the 6x6-foot Supersonic Wind Tunnel (SWT), a separate facility, operate on a combined average basis of two shifts per day, 5 days per week. With the improvements provided for by this project, it is estimated that future test requirements can be adequately met by 1.0 to 1.5 shifts per day, five days per week. The achievement of this condition will result in an estimated savings of about 20 million kwh per year. This coupled with manpower and other related savings will result in an estimated annual savings of $1.5 million. The estimate of the annual savings varies according to the number of shifts and tunnel run times. To be conservative, the savings estimate is based on the first full year of operation after the modification, recognizing the almost certainty that it will increase in each succeeding year. The ultimate closure of the 6x6-foot SWT will result in the continuation of the present joint research testing in the 8x7-foot and 9x7-foot legs of the UPWT.

PROJECT DESCRIPTION:

The proposed project will replace data acquisition systems in the 9x7-foot leg (Figure 3) and the 8x7-foot leg (Figure 4) with a computer-controlled data acquisition and processing system similar to the system presently being installed in the 11x11-foot Transonic Wind Tunnel.

Enlargement and rehabilitation of wind tunnel control rooms will be required to accommodate the new data system. The enlargement consists of construction of computer room areas next to the existing control rooms. The computer rooms will be air conditioned and equipped with electrical power for the computer. Rehabilitation of the control rooms will include installation of additional air conditioning and electrical power for the new equipment.

The proposed data systems will consist of a data gathering processor for each supersonic leg of the UPWT, a real-time executive processor, and auxiliary subsystems as indicated in Figure 5. The data gathering processor converts tunnel analog data into continuous digital samples, and records this data on magnetic tape. The real-time processor will provide control, continuous processing, and display of selected parameters such as lift and drag coefficients. The ability of the data system to provide "on-line" data reduction enables the test engineer to select only that data which is to be recorded for subsequent processing. The selected data are recorded on magnetic discs for "real-time" processing and for data editing.

Pretest checkout and calibrations during model assembly at remote sites prior to tunnel entry will be accomplished in the initial mode of operation. In this mode, tne number and types of data channels can be assigned by the operator. Prerun system checkout will be provided by a checkout mode of operation.

[redacted]

This cost estimate for this project is based on actual cost for similar equipment and a Preliminary Engineering Report for the construction.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition..	---	---	---	---
Construction.....	---	---	---	490,000
9x7-foot wind tunnel, modification for control room.	LS	---	---	260,000
8x7-foot wind tunnel, modification for control room.	LS	---	---	230,000
Equipment	---	---	---	4,900,000
9x7-foot wind tunnel.....	---	---	---	2,980,000
Data gathering system....	LS	---	---	(1,875,000)
Data processing system.....	LS	---	---	(790,000)
Systems integration	LS	---	---	(315,000)
8x7-foot wind tunnel.....	---	---	---	1,920,000
Water gathering system.....	LS	---	---	(1,250,000)
Data processing system.....	LS	---	---	(355,000)
Systems integration.	LS	---	---	(315,000)
Fallout Shelter (not feasible)	---	---	---	---
Total...				5.390.000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Unitary Plan Wind Tunnel Complex
Figure 3 - 9x7-Foot Wind Tunnel
Figure 4 - 8x7-Foot Wind Tunnel
Figure 5 - Typical Block Diagram of Real-Time Data Acquisition System

AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF UNITARY PLAN WIND TUNNEL

AMES UNITARY PLAN WIND TUNNEL COMPLEX

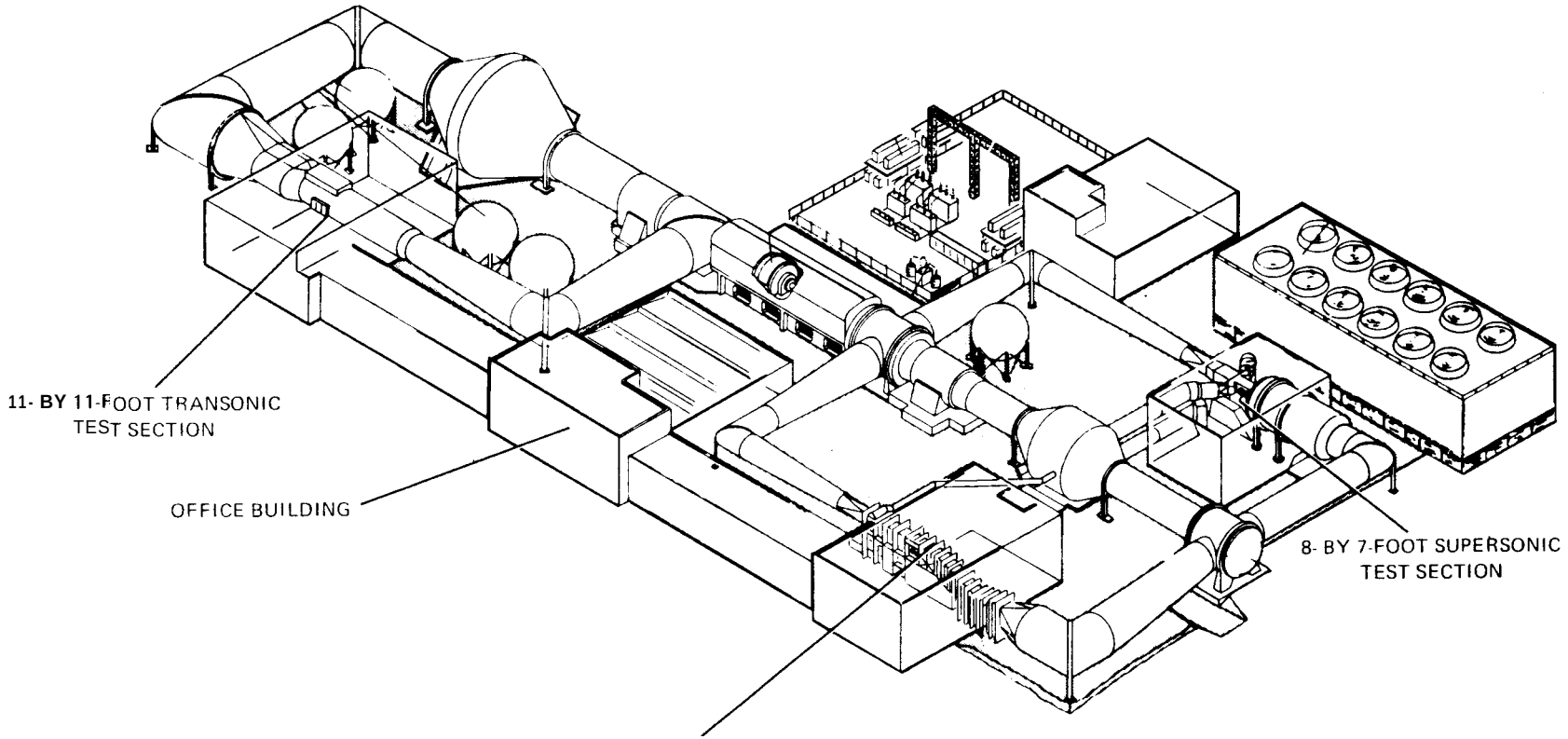
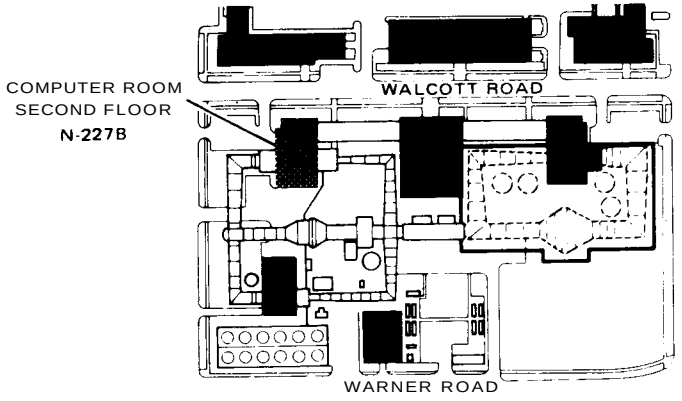


Figure 2

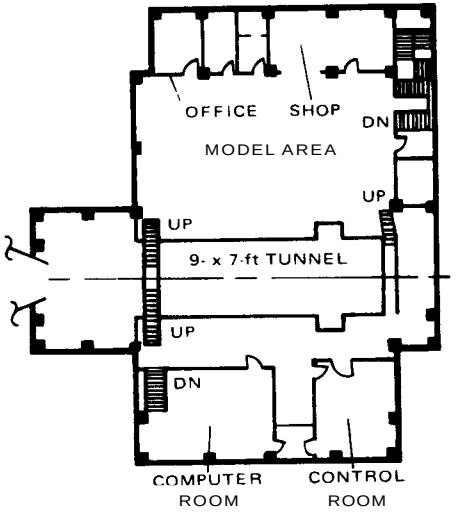
AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

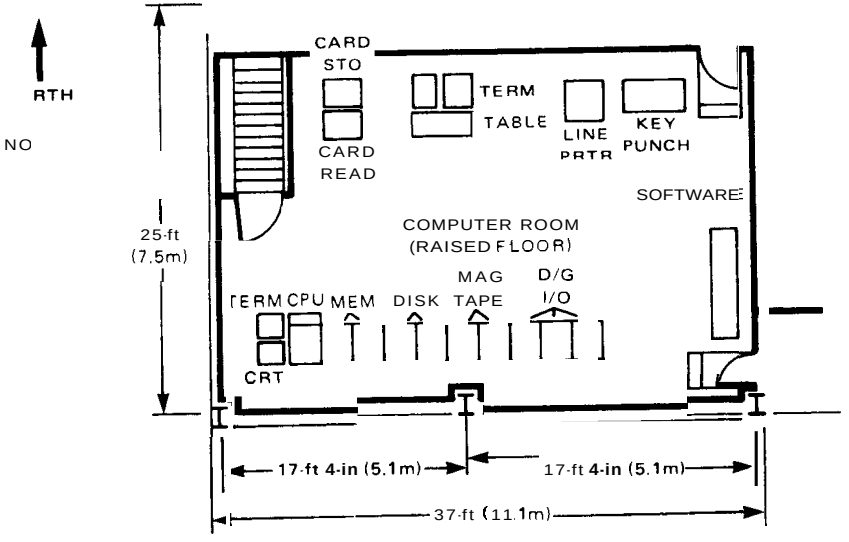
MODIFICATION OF UNITARY PLAN WIND TUNNEL
MODIFICATION OF THE 9- X 7-ft WIND TUNNEL
DATA ACQUISITION SYSTEM



SITE PLAN



SECOND FLOOR PLAN



PLAN – COMPUTER ROOM

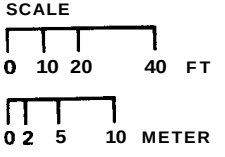
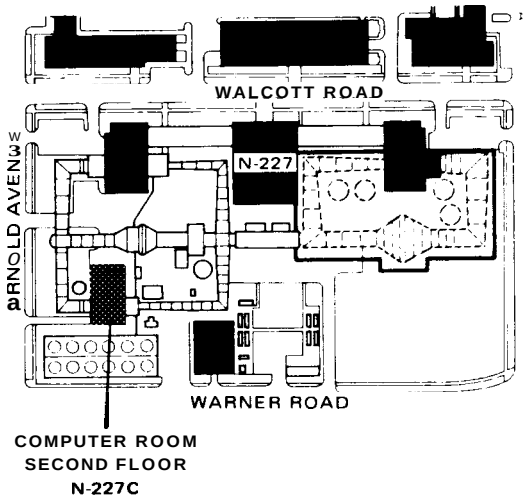


Figure 3

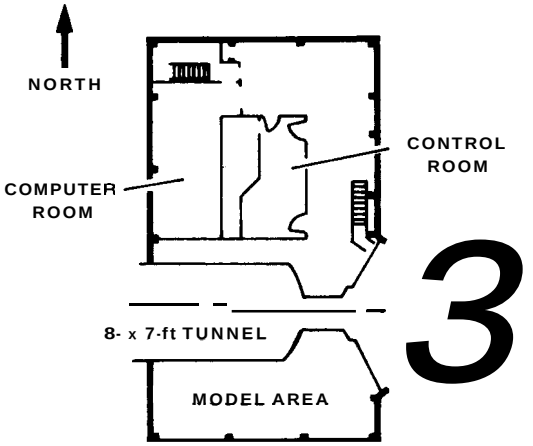
AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

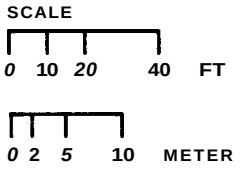
MODIFICATION OF UNITARY PLAN WIND TUNNEL
MODIFICATION OF THE 8- X 7-ft WIND TUNNEL
DATA ACQUISITION SYSTEM

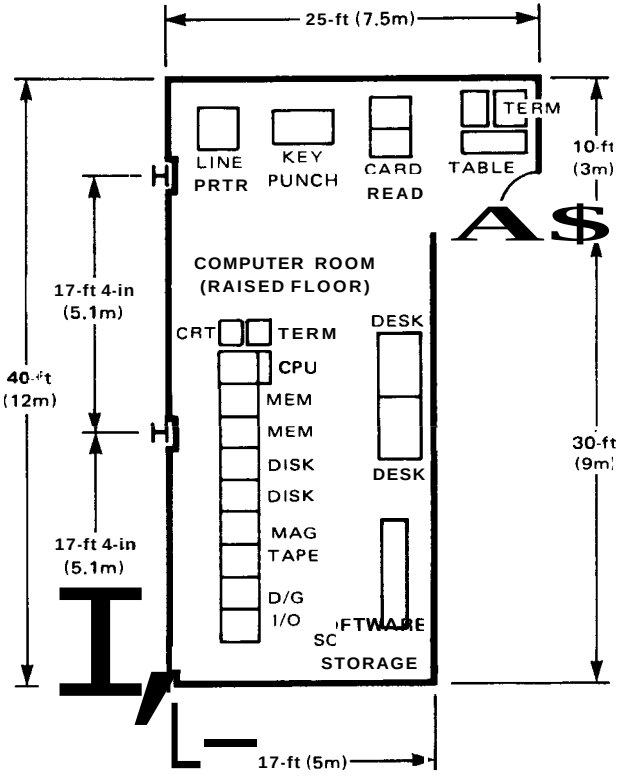


SITE PLAN



SECOND FLOOR PLAN





PLAN–COMPUTER ROOM

Figure 4

CF 1-8

LANGLEY JET PROPULSION LABORATORY GODDARD SPACE FLIGHT CENTER

AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF UNITARY PLAN WIND TUNNEL

TYPICAL BLOCK DIAGRAM OF REAL TIME DATA ACQUISITION SYSTEM

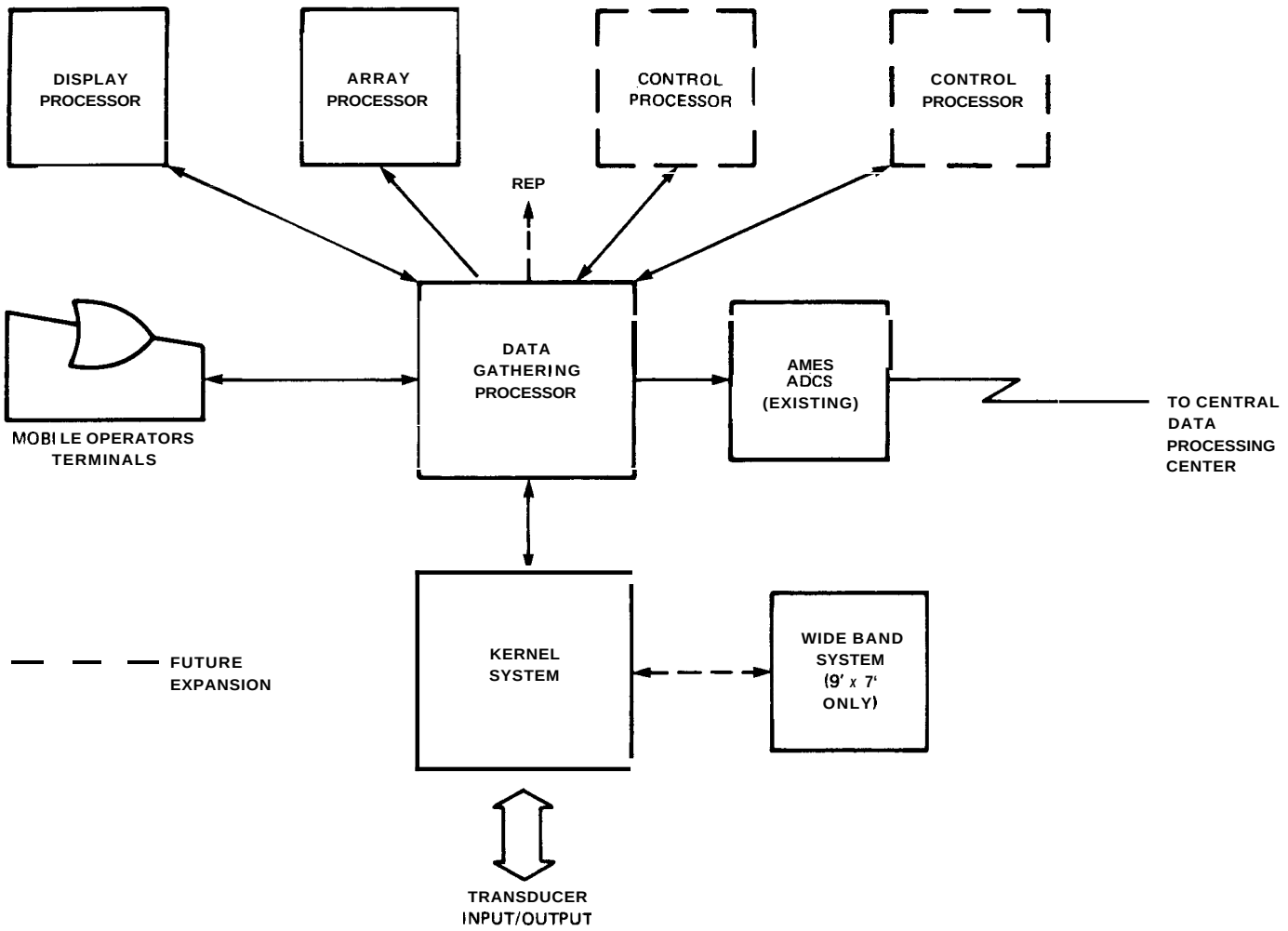


Figure 5

CF 1-9

LANGLEY JET PROPULSION LABORATORY GODDARD SPACE FLIGHT CENTER

AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF THE 3.5-FT WIND TUNNEL
LOCATION PLAN

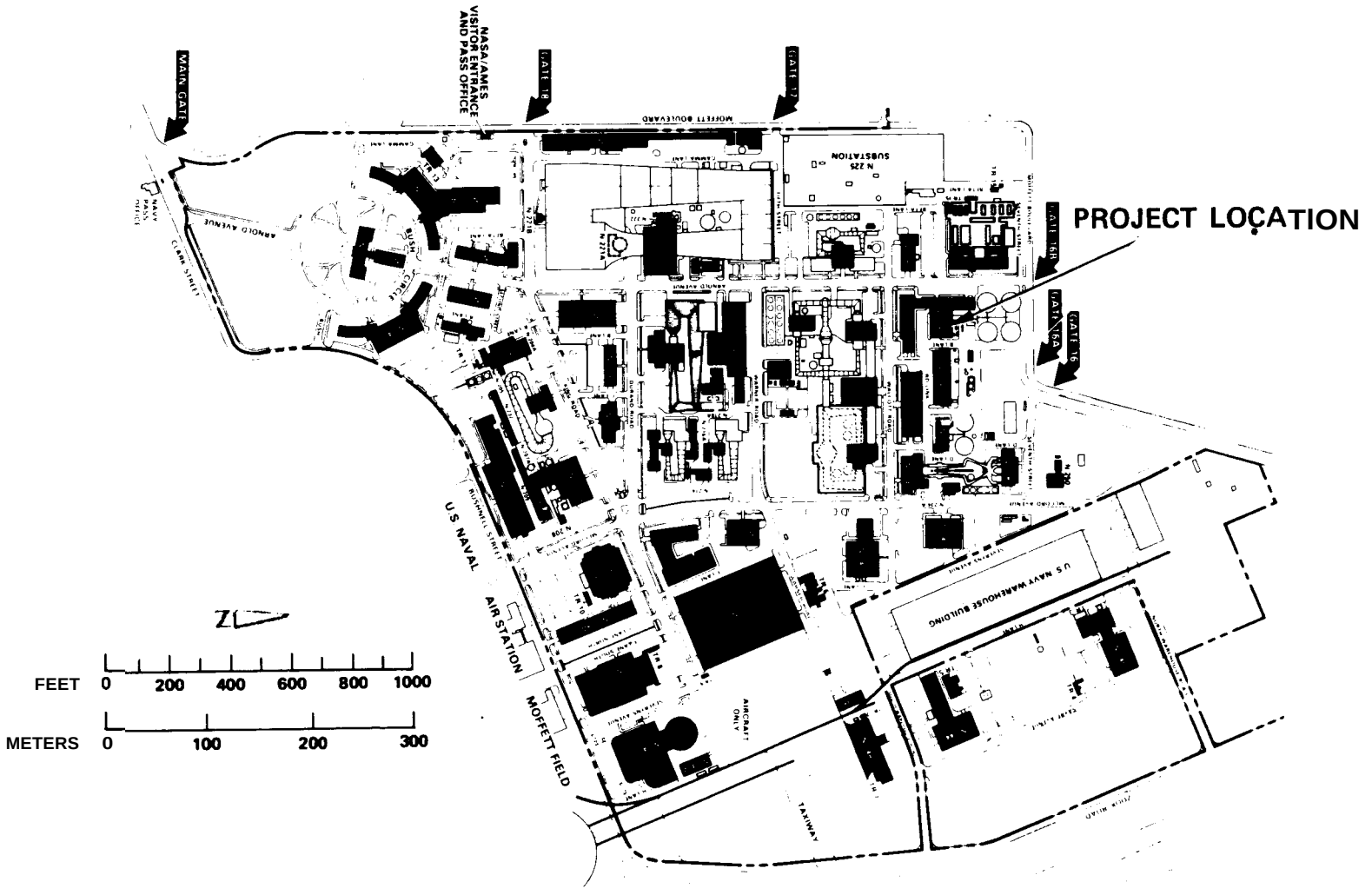


Figure 1

CF 1-10

GODDARD SPACE FLIGHT

PROJECT TITLE: Modification of 3.5-Foot Wind Tunnel

INSTALLATION: Ames Research Center

FY 1979 CoF ESTIMATE: $1,870,000

LOCATION OF PROJECT: Moffett Field, Santa Clara County, California

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project.

	Planning and Design	Construction	Total
Specific CoF funding	50,000	68,000	118,000
Other affiliated funding	---	16,696,588	16,696,588
Total	50,000	16,764,588	16,814,588

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to increase the operational efficiency of the 3.5-foot (1.1 meter) Hypersonic Wind Tunnel (Figure 1) at Ames Research Center (ARC) by significantly improving its data acquisition capability. The project involves modifications that will increase productivity, provide for reductions in energy consumption, reduce manpower and operating costs, and furnish more effective responsiveness to the requirements of the technical programs served by this facility. The proposed data system will be similar to that approved for the 11x11-foot (3.4x3.4 meter) Transonic Wind Tunnel leg in the FY 1976 CoF Program.

Modification of this data system will include replacing the existing equipment with a computer-controlled data processing system. Improvements will provide increased data acquisition speed, improved data system

[illegible], increased reliability, decreased maintenance, and reduced energy consumption and test setup time. **Monitoring and display of tunnel** conditions and aerodynamic parameters will be provided on a real-time basis **as will the capability** for controlling selected wind tunnel operations.

PROJECT JUSTIFICATION:

The 3.5-foot Hypersonic Wind Tunnel is used to conduct testing and research requested by the Department of Defense (relating *to* advanced aircraft and weapons systems), the aircraft industry (relating to commercial transports), in-house research organizations (relating to advanced NASA programs), and other NASA Centers and government organizations (relating to a broad range of advanced aircraft and aerospace projects). The facility has been a mainstay in the Space Shuttle program for the past several years for investigating aerothermodynamic characteristics of the Orbiter. In response to such requests, the 3.5-foot (1.1 meter) tunnel is currently operated in two shifts per day, five days per week.

The static data acquisition system and strain gauge signal conditioning equipment have been in operation since 1961. They are obsolete. Certain replacement parts are no longer manufactured. Reliability is deteriorating while maintenance requirements are increasing, meaning that more time is required to achieve test objectives. This creates scheduling problems. The existing dynamic data acquisition system does not provide on-line data reduction nor improved safety and efficiency in certain wind tunnel investigations. The proposed data system modification for both static and dynamic data acquisition will provide not only increased reliability and decreased maintenance, but also improved data system accuracy, increased data acquisition speed, reduced test setup time, and improved data reduction and real-time monitoring.

An ARC analysis of the existing capability of the 3.5-foot Hypersonic Wind Tunnel indicates that for aeronautical and space research programs to be conducted between 1980 and 1985, workloads of one to two shifts per day will continue. Currently, Ames is operating this tunnel two shifts per day. It is anticipated that this load will decrease by 1981, and that, with the improved data system, ARC will be able to perform the equivalent of 1-1/3 shifts of testing on a one-shift operation. This represents potential manpower and energy savings over present operations of about $225,000 per year in the 1980's.

PROJECT DESCRIPTION:

The proposed modification consists of replacing the existing 3.5-foot wind tunnel data acquisition system with new computer-controlled data acquisition/processing equipment. (Similar systems are being proposed for the 9x7-foot (2.7x2.1 meter), 8x7-foot (2.4x2.1 meter), and 12-foot (3.7 meter) wind tunnel legs.) When fully implemented, these systems will comprise a standardized family of distributed systems, each performing a particular task and interconnected to operate as a family of systems. Such a system is more flexible and requires less manpower to support than other multiple computer arrangements. The advantages of the distributed system include capabilities for multiprocessing and independent operation; the system can be readily expanded to accommodate increased requirements.

Rehabilitation of 1,000 square feet (93 square meters) of the wind tunnel control room (Figure 2) will be performed to accommodate the new data system and computer equipment. This work will include the installation of a raised computer floor system, additional air conditioning and electrical power, and accoustical treatment of wall surfaces.

The proposed data system will utilize state-of-the-art hardware and will consist of the following subsystems: an analog/digital converter, a data-gathering processor, a display processor, an array processor, and an operator/communication terminal. The new data system will provide high speed acquisition of both static and dynamic data. The analog/digital converter subsystem will convert the tunnel analog data into continuous digital samples under the control of the data-gathering processor. These data are then recorded on magnetic tape. The data-gathering processor will provide on-line data reduction, enabling the test engineer to rapidly review the data and select test conditions for which data are to be recorded for subsequent processing. The selected data are recorded in standard format on digital magnetic tape as well as on shared discs. The shared discs are used for real-time processing and for data editing. The data acquisition system will continuously monitor the condition of all input channels and will identify any channels which are inoperative or out-of-limits.

Pretest checkout and calibrations during model assembly at remote sites prior to tunnel entry will be accomplished by an initial mode of operation. In this mode, the operator will assign the number and types of data channels, which may be modified during tunnel operation to accommodate equipment failures. Prerun system checkout will also be provided by this equipment. During this operation, the analog input channels will be atuomatically stepped by the computer through known input voltages to verify status and amplifier gain and offset.

PROJECT COST ESTIMATE:

This cost estimate for this project is based on actual cost for similar equipment and a Preliminary Engineering Report for the construction.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition..	---	---	---	---
Construction	---	---	---	180,000
Building rehabilitation.....	---	---	---	180,000
Architectural.....	SF	1,000	*26.00*	*(26,000)*
Mechanical	SF	1,000	*96.00*	*(96,000)*
Electrical.....	SF	1,000	58.00	*(58,000*

	Unit of Measure	Quantity	Unit cost	Total cost
Equipment.....	---	---	---	1,690,000
Data gathering System.....	LS	---	---	1,080,000
Data processing system....	LS	---	---	295,000
Systems integration..	LS	---	---	315,000
Fallout Shelter (not feasible)	---	---	---	---
Total				1,870,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Single Line Drawing

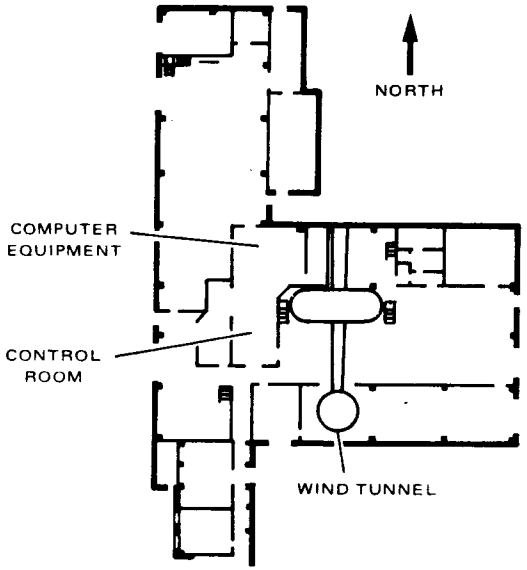
OTHER EQUIPMENT SUMMARY:

No additional known collateral or noncollateral equipment is required to make this facility operational.

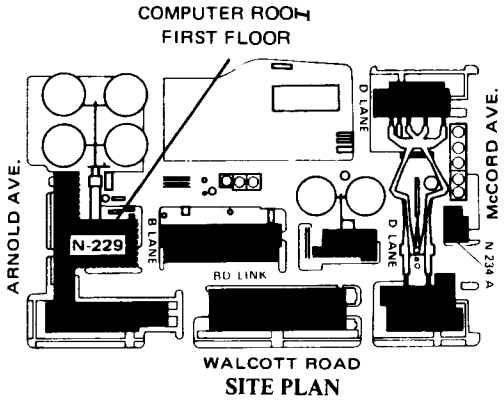
FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

As presently planned, there are no anticipated future funding requirements necessary to complete this project.

MODIFICATION OF THE 3.5-ft WIND TUNNEL



3.5-ft WIND TUNNEL
FLOOR PLAN



SITE PLAN

SCALE

0 20 40 FT

0 5 10 METER

Figure 2

MODIFICATION OF 12-FT PRESSURE WIND TUNNEL
LOCATION PLAN

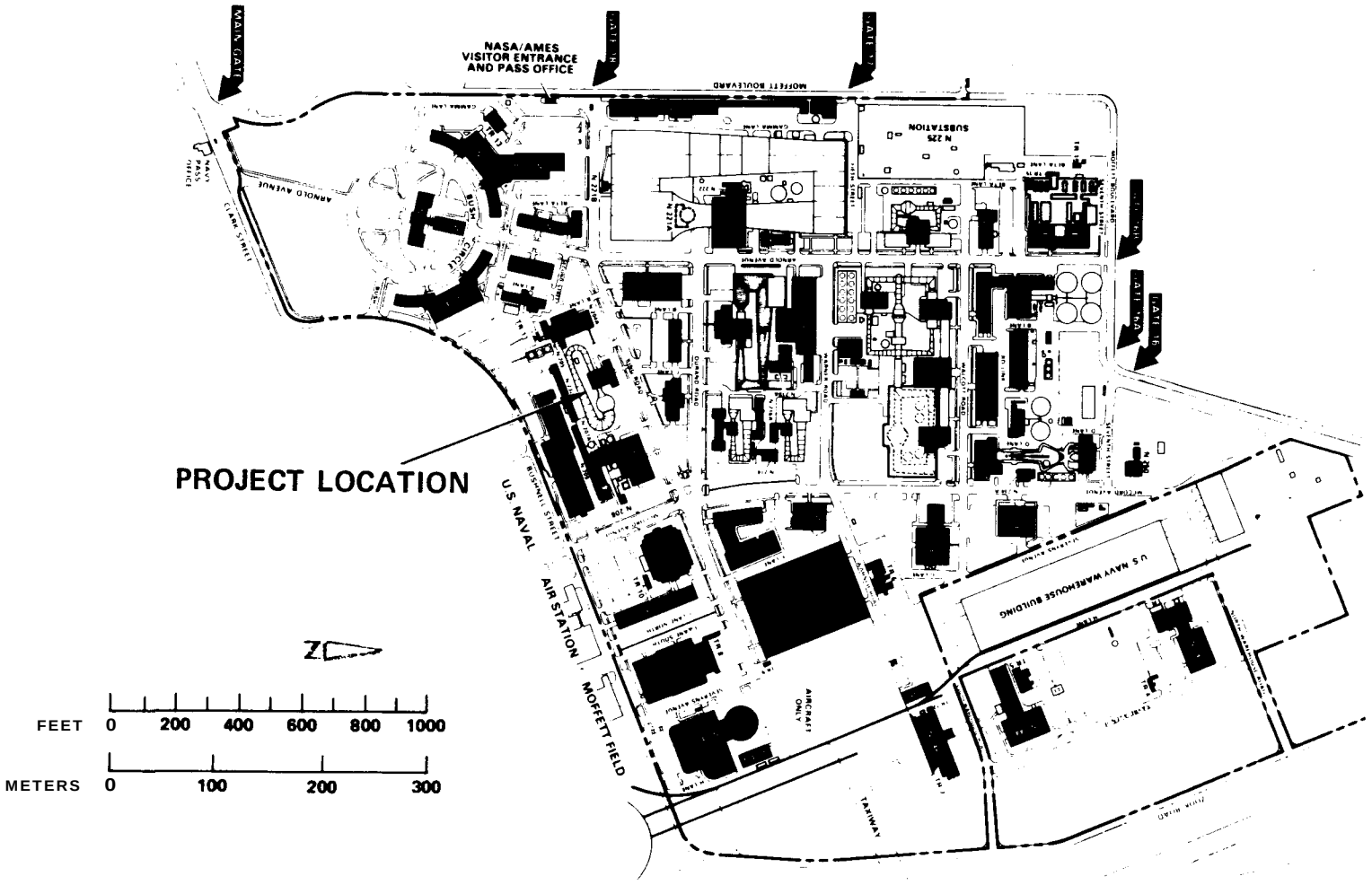


Figure 1

PROJECT TITLE: Modification of 12-Foot Pressure Wind Tunnel

INSTALLATION: Ames Research Center

FY 1979 CoF ESTIMATE: $2,510,000

LOCATION OF PROJECT: Moffett Field, Santa Clara County, California

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project.

	Planning and Design	Construction	Total
Specific CoF funding	136,000	415,000	551,000
Other affiliated funding	---	4,381,930	4,381,930
Total	136,000	4,796,930	4,932,930

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to modify the data acquisition system of the 12-foot (3.7 meter) Pressure Wind Tunnel to increase the tunnel's operating efficiency. This modification will provide increased data acquisition speed; improved data system accuracy; and decreased maintenance, energy consumption, and test setup time. The capability to monitor and display tunnel conditions and aerodynamic parameters on a real time basis and the capability to control certain key wind tunnel operations will also be provided. The location of the 12-foot (3.7 meter) Pressure Wind Tunnel is shown in Figure 1. The proposed data system is similar to that approved for the llxll-foot (3.4x3.4 meter) Transonic Wind Tunnel in a FY 1976 CoF project.

PROJECT JUSTIFICATION:

The 12-foot Pressure Wind Tunnel is a uniquely valuable test facility at ARC. Its moderately high Reynolds number capability at low subsonic speeds, combined with very low stream turbulence, cause this facility to be very much in demand for testing landing-takeoff configurations and for stall/spin research. Aircraft programs supported by this facility in the recent past include the A-9, A-10, B-1, C-141, C-5, F-14, F-16, F-18, DC-8 DC-9, DC-10, L-1011, B-747, B-737, and Space Shuttle. Further, the remarkably low turbulence flow characteristic makes it extremely valuable for boundary layer flow studies on large bodies. One such application was to the Aircraft Energy Efficiency program. Future activities include expanded requirements for ARC's key mission in short-haul and Vertical/Short Takeoff and Landing (V/STOL) aircraft research, including research specifically oriented to understanding stall/spin phenomena critical to future aircraft design. To satisfy these test needs, this facility normally operates 16 hours per day, 5 days per week. With growing emphasis on aeronautical research and development, the demand for experimental investigations in this facility will increase in future years.

The data acquisition system and strain gage signal conditioning equipment now installed in this tunnel have been in operation since 1961. This equipment is obsolete and certain replacement parts are no longer manufactured. Reliability is deteriorating and maintenance requirements are increasing. More time is required to achieve test objectives thus generating a situation that produces critical scheduling problems. The present data acquisition system does not provide on-line data reduction, a feature essential to more efficient conduct of certain wind tunnel investigations. The proposed data system modification will provide not only the necessary increase in reliability and decreased maintenance, but also improved data system accuracy; increased data acquisition speed; reduced test setup time; on-line data reduction; and real-time monitoring, all of which will effectively increase facility operational efficiency.

Operational efficiency is the key to satisfying the mounting demands on this wind tunnel. As the volume of work increases, the facility's capacity to handle it has decreased. The reason for this is that present data acquisition equipment is too slow to perform the vast data processing required of this tunnel. Coping with such work loads at all requires a great deal of time and results in costly manpower and energy use which are especially difficult to justify when this work can be performed far faster with modern equipment.

A recent analysis of this wind tunnel's aeronautical and space research programs to be assigned to this facility between 1980 and 1985 indicates that two to three shifts per day will be required. Currently, ARC is operating this tunnel at more than two shifts per day, and it is anticipated that this rate of use will continue through 1981. The proposed data system would give ARC the capability to perform work equal to three shifts of testing in just two shifts. Translated to energy savings alone, this means that the proposed data system would save 1.8 million KWH of energy over the present system, coupled with the new system's effect on overall scheduling and its capacity to cope with ARC's anticipated workload. Savings could amount to about $500,000 a year, resulting in a 5-year payback for the new system. This is an important factor even setting aside the basic programmatic needs.

PROJECT DESCRIPTION:

The proposed data processing system is a scaled down version of the system being installed in the llxll-foot (3.4x3.4 meter) Transonic Wind Tunnel under an approved FY 1976 CoF project. Similar systems are being proposed for the 9x7-foot (2.7x2.1 meter), 8x7-foot (2.4x2.1 meter), and 3.5-foot (1.1 meter) wind tunnels. When fully implemented, these systems will comprise a standardized "family" of data systems, each tailored to the individual requirements of a specific wind tunnel.

Rheabilitation of 1,200 square feet (111 square meters) of the existing wind tunnel control room (Figure 2) will be required to accommodate the new data system. It will also include installation of additional air conditioning and electrical power for the new control room equipment. Power conditioning equipment required for the proposed data system is included as part of this project.

The proposed data systems will use state-of-the-art proven hardware. It will consist of a data-gathering processor, a real-time executive processor, and auxiliary subsystems. The new data system will provide high speed data acquisition of both static and dynamic data. The tunnel analog data will be converted into continuous digital samples under the control of the data processor. This data will be recorded on magnetic tape. The real-time processor will provide control, continuous processing, and display of selected parameters such as lift and drag coefficients. The ability of the data system to provide on-line data reduction will enable the test engineer to select test conditions for which data are to be recorded for subsequent processing. The system will also verify that all input channels are functioning properly.

Present checkout and calibrations during model assembly at remote sites prior to tunnel entry will be accomplished by an initial mode of operation. In this mode, the operator can assign the number and types of data channels. The operator will be able to alter the assignment during tunnel operation to accommodate equipment failures. The equipment will also provide prerun system checkout. During this operation, the analog input channels are automatically stepped through known input voltages by the computer to verify status, amplifier gain, and amplifier offset.

PROJECT COST ESTIMATE:

This cost estimate for this project is based on actual cost for similar equipment and a Prelimnnary Engineering Report for the construction.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition	---	---	---	---
Construction	---	---	---	250,000
Building rehabilitation	---	---	---	250,000
Architectural	SF	1,200	28.30	(34,000)
Mechanical	SF	1,200	104.10	(125,000)
Electrical	SF	1,200	75.80	(91,000)
Equipment	---	---	---	2,260,000
Data-gathering processor	LS	---	---	1,628,000
Real-time executive processor	LS	---	---	632,000
Fallout Shelter (not feasible)	---	---	---	---
Total				2,510,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Single Line Drawing - Plan View

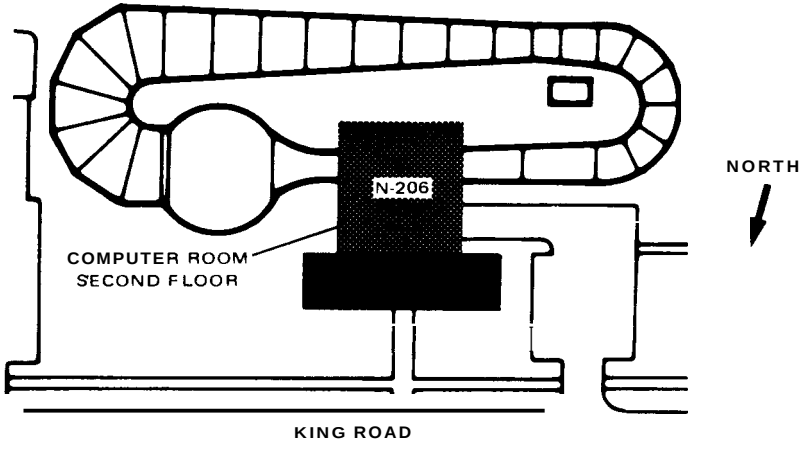
OTHER EQUIPMENT SUMMARY:

No additional known collateral or noncollateral equipment is required to make this facility operational.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

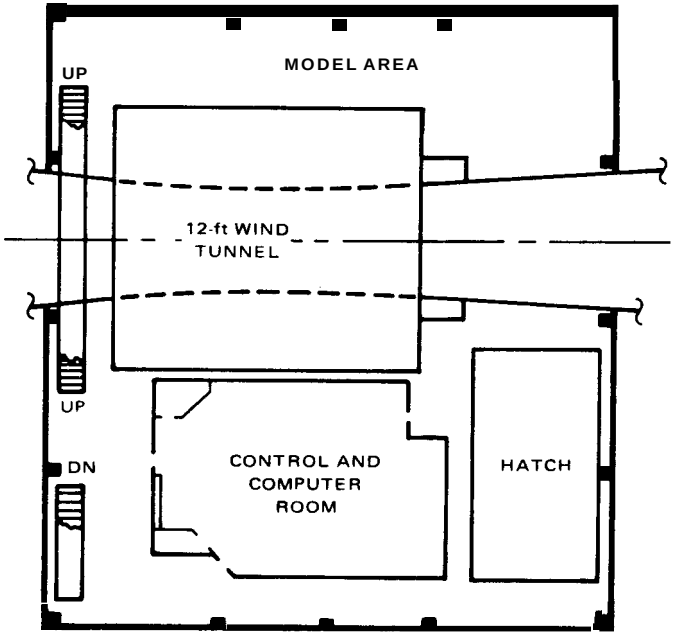
There are no foreseen future funding requirements necessary to complete this project; however, approximately $8 million may be required in some future year to increase this tunnel's performance capability.

MODIFICATION OF 12-FT PRESSURE WIND TUNNEL
PLAN VIEW



SITE PLAN

NORTH



SECOND FLOOR PLAN

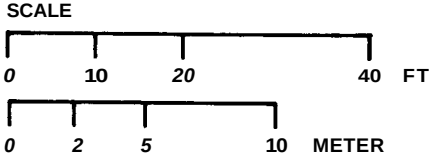


Figure 2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

SUMMARY

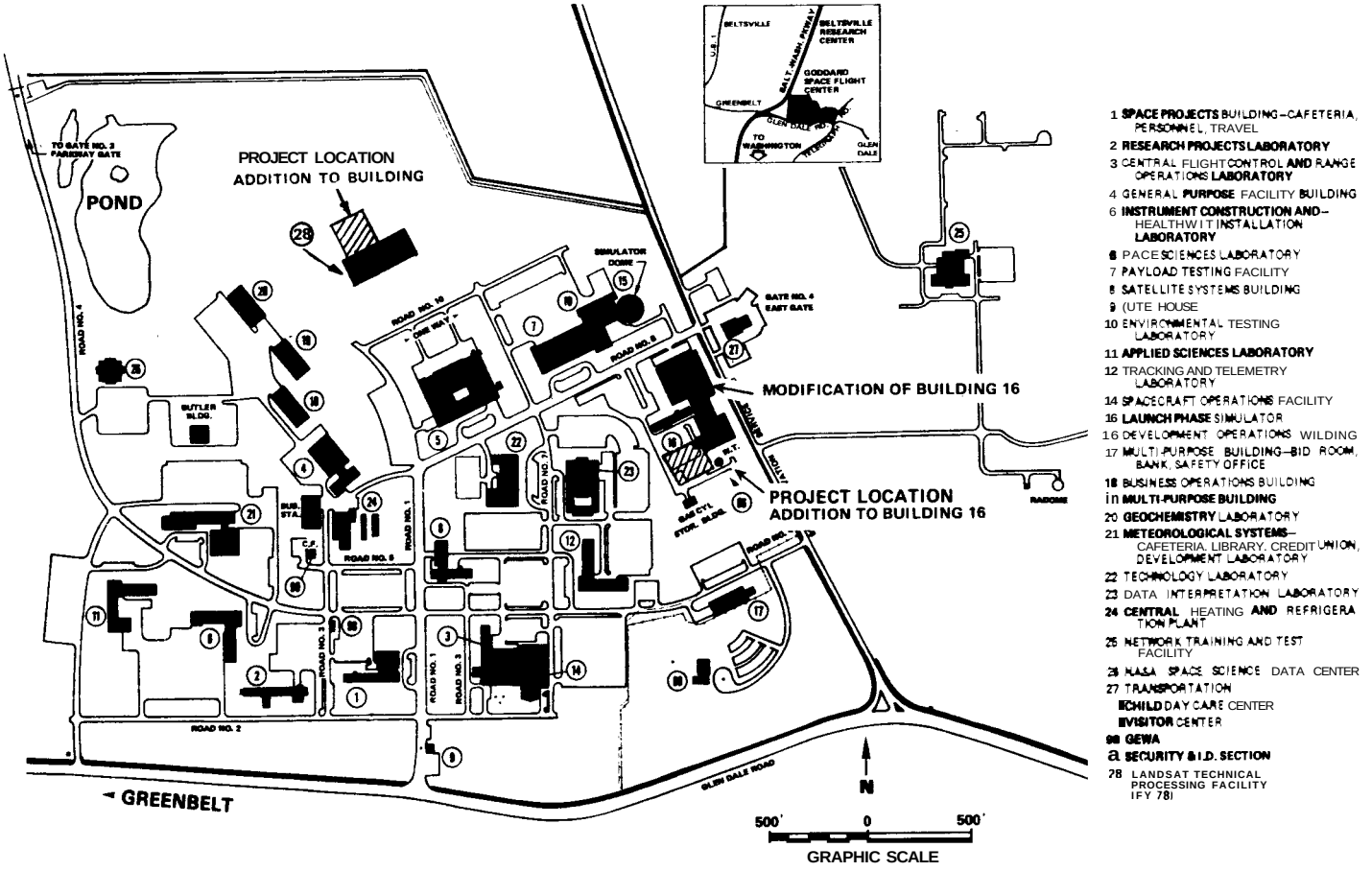
GODDARD SPACE FLIGHT CENTER

	Amount	Page No.
Office of Management Operations:		
Modifications and additions for logistic and supply functions.....	5,640,000	CF 2-1

GODDARD SPACE FLIGHT CENTER
FISCAL YEAR 1979 ESTIMATES

MODIFICATIONS AND ADDITIONS FOR LOGISTIC AND SUPPLY FUNCTIONS

LOCATION PLAN



1 **SPACE PROJECTS** BUILDING–CAFETERIA, PERSONNEL, TRAVEL
2 **RESEARCH PROJECTS LABORATORY**
3 CENTRAL FLIGHT CONTROL **AND** RANGE OPERATIONS **LABORATORY**
4 GENERAL **PURPOSE** FACILITY BUILDING
6 **INSTRUMENT CONSTRUCTION AND**– HEALTH WITT INSTALLATION **LABORATORY**
8 PACE SCIENCES LABORATORY
7 PAYLOAD TESTING FACILITY
8 SATELLITE SYSTEMS BUILDING
9 (UTE HOUSE
10 ENVIRONMENTAL TESTING LABORATORY
11 **APPLIED SCIENCES LABORATORY**
12 TRACKING AND TELEMETRY LABORATORY
14 SPACECRAFT OPERATIONS FACILITY
16 **LAUNCH PHASE** SIMULATOR
16 DEVELOPMENT OPERATIONS WILDING
17 MULTI-PURPOSE BUILDING–BID ROOM, BANK, SAFETY OFFICE
18 BUSINESS OPERATIONS BUILDING
in **MULTI-PURPOSE BUILDING**
20 **GEOCHEMISTRY** LABORATORY
21 **METEOROLOGICAL SYSTEMS**– CAFETERIA, LIBRARY, CREDIT UNION, DEVELOPMENT LABORATORY
22 TECHNOLOGY LABORATORY
23 DATA INTERPRETATION LABORATORY
24 **CENTRAL** HEATING **AND** REFRIGERATION PLANT
25 NETWORK TRAINING AND TEST FACILITY
26 NASA SPACE SCIENCE DATA CENTER
27 TRANSPORTATION
CHILD DAY CARE CENTER
VISITOR CENTER
98 GEWA
a **SECURITY & I.D. SECTION**
28 LANDSAT TECHNICAL PROCESSING FACILITY IFY 78)

FIGURE 1

PROJECT TITLE: Modifications and Additions for Logistic and Supply Functions

INSTALLATION: Goddard Space Flight Center

FY 1979 CoF ESTIMATE: $5,640,000

LOCATION OF PROJECT: Greenbelt, Prince Georges County, Maryland

COGNIZANT HEADQUARTERS OFFICE: Office of Management Operations

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project.

	Planning and Design	Construction	Total
Specific CoF funding	480,000	475,000	955,000
Other affiliated funding	---	2,797,000	2,797,000
Total	480,000	3,272,000	3,752,000

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to provide onsite space into which the Goddard Space Flight Center (GSFC) supply and logistics functions may be consolidated and thus effect a more efficient and economical total operation. At present, these functions are performed in one onsite (45,000 net square feet, 4,180 square meters) location and in three offsite leased locations having a total of about 180,000 new square feet (16,722) square meters). The onsite function is in the Development Operations Building, Building 16, which was originally intended for warehouse type functions but which, over the years, has been partially converted to other than more, pressing uses. However, a recent detailed review of existing facility utilization, in conjunction with projected future needs indicated that the best use of Building 16 would be for supply and logistic activities as initially conceived. To achieve the needed consolidation then, it is necessary to: (1) provide an 88,000

gross square feet (8,175 square meters) addition to Building 16, (2) modify to varying degrees 92,00 net square feet (8.547 square meters) of Building 16 to include the recapture of 47,000 net square feet (4,366 square meters) of space now occupied by other activities as indicated above, and (3) build a new facility of 57,000 gross square feet (5,295 square meters) to accommodate activities of the Space Applications program being displaced from Building 16. In the end position, supply and logistic functions, as consolidated, will occupy approximately 180,000 square feet (16,722 square meters) as compared to the 225,000 net square feet (20,902 square meters) now occupied. The elimination of the physically separated but related functions will permit better utilization of manpower and space with improved operating efficiency and significant cost savings. This total project is cost effective with a first year savings of approximately $1,060,000, based on the reduced manpower required for the consolidated operation and the avoidance of the present offsite lease costs.

PROJECT JUSTIFICATION:

GSFC is responsible for the development and management of unmanned earth orbit satellites, sounding rocket programs, the Delta program, and for the management and operation of NASA's Tracking and Communications network for manned and unmanned satellites. Included in this responsibility is the tracking and data acquisition of all of GSFC's satellites as well as the responsibility of being the communications center for all of NASA. To perform these functions effectively, a central warehouse is needed to store, inventory, and maintain supplies and equipment for GSFC's onsite activities and those of the tracking network.

Currently, GSFC basically must operate two separate supply systems, one that supports the tracking station network and another for the GSFC onsite requirements. The two systems draw from warehousing facilities in four locations. One is in Building 16; two others are in leased facilities at Glendale I and Glendale III, each a mile (1.6 kilometers) from GSFC. The fourth is at Hollins Ferry, Maryland, 25 miles (40 kilometers) from GSFC. The construction of the proposed facility will permit consolidation of these functions and thus provide a personnel savings of over 20 man-years annually representing approximately $480,000 during the first year of operation (FY 1981). In addition, the elimination of 49,555 square feet (4,605 square meters) of leased space in Glendale I, 50,925 square feet (4,731 square meters) in Glendale III, and 81,267 square feet (7,550 square meters) in Hollins Ferry, will provide an estimated annual savings of $580,000 in the first year of operations. Savings resulting from the elimination of transportation now required between the various leased facilities and duplicated administrative support will be offset by the maintenance and utility costs for the new facility. Based upon the above savings and escalation factors, a discounted payback of about four years is realized making this a most pressing and attractive investment. A review of the combined inventory requirements indicates that the proposed space will meet the currently projected warehousing requirements at GSFC through the 1980s.

This proposed housing plan is the result of an extensive analysis of the GSFC housing situation. It has been determined that the relocation of the Applications Directorate functions from Building 16 into a new facility is the most cost effective method for satisfying the Center's logistic and supply functions when taken in the

context of all other projected facility needs. The Technical Processing Facility, Building 28, a FY 1978 Construction of Facilities project, has been selected for expansion to house the relocation Applications activities because of the similarity of work performed as well as organizational relations between the Applications Directorate and the Landsat program that is to be housed in Building 28.

This housing plan is based on the completion of the addition to Building 28 and the relocation of the Application Directorate in early 1981. The completion of the addition to Building 16 and the modification of the existing space will permit an orderly relocation of the warehousing functions and the release of the off-site leased space during 1981. This cost effective project provides some savings in energy and will consolidate the Center's logistic and supply functions from four scattered locations to an improved onsite facility. It will also provide better space for the Applications Directorate that is more appropriate for their operations, with improved utilization of resources.

PROJECT DESCRIPTION:

This project provides for the expansion and modification of Building 16 for logistic and supply functions and the expansion of the Landsat Technical Processing Facility, Building 28, to house the activities of the Applications Directorate, which will be displaced from Building 16.

The site of the proposed expansion and modification of Building 16 is within the main GSFC site, adjacent to Soil Conservation Service Road, south of the Building 7/10/15 complex. The site of the expansion of the Technical Processing Facility, Building 28, is within the main GSFC site, north of Building 5 as shown in Figure 1.

The addition to Building 16 will contain approximately 88,000 square feet (8,175 square meters) of warehouse and office space (Figure 2). A two-story structural steel facility is planned with insulated industrial siding exterior walls to match the existing building. The building addition will be heated and ventilated but not air conditioned. Primary utilities such as steam, water, sewage, and power are available in sufficient capacities in the site area and will be extended accordingly. A hydraulic freight elevator and fire detection and protection systems will be provided. The existing road system of the Center is adequate to serve this facility.

The modification of approximately 92,000 square feet (8,547 square meters) of existing area in Building 16 is also involved. This includes *47,000* square feet (4,366 square meters) presently occupied by elements of the Applications Directorate and the Office of Flight Assurance. Modifications of existing internal features include partition changes; electrical power, heating ventilating, water, and sewage systems; and the reworking of internal traffic patterns including access to an egress from the facility. The final arrangement will be suitable for warehouse-type occupancy.

The addition to the Landsat Technical Processing Facility, Building 28 (Figure 3), will include approximately 57,000 square feet (5,295 square meters) of space. This addition consisting of *two* stories and a basement will

reinforced concrete and steel construction to match the existing building. Space will be included for data processing equipment, technical support, cartographic and earth resources analysis, and office areas. The equipment areas will include a raised floor system. Parking will be provided for approximately 300 people that will be housed in the facility. Utility services will be extended from Building 28.

PROJECT COST ESTIMATE :

This cost estimate is based on a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Total cost
Land Acquisition	---	---	---	---
Construction	---	---	---	5,640,000
Expansion of Building 16	---	---	---	2,250,000
Site work and utilities	LS	---	---	(170,000)
Architectural/structural	SF	88,000	11.25	(990,000)
Mechanical	SF	88,000	5.60	(495,000)
Electrical	SF	88,000	5.45	(480,000)
Elevator	---	---	---	(115,000)
Modification of Building 16	SF	92,000	3.70	340,000
Expansion of Building 28	---	---	---	3,050,000
Site work and parking	LS	---	---	(160,000)
Architectural/structural	SF	57,000	30.55	(1,740,000)
Mechanical	SF	57,000	10.25	(585,000)
Electrical	SF	57,000	9.90	(565,000)
Utilities	SF	---	---	---
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				5,640,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Plan View-Modification and Addition to Building 16
Figure 3 - Plan View-Addition to Landsat Facility, Building 28

OTHER EQUIPMENT SUMMARY:

No additional equipment is required to complete this project.

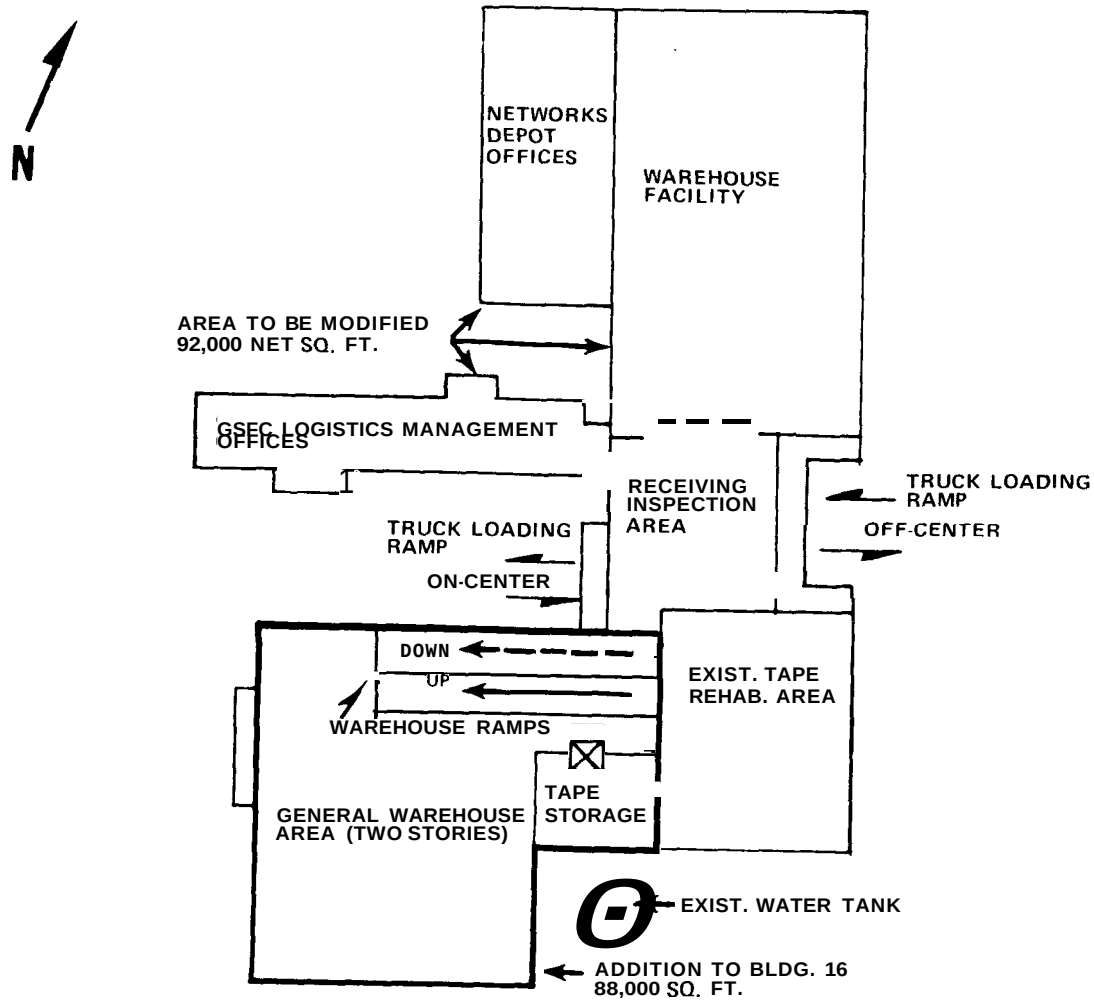
FUTURE CoF **ESTIMATED** FUNDING REQUIRED TO COMPLETE **THIS** PROJECT:

For presently planned usage, there are no currently foreseen future funding requiremen.ts necessary to complete this project.

GODDARD SPACE FLIGHT CENTER
FISCAL YEAR 1979 ESTIMATES

MODIFICATION AND ADDITIONS FOR LOGISTIC AND SUPPLY FUNCTIONS

PLAN VIEW



MODIFICATION AND ADDITION TO BUILDING 16

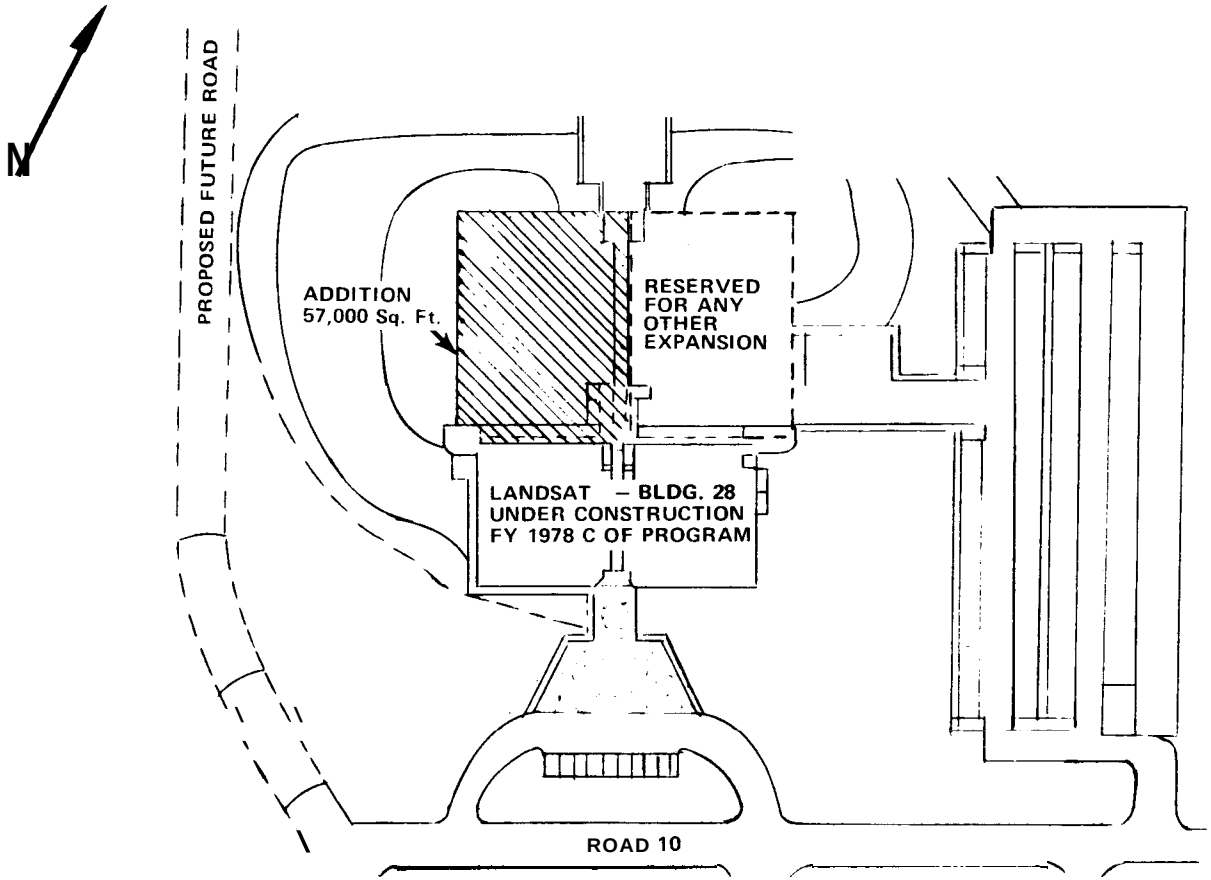
FIGURE 2

JET PROPULSION LABORATORY

LANGLEY

GODDARD SPACE FLIGHT CENTER
FISCAL YEAR 1979 ESTIMATES

MODIFICATION AND ADDITIONS FOR LOGISTIC AND SUPPLY FUNCTIONS
PLAN VIEW



ADDITION TO LANDSAT FACILITY, BUILDING 28

FIGURE 3

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

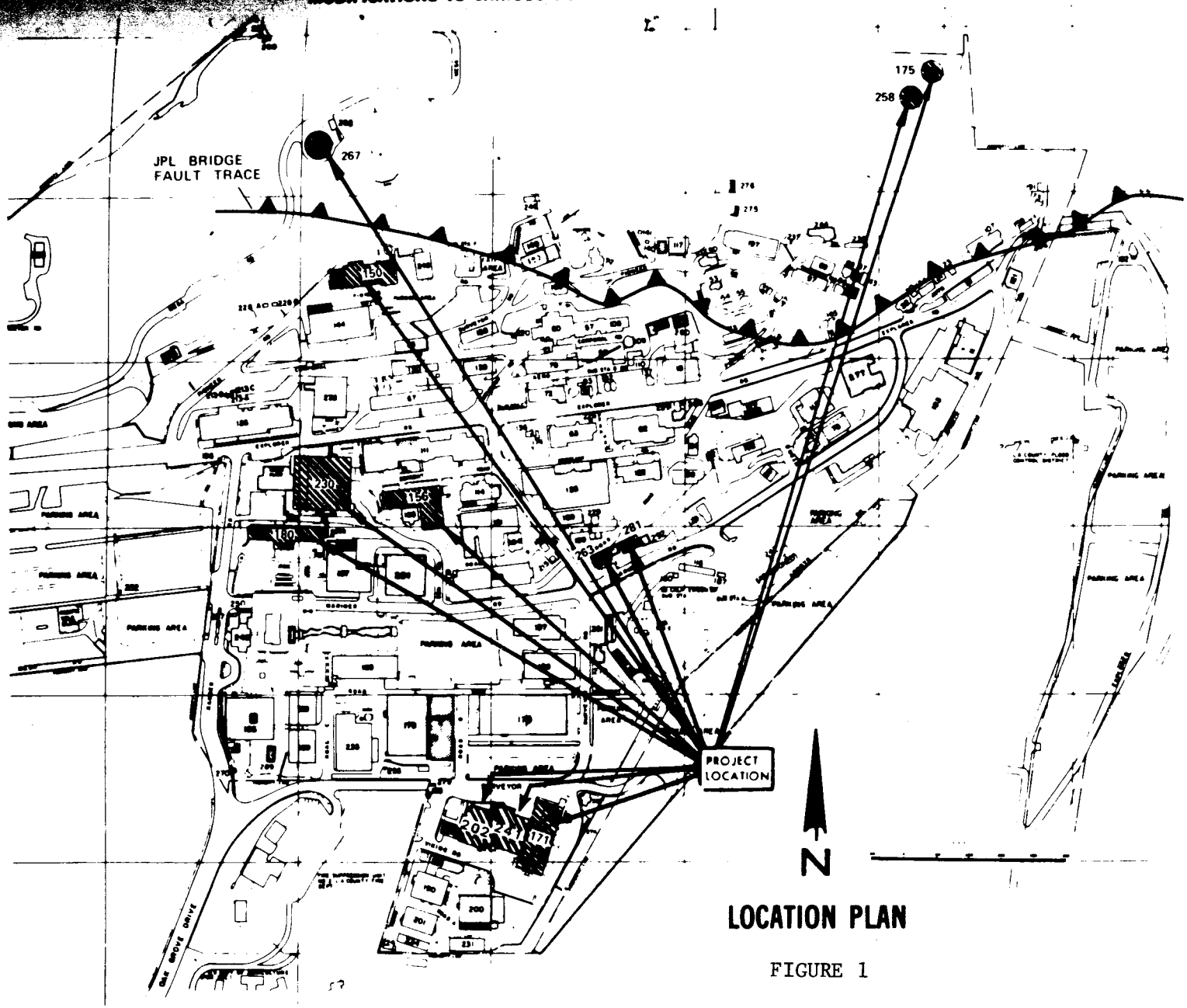
CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

SUMMARY

JET PROPULSION LABORATORY

	Amount	Page No.
Office of Management Operations:		
Modifications to various buildings for seismic protection.	1,570,000	CF 3-1
Office of the Comptroller:		
Modification and addition to the space flight operations facility.....	3,060,000	CF 3-8
Total	4,630,000	



LOCATION PLAN

FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL **YEAR** 1979 ESTIMATES

PROJECT TITLE: Modifications to Various Buildings for Seismic Protection

INSTALLATION: Jet Propulsion Laboratory

FY 1979 CoF ESTIMATE: $1,570,000

LOCATION OF PROJECT: La Canada-Flintridge, Los Angeles County, California

COGNIZANT HEADQUARTERS OFFICE: Office of Management Operations

FY 1978 AND PRIOR YEARS FUNDING: **The** following prior years funding is related to this project.

	Planning and Design	Construction	Total
Specific CoF funding	397,000	2,967,000	3,364,000
Other affiliated funding	23,000	250,000	273,000
Total	*420.000*	3.217.000	3,637,000

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to complete the work, begun with FY 1978 resources, necessary to minimize human fatalities at major Jet Propulsion Laboratory (JPL) facilities identified as those most susceptible to collaps in the event of a major earthquake. Major facilities are those associated with a potential impact on either a large number of personnel through a probable loss of life if such facilities were subjected to major earthquake forces.

As indicated the FY 1978 estimates, extensive studies were made after the San Fernando earthquake of 1971 to assess the seismic hazard and risks at JPL and to develop new insight into earthquake resistant design of facilities. The seismic hazard for the JPL site is greater than the average hazard for the Los Angeles basin.

[illegible] because the site lies on the fault system of the San Gabriel, Sierra Madre, JPL Bridge, Raymond Hill, and Verdugo fault zones and is within 25 miles (40 kilometers) of the San Andreas fault zone. A Seismic Safety Plan for JPL has been prepared. It is a composite of the various results and recommendations of these earlier studies and provides a plan of priorities for upgrading the seismic resistance of the JPL facilities. It includes the following seismic hazard predictions as the basis for all modifications.

1. The probability of a major earthquake causing an onsite peak ground acceleration of 0.4g for 10 to 15 seconds is 10 percent in 50 years. A major earthquake is considered to be one of 8+ on the Richter scale in the San Andreas fault zone or one of 5.5 to 6.5 on the Richter scale in the San Gabriel, Sierra Madre, or JPL Bridge fault zones.

2. The probability of such a major earthquake causing an onstie peak ground acceleration of 0.2g for an extended period is 50 percent in 50 years. Such earthquakes are those under 5.5 on the Richter scale in either the San Andreas fault zone or in one of the fault zones within the Los Angeles basin.

Structural, architectural, mechanical and electrical systems will be improved in accordance with the JPL Seismic Safety Plan to minimize fatalities and provide for the safe exit of personnel from all areas even if structural damage is irreparable. The FY 1978 project provided for comparable efforts in some 11 other major buildings. This project includes improvements to 9 additional major buildings all with serious deficiencies. It also provides for improvements to the JPL water storage system. This system, in its present condition, presents a potential flood hazard. It also must be preserved since it is the source of fire fighting water. The utilization of facilities involved in this element of work is planned through the 1980's and therefore, these improvements are necessary and most prudent. Cumulative recorded book balue of the facilities in this request is $18 million.

PROJECT JUSTIFICATION:

This project is necessary to minimize potential high fatality seismic risks associated with the JPL seismic hazard. Structural modifications to the buildings will prevent collapse even in the event of irreparable structural damage. Other modifications will minimize risks from hazards within the buildings, such as falling ceilings, partitions, or hardware; broken water and natural gas lines; failure of elevator hoistways; and blockage of stairways. Modifications to the water storage system will include structural and other work to reduce the possible adverse impact on its fire fighting serviceability and to minimize the potential of floods from burst storage tanks and/or pipes. Since the average seismic hazard for the JPL site is quite high, this work should be completed as soon as possible.

The JPL site is located in rugged topography at the base of the San Gabriel Mountains. The northern portion of the site is steep and mountainous. The lower portion is a decomposed granite alluvial fan with slopes of 14 percent. After the 1971 San Fernando earthquake, geologic investigations located a thrust-type fault

[illegible] west across the northern end of the site. The fault, named the "JPL Bridge Fault", is related to the San Gabriel fault zone that produced the San Fernando earthquake and is considered potentially active.

JPL initiated seismic studies on a priority basis soon after the 1971 San Fernando earthquake. Over the past several years, the seismic hazard and the earthquake-resistance of a significant number of JPL facilities have been investigated. In summary, these studies included: (1) determination of local and regional geology and seismicity; (2) studies of foundation materials; (3) determination of earthquake probabilities and the nature of resultant ground shaking; (4) determination of seismic design criteria; (5) design checks of numerous suspect facilities under the provisions of new codes; (6) dynamic analyses of several buildings; (7) identification of unsafe facilities or structural elements, (8) cost estimates for upgrading facilities, and (9) cost estimates for replacement of facilities. Results of these studies were used to develop the JPL Seismic Safety Plan, which is the basis for the FY 1978 estimate as well as this follow-on request. Many of the facilities at JPL were designed in accordance with codes in effect at the time of construction, but they are now determined to have inadequate earthquake resistance in view of the present seismic hazard knowledge and assessment and more specifically in view of the latest building codes. The facilities included in this work are those remaining major facilities at JPL having high fatality seismic risks. The FY 1978 project included as much of this work as could be accomplished in one fiscal year time frame and this project completes the remaining major work as now foreseen.

PROJECT DESCRIPTION:

The work includes structural modifications to prevent the collapse of the walls and floors in buildings, and other modifications to minimize hazards from architectural, electrical, and mechanical failures. Structural modifications include adding reinforced concrete shear walls, guniting and reinforcing existing walls and columns, and adding masonry anchors to tie roofs and floors to masonry walls. Other modifications include providing elevator hoistway bracing; adding battery-powered fire alarm and light systems; strengthening stairways; tying down heating, ventilating, and air conditioning (HVAC) equipment; providing automatic shutoff valves on water and natural gas pipelines; and providing building utility pipeline and powerline flexibility. Modifications to the water storage system include strengthening the three steel storage tanks (two 600,000 gallon (2,271 kiloliters) and one 1,000,000 gallon (3,785 kiloliters) all at an elevation of 1,435 feet (437 meters)), building water diversion walls to direct possible water spillage away from nearby occupied facilities in the event of a tank rupture, installing automatic shutoff valves and controls on system pipelines, and providing emergency vehicle access to water storage tanks.

The following facilities, with a cummulative occupancy of approximately 1,200 people, are included in this project:

Facility Number	Facility Title
150	25-foot Space Simulator
156	Computer Program Office
171	Material Services Building

Facility Number	Facility Title
180	Administration Building
202	Procurement and Communications Support Building
230	Space Flight Operations Facility structural modifications (nonstructural modifications in FY 1978 project)
241	Receiving and Shipping Building
263	First Aid Building
281	Fireman and Guard Station
175, 258, 267	Water Storage System

PROJECT COST ESTIMATE:

The basis of this cost estimate is a detailed Preliminary Engineering Report supported by related studies.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition	---	---	---	---
Construction	---	---	---	1,570,000
Modifications to Building 150	LS	---	---	215,000
Modifications to Building 156	LS	---	---	205,000
Modifications to Building 171	LS	---	---	105,000
Modifications to Building 180	LS	---	---	110,000
Modifications to Building 202	LS	---	---	105,000
Modifications to Building 230	LS	---	---	210,000
Modifications to Building 241	LS	---	---	85,000
Modifications to Building 263	LS	---	---	20,000
Modifications to Building 281	LS	---	---	20,000
Modifications to water storage system	LS	---	---	495,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				1,570,000

LIST OF RELATED GRAPHICS:

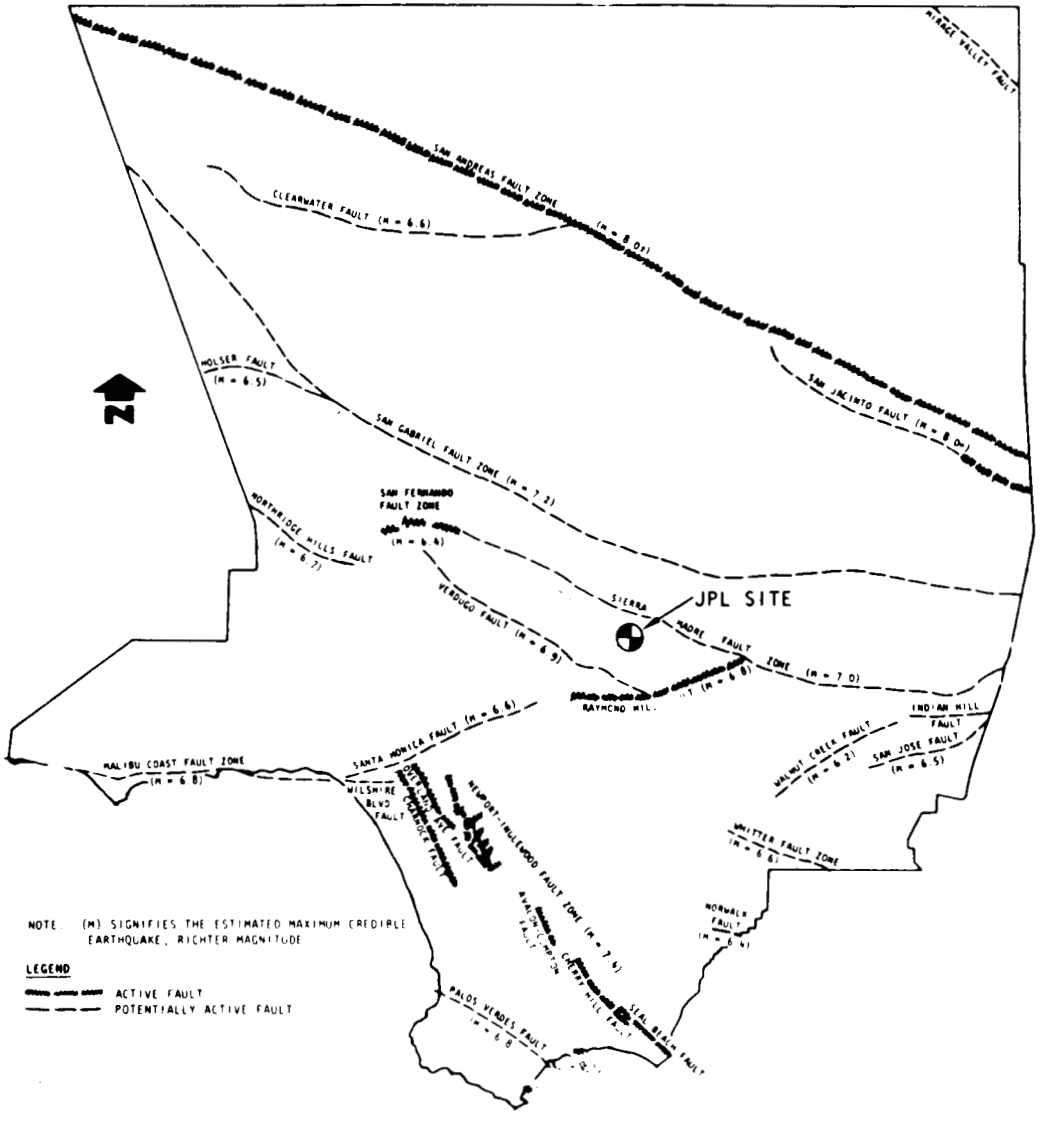
Figure 1 - Location Plan
Figure 2 - Geological Fault Map of Los Angeles County

OTHER EQUIPMENT SUMMARY:

There is no known additional equipment, either collateral or noncollateral, required for these facilities.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

This project completes all modifications needed for seismic protection in the more significant facilities at JPL. It is recognized, however, that continuing investigations of minor facilities may identify more facilities having probable collapse risks, and consequently, some added CoF funding for such follow-on minor facilities may be needed in the future.



GEOLOGICAL FAULT MAP OF LOS ANGELES COUNTY

FIGURE 2

JET PROPULSION LABORATORY
FY-79 C of F ESTIMATES
MODIFICATIONS AND ADDITION TO THE SPACE FLIGHT OPERATIONS FACILITY

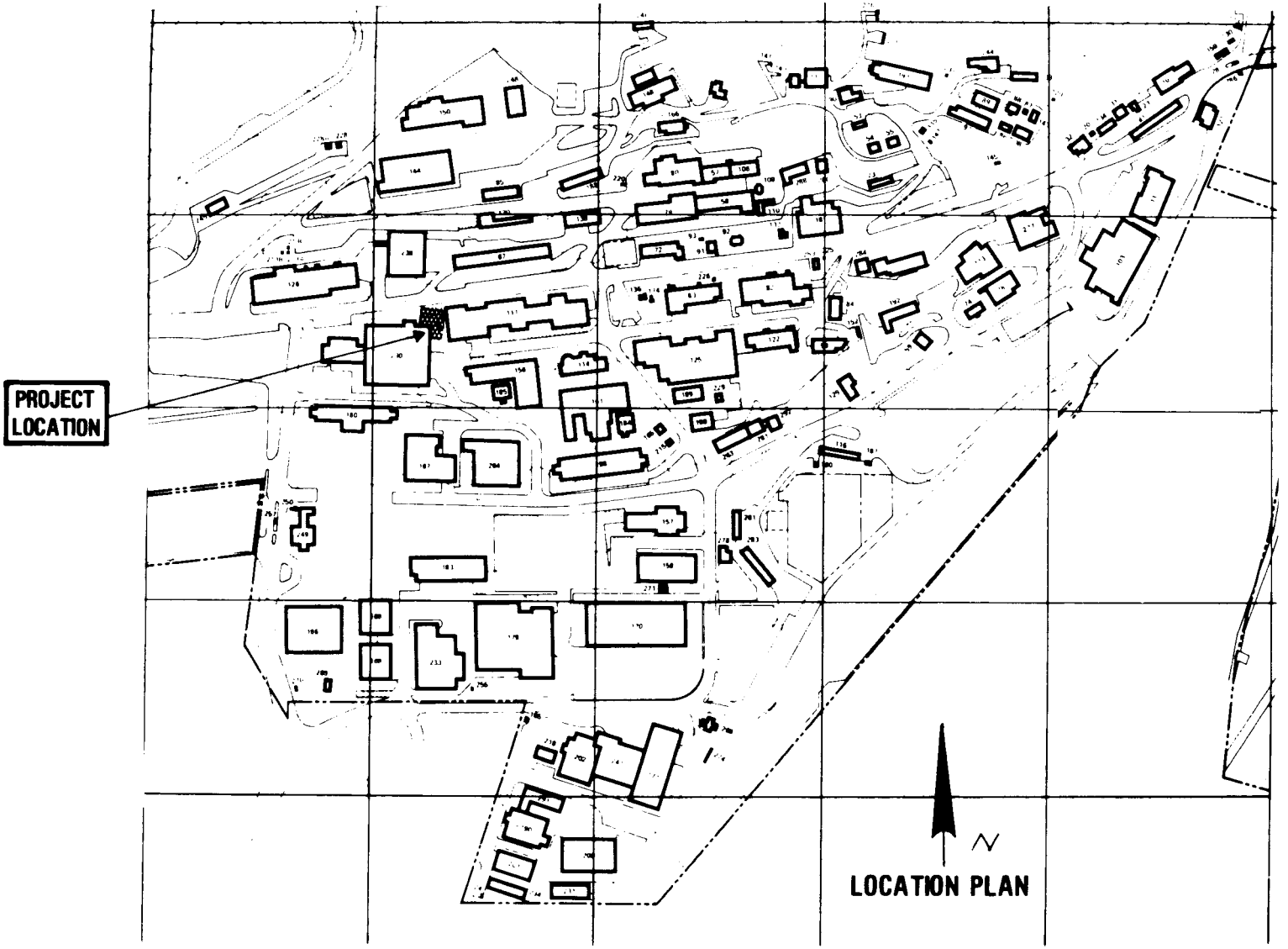


Figure 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE: Modifications and Addition to the Space Flight Operations Facility

INSTALLATION: Jet Propulsion Laboratory

FY 1979 CoF ESTIMATE: $3,060,000

LOCATION OF PROJECT: La Canada-Flintridge, Los Angeles County, California

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller

N 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	P1anning and Design	Construction	Total
Specific CoF funding	328,000	345,000	673,000
Other affiliated funding	---	8,286,000	8,286,000
Total	328,000	8,631,000	8,959,000

SUMMARY PURPOSE AND SCOPE:

This project will provide for a fully integrated heating, ventilating and air conditioning (HVAC) system to support mission flight operations at the Jet Propulsion Laboratory's (JPL) Space Flight Operations Facility (SFOF), Building 230. The planned modifications in Building 230 and a 2,600-square foot (242 square meter) addition to house the new equipment will permit the replacement of the five separate HVAC systems now serving Building 230 with a single plant that will increase reliability and redundancy, simplify control and maintenance, and conserve energy.

[illegible] systems are used 2 hours a day 7 days a w[illegible] Repairs are frequent and costly. Many of these repairs must be "unscheduled" and t[illegible] adversely affect p[illegible]i[illegible] a situation which is potentially hazardous to the success of planetary missions. The existing equipment must then be replaced. To a large extent this replacement must be done in the FY 1979 timeframe when mission schedule restraints are expected to be less than they will be later. This lull in activity will permit a partial building shutdown to allow for the necessary modifications and building tie-ins to be made without major programmatic impact.

PROJECT JUSTIFICATION:

The SFOF is the prime control center for NASA's multimillion dollar deep space missions. The SFOF physical plant houses the mission control and computer center, where computers highly sensitive to temperature, video displays, and instrumentation valued in excess of $50 million must operate continuously in a controlled environment. The building, constructed in 1963 as a two-story structure and basement, was then considered to be a "state-of-the-art" facility. Since then, the SFOF has changed significantly. As space flight techniques have grown more sophisticated, so have the related equipment requirements involved in controlling them. From 1963 to 1969, four substantial additions to the initial Building 230 were required to provide the increasing capacities needed for operating the progressive missions involved. While the resultant facility is in essence now one large facility dedicated solely to the control of planetary space flight, it is physically, in reality, a combination of five distinct construction projects.

As the SFOF was enlarged, HVAC equipment was provided in each addition, and as the overall facility grew to satisfy the requirements placed upon it, little could be done to consolidate and integrate this equipment for ease of maintenance and redundancy. As a result, the SFOF operates today with five separate systems which are not necessarily compatible with one another, and they have been repaired many times since the first system was installed 14 years ago. The resulting inefficient arrangement of HVAC equipment has plagued the SFOF with excessive facility operation costs. At the same time, the present HVAC arrangement does not provide any reasonable redundancy in a total system sense.

The continuous operation of this facility not only makes preventive maintenance difficult and costly but also effectively triples the HVAC equipment running time in comparison to what it would be in an integrated installation. The downtime of SFOF electronic equipment during the height of the Viking mission caused serious problems in mission control and created the possibility of losing a multimillion dollar mission because of malfunctions in overworn HVAC equipment. The problem is that the physical plant improvement has not kept pace with the needs imposed by the sensitive and expensive electronic equipment it must support.

NASA has conducted several studies of the SFOF problem and developed guidelines for the alleviation of this worsening situation. The reports all indicate the need for a complete replacement of the HVAC equipment and propose that the only satisfactory and viable solution involves the installation of a consolidated single system with crossover redundancy capability. This solution is considered to be the most economical and logical path to support the future deep space activities.

The urgency for implementing this project during FY 1979 is that: (1) The true age of the equipment is approximately three to four times that of equipment normally operating 8 hours a day. Because this facility must operate 24 hours a day, 7 days a week, long periods of shutdown for equipment maintenance are not possible. In any event, the existing equipment must be replaced soon. Consequently, the best solution is to replace the old equipment by installing new equipment in an addition to Building 230 to solve the operational as well as the reliability problems that exist. The time required to replace the individual systems in place would be a much longer period of time for this work-around situation besides being technically infeasible. (2) The expected use of Building 230 during this time-frame best accommodates this work. The planned use reflects a lull during late CY 1980 and early CY 1981, which will be used to minimize any impact on deep space operations. This is important because partial shutdown of some areas of the building will be necessary to make modifications to the existing HVAC systems. In summary, the penalties that would be accrued if this project is not accomplished in this time-frame, while not measurable, could be severe.

PROJECT DESCRIPTION:

A 2,600-square foot (242 square meter) L-shaped addition (Figures 2 and 3) to the northeast corner of Building 230 will be constructed so that the roof will be near ground level of the existing building. Three cooling towers will be installed on the roof of this structure. Included in the addition to Building 230 will be three air conditioning water chillers to replace the seven existing water chillers in Building 230; three new cooling towers to replace the five existing cooling towers on the roof of Building 230; new piping, pumps, and necessary controls; a hot water system; and all necessary electrical power to the chillers and associated equipment.

Modifications within Building 230 include modifying approximately 24,000 square feet (2,230 square meters) of space on the roof and elements of all floors of the existing building. This work will involve removing and replacing the existing air handlers with new equipment and controllers to accommodate economizer cycles. Included in this work will be duct work, and damper and motor control modifications necessary to correct these serious deficiencies. These modifications will provide for better air distribution as well as a more energy-efficient system for handling HVAC load requirements in those critical areas of Building 230.

PROJECT COST ESTIMATE:

The basis of this cost estimate is a Preliminary Engineering Report and related studies.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition	---	---	---	---
Construction				3,060,000
Demolition	LS	---	---	30,000
Architectural/structural addition	SF	2,600	92.30	240,000
Modifications in existing building	SF	24,000	7.90	190,000
WAC system	LS	---	---	2,060,000
Electrical connection	LS	---	---	540,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				3,060,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Site Plan
Figure 3 - Building Addition Layout

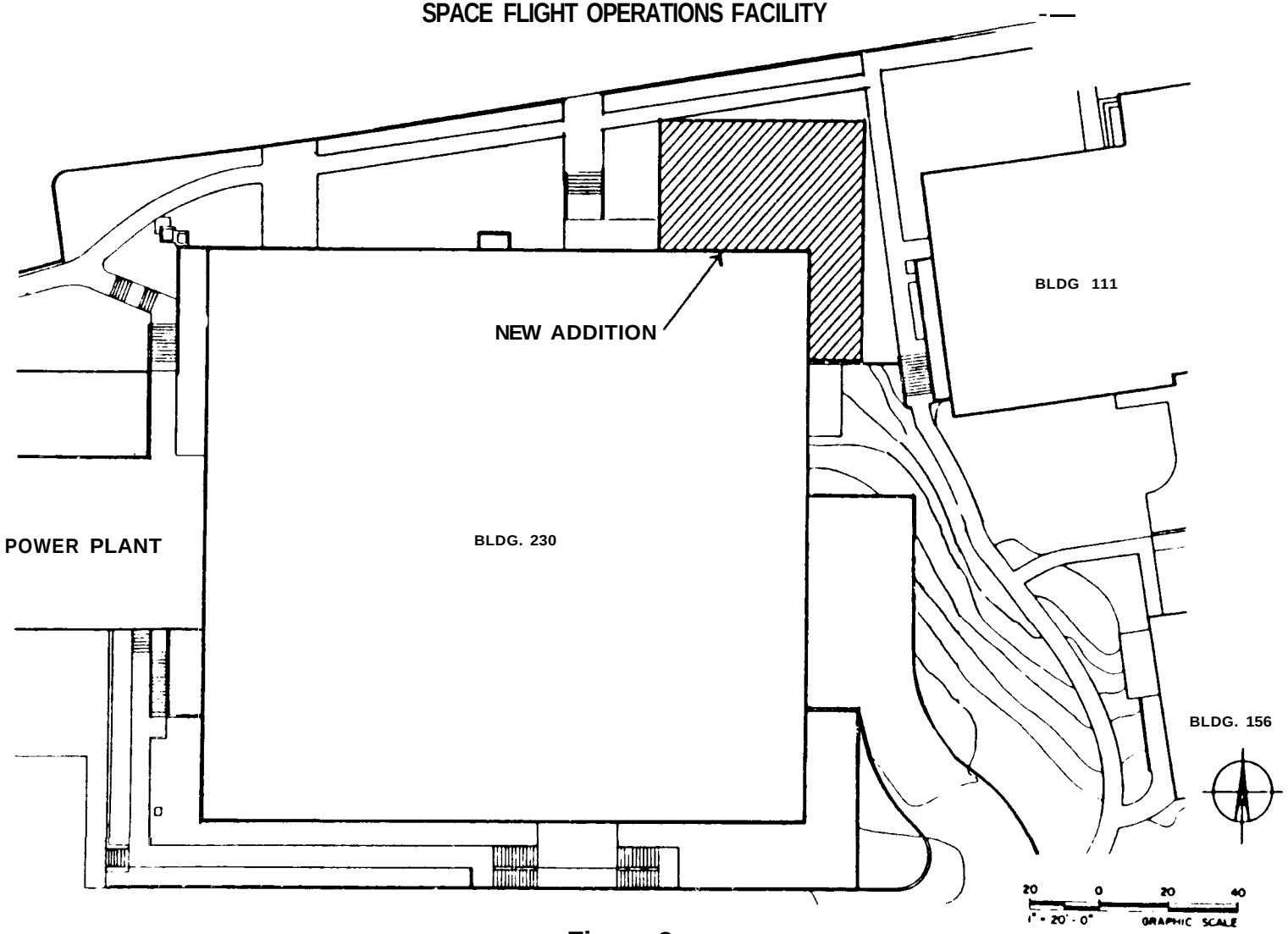
OTHER EQUIPMENT SUMMARY:

There is no other equipment required to be used with this facility project.

FUTURE CoF ESTIMATED FUNDING REQUIREMENT TO COMPLETE THIS PROJECT:

Additional funding for basic plant equipment is not anticipated; however, future modification work may be necessary for satisfying unique future programmatic requirements as they may evolve.

JET PROPULSION LABORATORY
FY 79 C of F ESTIMATES
MODIFICATIONS AND ADDITION
TO THE
SPACE FLIGHT OPERATIONS FACILITY



SITE PLAN

Figure 2

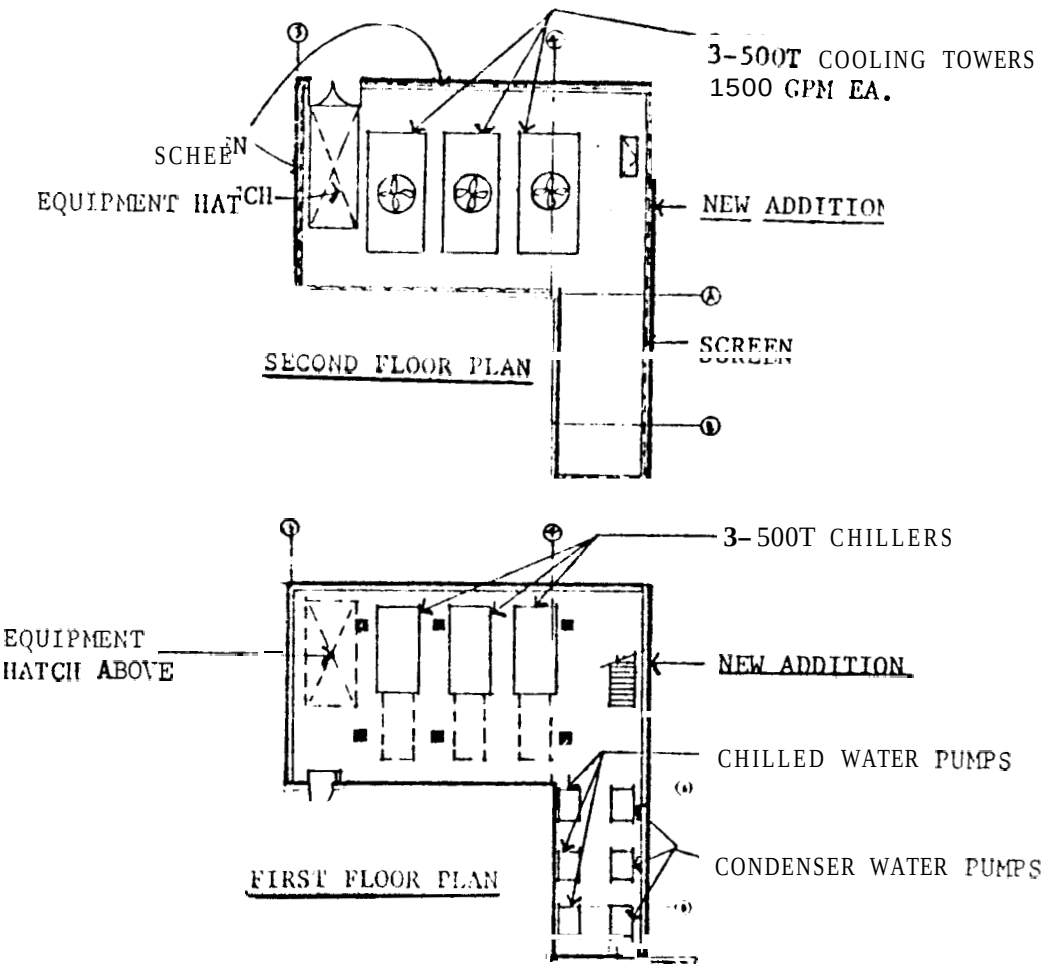
CF 3-13

LEWIS RESEARCH CEN
LANGLEY RESEARCH CENTER

LARGE

JET PROPULSION LABORATORY
FY 79 C of F ESTIMATES

MODIFICATIONS AND ADDITION TO THE SPACE FLIGHT OPERATIONS FACILITY



BUILDING ADDITION LAYOUT

FIGURE 3

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

IN

LANGLEY RESEARCH CENTER

	Amount	Page No.
Office of Management Operations:		
Modifications for utility control system	1,980,000	CF 4-1
Office of Aeronautics and Space Technology:		
Rehabilitation of unitary plan wind tunnel	4,520,000	CF 4-8
Total	6,500,000	

LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

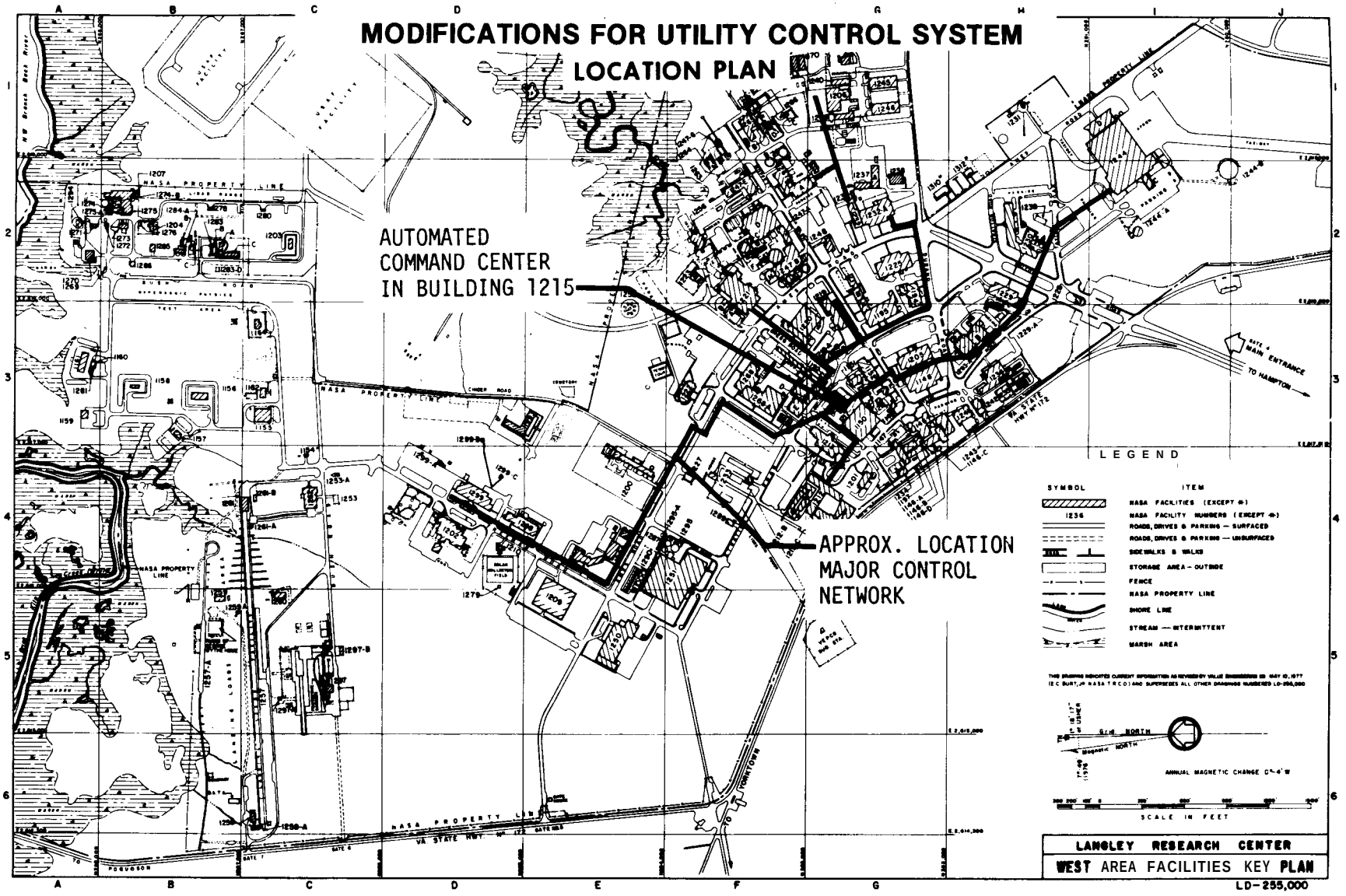


FIGURE 1

CF 4-1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE: Modifications for Utility Control System

INSTALLATION: Langley Research Center

FY 1979 CoF ESTIMATE: $1,980,000

LOCATION OF PROJECT: Hampton, Virginia

COGNIZANT HEADQUARTERS OFFICE: Office of Management Operations

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	26,850	---	26,850
Other affiliated funding	---	---	---
Total	26,850	---	26,850

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to provide a Utility Control System (UCS) that will streamline energy and manpower requirements for more efficient operation of building utility systems at Langley Research Center (LaRC). The utility systems include heating, ventilating, air conditioning (HVAC), and lighting systems in major buildings. The UCS will consist of an automated control center to be located in the main heating plant, Building 1215, with real time control over these building utility systems. The installation of sensing and control devices on the building utilities and the integration of these functions will conserve energy, reduce manpower and maintenance, and contribute to better overall management of Center facilities.

PROJECT JUSTIFICATION:

The multiplicity of existing building systems, combined with the number of buildings and parameters that control these systems, make automated techniques the most effective method of totally optimizing manpower and energy usage related to building operation and maintenance. This project is expected to reduce total electrical power and fuel oil consumption used for institutional purposes by approximately 20 billion Btu's per year which when combined with additional savings of 12 man years of labor per year and improvements in equipment operation and maintenance results in an estimated total savings of $620,000 per year starting in 1980, the first full year of operation for the UCS. These savings are in addition to present measures being taken to conserve energy and optimize operations. The proposed system will also provide increased reliability; extend equipment life; and improve manpower utilization, data logging, and management of LaRC's major utility system operations. The payback for this project is approximately 3.5 years making this a very promising and prudent investment. This project, coupled with those UCS projects in the FY 1979 Rehabilitation and Modification program, will basically complete the overall planned NASA UCS systems at all locations. This NASA-wide program was initiated in FY 1974 and is geared to an objective of better management of energy resources and consequently lower consumption as well as more effective applications.

PROJECT DESCRIPTION:

To implement this project, 400 square feet (37.2 square meters) of space in the main heating plant, Building 1215, will be modified to accommodate a central control room. The control room will provide space for an operations console consisting of a central processing computer and related peripheral equipment. The operations console will monitor and control building utility systems by control signals from the computer to the 22 buildings selected because of their significant energy consumption. Signals will be transmitted over approximately 10,000 feet (3,048 meters) of new data transmission cables, to be placed in existing utility tunnels and conduit extending directly from the tunnels (Figure 1). The data transmission lines will be connected to remote control cabinets in the buildings, which also will include the power supply and related transmission equipment. This equipment will be connected to some 1,800 instrumentation points to control heating, ventilating, air conditioning, and lighting systems in the applicable buildings.

The central processing computer will be programmed to conserve and optimize energy use. In Buildings 1268 and 12688, which have large air conditioning systems, the chilled water pumps, condenser pumps, cooling tower, and chiller loading will be controlled by the computer to provide efficient building cooling with minimum energy expenditures. Maximum energy efficiency is attained by starting and stopping air conditioning systems as needed to serve the cooling load, with appropriate consideration to prevent excessive equipment cycling. Lighting controls will automatically extinguish lights in all 22 buildings at the end of each working day and relight them at appropriate times at the start of each working day.

A maintenance program will also be a by-product of the total system so that routine maintenance can be scheduled based on actual equipment run times and at planned preventive maintenance intervals. Installation of appropriate sensors and transmitters to signal trouble and protect equipment will further reduce breakdowns, maintenance, and trouble-shooting.

A typical Utility Control System operates in the following manner. Sensors and controllers are to be installed at specified locations in major LaRC buildings, and heating plant as indicated in the typical diagram (Figure 2). These send signals to the Central Processing Unit (CPU) which either processes the data into operational reports or compares it to "set points" for automatic control decisions. When a control change is required, the CPU transmits a signal to affect the change, such as start or stop a motor or modulate a damper. Status will also be monitored on the printer or Cathode Ray Tube (CRT) and conditions modified, when necessary, by the operator's keyboard to provide efficient operation of all equipment.

The UCS is of a proven, completely modular design, providing the capacity and flexibility for additions without control room hardware modifications. As new buildings and facilities, such as the refuse-fired steam generating plant, are constructed, or existing facilities, such as the West Area heating plant, are considered necessary for inclusion in the system, they can be added by providing the necessary instrumentation and software to make them compatible with the control center hardware.

PROJECT COST ESTIMATE:

This cost estimate is based on a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---			-
Construction	---	---	---	70,000
Rehabilitation of control room	SF	400	25.00	10,000
Communications between buildings and central control..	LF	10,000	6.00	60,000
Equipment	---	---	---	1,910,000
Control room hardware	LS	---	---	135,000
Remote terminal units	EA	20	4,500.00	90,000
Instrumentation for HVAC systems..	LS	---	---	1,575,000
Lighting control	LS			110,000
Fallout Shelter (not feasible)	---	---	---	---
Total				1,980,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Master Control Layout

OTHER EQUIPMENT SUMMARY:

No other collateral or noncollateral equipment is involved.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE **THIS** PROJECT:

At the present tine, there is no foreseen requirement for future CoF funding for the buildings included in this project. However, experience in actual operation nay justify some future improvements in other buildings at the site as well as with respect to the Central Heating Plant and the Refuse-Fired Steam Generating Facility.

LANGLEY RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

Modifications for Utility Control System

(Typical Diagram)

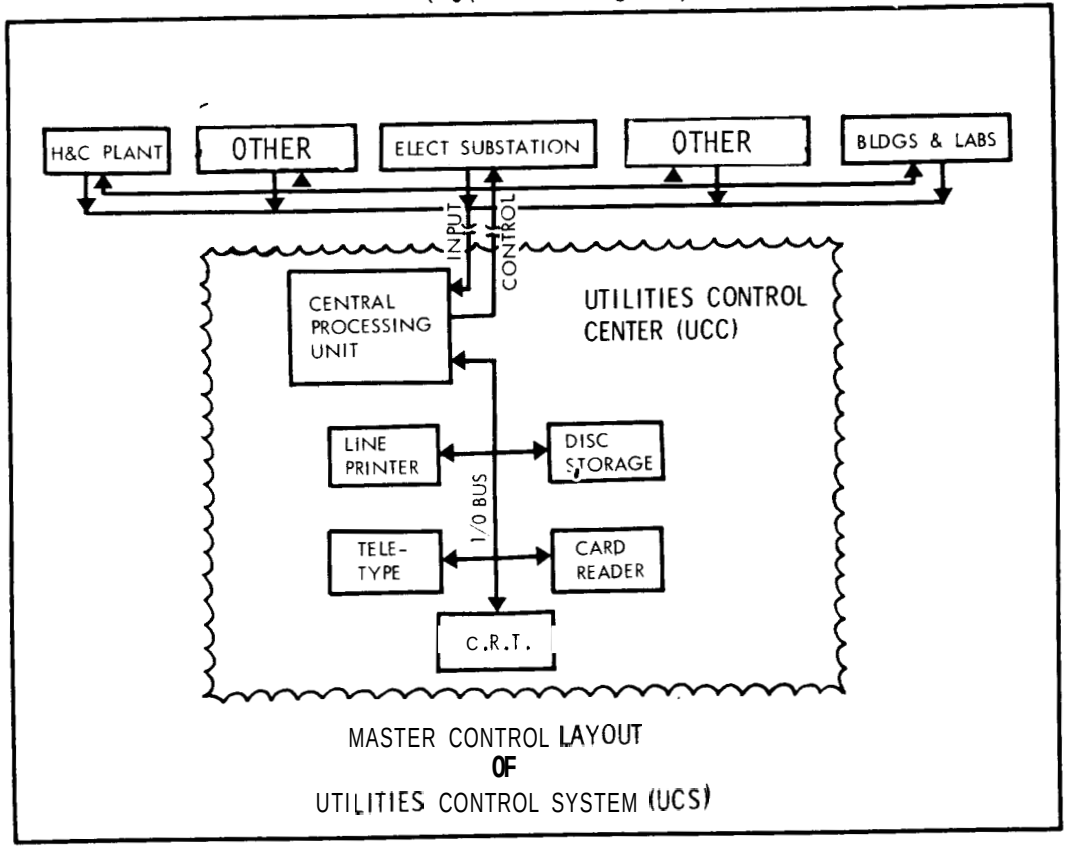


Figure 2

LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

REHABILITATION OF UNITARY PLAN WIND TUNNEL
LOCATION PLAN

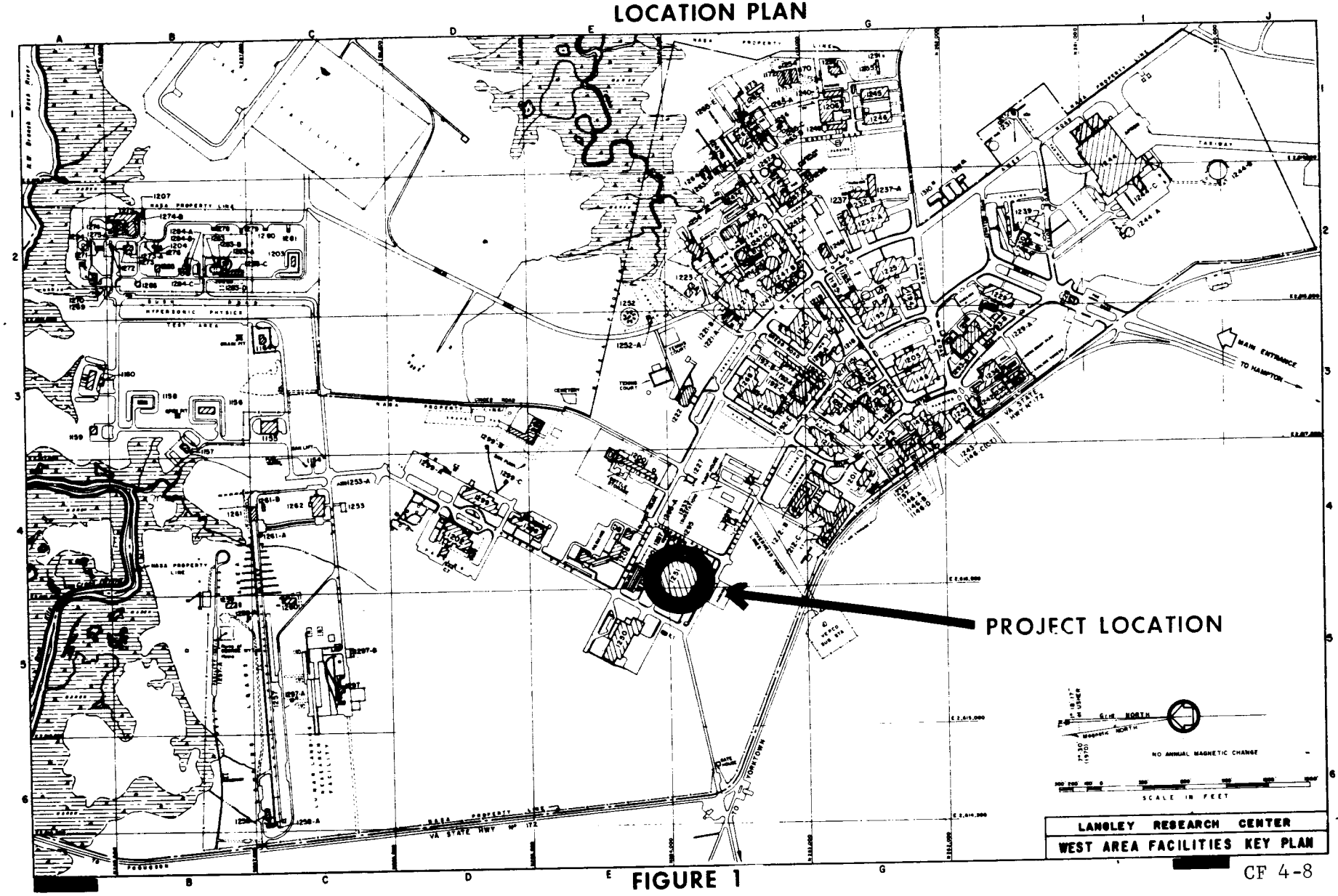


FIGURE 1

CF 4-8

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE: Rehabibilation of Unitary Plan Wind Tunnel

INSTALLATION: Langley Research Center

FY 1979 CoF ESTIMATE: $4,520,000

LOCATION OF PROJECT: Hampton, Virginia

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project.

	Planning and Design	Construction	Total
Specific CoF funding	458,000	1,470,000	1,928,000
Other affiliated funding	---	19,500,000	19,500,000
Total	458,000	20,970,000	21,428,000

SUMMARY PURPOSE AND SCOPE:

This rehabilitation of the Unitary Plan Wind Tunnel (UPWT) (Figure 1) will provide a continuing and more efficient research capability to adequately support national test programs in supersonic aerodynamics, stability and control, and fluid mechanics. Improvements of this 22-year-old facility (Figure 2) will include the provision for a new pressure acquisition system, rehabilitation of the model support systems, critical component replacements in ancillary equipment, and rehabilitation of the associated office and shop areas. This project will reduce unscheduled maintenance time now impacting current tunnel operations and it will make possible a reduction of tunnel energy requirements by approximately 7 to 8 $\times 10^6$ KWH of electricity annually.

PROJECT JUSTIFICATION:

The Unitary Plan Wind Tunnel Act of 1949 provided for the construction of this unique facility to meet the critical needs of NASA, industry, military, and other Government agencies in the development of high speed aircraft and missiles. It has played a major role in space systems development in the critical boost and re-entry phases, and is a primary facility in Space Shuttle development testing. In military support, essentially all of our nation's supersonic configurations have been tested in this facility. Examples include development programs on the F-14, F-15, and F-16 aircraft. The research capability of this facility is essential to current and future aerodynamic and missile research programs.

Rehabilitation of this facility (Figure 3) is necessitated by the increasingly unreliable condition of certain crucial mechanical elements, such as the main drive system (Figure *4)* and ancillary equipment, and model supports. This project will improve the tunnel operational readiness time, minimize manpower maintenance requirements and reduce electrical power consumption. Various ancillary systems will be inspected and repaired by the replacement of faulty and obsolescent components. The existing model support systems will be modified! replaced to reduce model installation time, reduce energy consumption, and enhance the research capability of the facility. A new and larger capacity vacuum pump system and a pressure data acquisition system will be installed to effect further reductions in energy consumption. It is estimated that the proposed rehabilitation and the associated modification work will conserve approximately 7 to 8 x 10^6 KWH of electricity annually. This will be accomplished with no compromise in research data acquisition capability and at a cost payback of about *4* years.

Rehabilitation of this facility is essential to reduce equipment breakdown with attendant lost and unscheduled downtime. Procurement lead time for many of the critical components in this large facility is six to eighteen months. Requirements of this facility have been *so* demanding that it has remained in constant use since initial operation and maintains a six-month backlog of planned R&D activities. It is estimated that the facility will have logged approximately 41,800 hours without a major overhaul by the time it is renovated via this project. The probability of time consuming shutdowns increases with additional operating time and consequently there is a pressing need for this work.

The alternative to this project will be the continued operation of this facility at high maintenance cost and increased risk of a serious equipment failure and prolonged downtime, plus the continued operation of energy inefficient model support and pressure data acquisition systems.

This facility is essential to current and projected programs in missile research, military aircraft research, and long haul aircraft research. The UPWT is the only supersonic wind tunnel capable of stability, control and performance testing required to support current and projected test requirements. In addition to these major test programs, the facility will continue to support the Space Shuttle program, Department of Defense, and industry.

Tunnel research operations will encounter minimum interference during the rehabilitation. Long-lead items will be procured and supplied for contract installation to coincide with three-week semiannual maintenance shutdown periods. Some preparatory work will also be scheduled to occur on a noninterference basis. The UPWT will be down for short periods of time totalling an estimated six months during the rehabilitation period. During this time, planning and scheduling of the rehabilitation work will be coordinated with the research test program in order to minimize the impact on research activities.

PROJECT DESCRIPTION:

This project will provide for the continuation of rehabilitation work started in FY 1978 of the Unitary Plan Wind Tunnel, Building 1251 at LaRC. This work will not only reduce unscheduled maintenance of the current tunnel operations but will also increase productivity by 25 to 50 percent through the automation of the tunnel controls and model support and data acquisition systems. The FY 1979 rehabilitation work will include improvements to the two model support systems to increase research test time in this tunnel. The six large main drive compressors and a gear box will be inspected and rehabilitated by replacement of the required couplings, seals, bearings and related worn components. Two existing air compressors (150 psig and 300 psig) will be rehabilitated or replaced with new compressors to reduce the running time in pumping down the wind tunnel. The deteriorated cooling water system will be improved by the installation of eight new pumps, couplings, check valves and related mechanical work.

In the direct support areas the work will include the general rehabilitation of 42,000 square feet (3,900 square meters) of office area to include new wall partitions, acoustical tile ceilings and floors. The existing steam unit heaters and package type air conditioning units will be replaced with a new air system, steam absorption chiller, cooling tower, heat exchanger, and associated pumps and related piping. A remote block switching for master control of the lighting system will be provided and the installation of recessed type fluorescent fixtures with the related electrical power modifications are included. These improvements will result in two levels of lighting selectivity in each area with a related reduction in electrical energy.

The new equipment to be provided by the project includes the replacement of the existing mechanical pressure data acquisition system with a new multiport electronically scanned pressure sensor system. In addition, the obsolete and monmaintainable electrical switchgear will be replaced with electric breakers which can be installed in the existing transformer compartments and will be equipped with ground fault protection tripping devices. The existing vacuum pump will be replaced with a new pump including the drive motor and all necessary accessories.

The present manually operated 10-ton (9,072 kilogram) bridge crane now being used on an improvised basis as a 50-ton (45,360 kilogram) crane. It will be replaced with a new 50-ton (45,360 kilogram) electrically operated overhead crane. The existing 2-ton (1,814 kilogram) bridge crane will be replaced with a new 5-ton (4,536 kilogram) crane equipped with electric power for all drive functions in the main area.

The modifications of this unique test facility will increase its research capabilities, improve tunnel efficiency, and conserve energy.

PROJECT COST ESTIMATE:

This cost estimate is based on a completed Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition..	---	---	---	---
Construction.....	---	---	---	3,140,000
Rehabilitation of model support systems...	EA	2	332,500	665,000
Rehabilitation of main compressors and gear box..	LS	---	---	465,000
Rehabilitation of make-up compressors.....	LS	---	---	265,000
Rehabilitation of cooling water system..	LS	---	---	690,000
Rehabilitation of electrical switchgear	LS	---	---	105,000
Rehabilitation of direct support areas.....	LS	---	---	950,000
Equipment	---	---	---	1,380,000
Pressure data acquisition system..	EA	2	145,000	290,000
Electrical switchgear..	EA	2	180,000	360,000
Mechanical vacuum pumps.....	EA	2	150,000	300,000
50 ton crane.....	EA	1	375,000	375,000
5 ton crane.....	EA	1	55,000	55,000
Fallout Shelter (not feasible)	---	---	---	---
Total..				4.520.000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Site Location
Figure 3 - Plan View
Figure 4 - Main Drive

OTHER EQUIPMENT SUMMARY:

No other collateral or n collateral equipment is involved.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

Future CoF funding for possible automation of the UPWT may be a future consideration. If validated this work is estimated to cost $1.0 to $2.0 million.

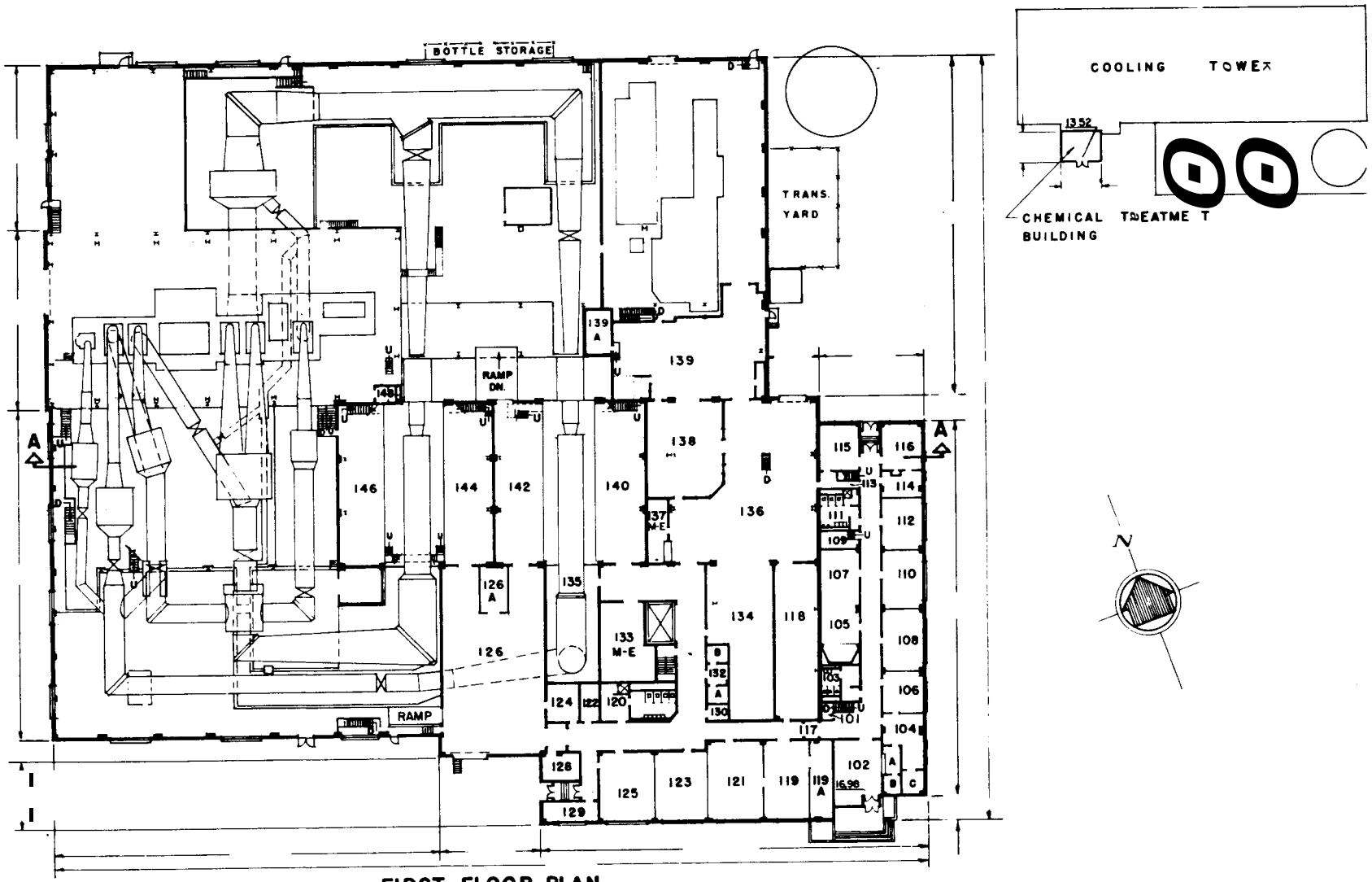
LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

REHABILITATION OF UNITARY PLAN WIND TUNNEL
SITE LOCATION

FIGURE 2

LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

REHABILITATION OF UNITARY PLAN WIND TUNNEL
PLAN VIEW

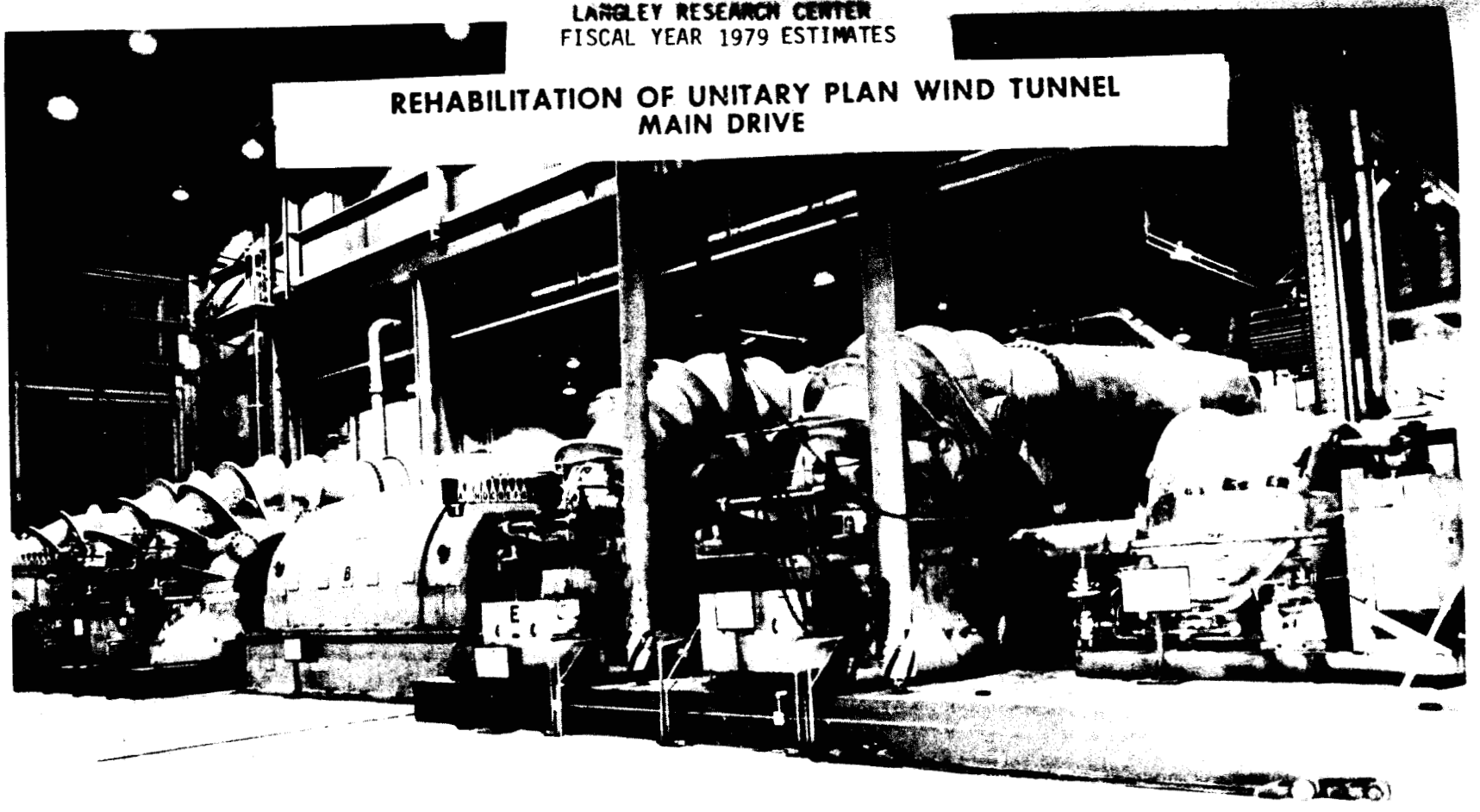


FIRST FLOOR PLAN
FIGURE 3

CF 4-15

LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

REHABILITATION OF UNITARY PLAN WIND TUNNEL MAIN DRIVE



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

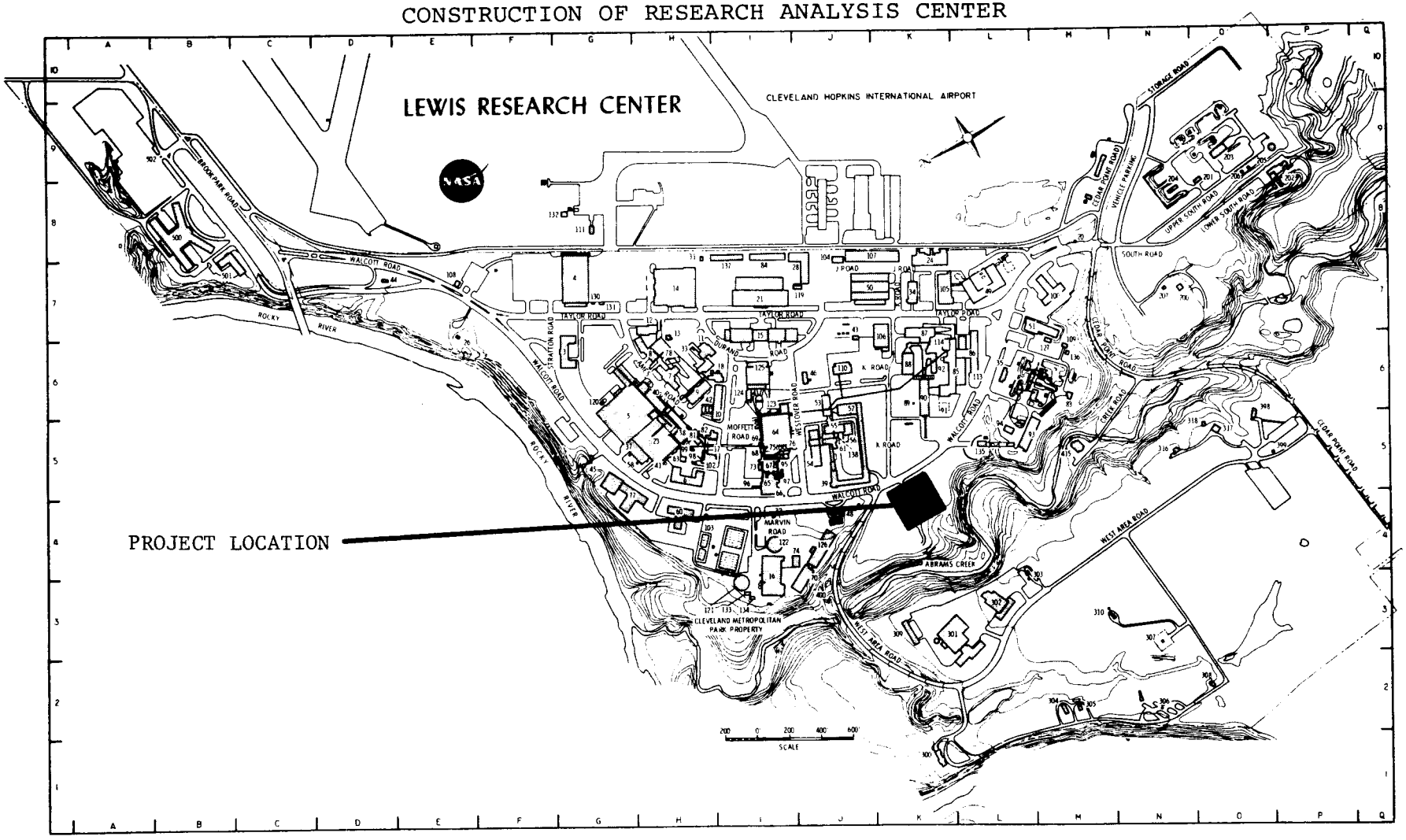
SUMMARY

LEWIS RESEARCH CENTER

	Amount	Page No.
Office of Aeronautics and Space Technology:		
Construction of research analysis center	6,140,000	CF 5-1

LEWIS RESEARCH CENTER
FISCAL **YEAR** 1979 **ESTIMATES**

CONSTRUCTION OF RESEARCH ANALYSIS CENTER



LOCATION PLAN

Figure 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE: Construction of Research Analysis Center

INSTALLATION: Lewis Research Center

FY 1979 CoF ESTIMATE: $6,140,000

LOCATION OF PROJECT: Cleveland, Cuyahoga County, Ohio

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	456,000	---	456,000
Other affiliated funding	---	---	---
Total	456,000		456,000

SUMMARY PURPOSE AND SCOPE:

This project provides for the construction of a new central research analysis facility at Lewis Research Center (LeRC). This facility will house new computer equipment programmed for installation at LeRC. In addition, it will accommodate certain of the computers and related research analysis equipment presently dispersed in several locations that are now overcrowded, undersized, and not physically configured for satisfactory data processing equipment installations. The new research analysis center will contain an operations area, a service area, and an office area. Each will be properly configured and interrelated to provide an efficient research analysis environment. The total facility will have an area of approximately 65,430 square feet (6,078 square meters).

PROJECT JUSTIFICATION:

The Lewis Research Center is the NASA center responsible for the development of advanced aeronautical propulsion systems. Over the recent past, the Center has been progressively enhancing its capability to develop efficient and environmentally compatible propulsion systems. A present inadequacy at LeRC is the lack of a modern data analysis center. It has become evident that to fulfill its mission, the Center must replace its data analysis facility at this time with more adequate and productive equipment.

A modern computational system is essential for carrying out and controlling tests; for controlling test facilities; and for collecting, analyzing, and disseminating the data rapidly, efficiently, and economically. The Center has incorporated every practical technical advance into its present equipment to increase capacity and extend its economical use. However, automating the test facilities and increased requirements generated by the Center's scientific and engineering needs for "on-line" computation as an integral part of research has reached the point where a new computer is required to fully utilize test facilities at this Center. An adequate computer system is required to fully utilize test facilities at this Center and the present system is a limiting factor to the research programs. This present system must be replaced with a system of expended capabilities.

Increased computational capability is essential not only for research but also for system design. For example, the interactions of turbofan engines can be studied to increase efficiency, improve reliability and reduce maintenance for a given engine configuration. However, a very significant increase in computer speed and storage is needed for proper study of these complex systems. Thus, advanced data processing equipment is needed to maintain and increase aeronautical technological superiority.

Present facilities, hampered by space and structural limitations, are not adequate to accommodate the new equipment. The Computer Services Division at LeRC, which provides data processing for the research and test facilities, is presently located on four different floors in two buildings originally designed for other purposes. The configuration of these facilities has dictated somewhat awkward and inefficient installation of equipment and in many cases it is not possible to make reasonable provisions for storage and office space. Structural inadequacies include limitations for supporting the weight of data processing equipment. In addition, floor-to-ceiling height is inadequate, underfloor air conditioning systems are inadequate, and the irregularly shaped areas prevent installation of the new data processing equipment in an efficient layout.

Construction of a new facility not only would provide for optimum efficiency of the data analysis center but also would release other badly needed office and warehouse space for consolidation of functions and better control of materials and supplies at LeRC. This would be achieved by relocating the Engineering Services Directorate from the Engineering Services Building No. 21 into the 10 x 10-Foot Supersonic Wind Tunnel Building that would be vacated by the Computer Services Division. This move will allow approximately 24,000 square feet (2,230 square meters) of the Engineering Services Building Annex to be returned to warehouse space. In turn,

the Technical Services Directorate would relocate to the Engineering Services Building No. 21 from Building 11 and Building 6. Space would thus be available in Building 6 to accommodate the light laboratory space for which it was designed and personnel currently located in Building 398. In addition, Building 11 would be "mothballed" and Building 398 would be demolished.

PROJECT DESCRIPTION:

This facility will consist of three major areas: operations, service, and office (see Figures 1 and 2). The operations area will be constructed on a steel structural frame with insulated metal wall panels. A metal roof deck with built-up roofing, a concrete subfloor, and raised computer floor will complete the building.

A one-floor service area will be constructed of masonry walls, metal joists and roof deck, and concrete floor slab. An acoustical ceiling will be used in the noisy areas. This portion will have microfilm processing, viewing, and copying areas; digitizers; a tape and technical library; business data processing and electronic accounting machines; a dispatch room; data cable terminal rooms; keypunch rooms; fast Fourier transform processing; and analog and hybrid maintenance areas. The service area and the operations area will have a fire detection and/or a sprinkler system.

A two-floor area will house offices and some service areas. This portion will consist of masonry walls, steel joists, metal roof deck, steel joist and concrete second floor, concrete floor slab on grade, and dual-glazed aluminum windows. Acoustical ceilings will be used in the offices. The wall, roof, and foundation will be optimally insulated for greater heat and sound resistance.

The total area on the foundations will be approximately 49,400 square feet (4,589 square meters) and the building will have a total floor area of 65,430 square feet (6,078 square meters). This total floor area will be comprised of 19,578 square feet (1,819 square meters) for the operations area, 22,919 square feet (2,129 square meters) for the service area, and 22,933 square feet (2,130 square meters) for the two-floor office area. The building will measure approximately 194 feet by 250 feet (59 meters by 76 meters) as shown in Figures 2 and 3. The operations area will contain two heating, ventilating, and air conditioning (HVAC) systems. One system will provide cooling required for the building envelope, electric lights, and personnel. The second system will be a modular system designed to respond to the loads and needs of the data equipment. The service area HVAC will be a variable-volume system for greater efficiency for this type of operation. The office area will be serviced by a system of individually controlled fan-coil units.

PROJECT COST ESTIMATE:

The current cost estimate is based on 100 percent completion of the final design drawings.

	Unit of Measure	Quantity	Unit Cost	Total cost
Land Acquisition	---	---	---	---
Construction...				6,140,000
Site work/utilities (outside 5' line)	LS	---	---	1,000,000
Architectural/structural	SF	65,430	32.71	2,140,000
Mechanical	SF	65,430	19.56	1,280,000
Electrical.	SF	65,430	26.29	1,720,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total...				6,140,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - First Floor Plan
Figure 3 - Second Floor Plan

OTHER EQUIPMENT SUMMARY:

Existing noncollateral data equipment valued at $11,000,000 will be relocated to this facility from its present locations at LeRC. Also programmed for installation in the new Research Analysis Center is new and related equipment and software valued at approximately $7,400,000. It is planned that this equipment and software will be acquired over this and the next fiscal year.

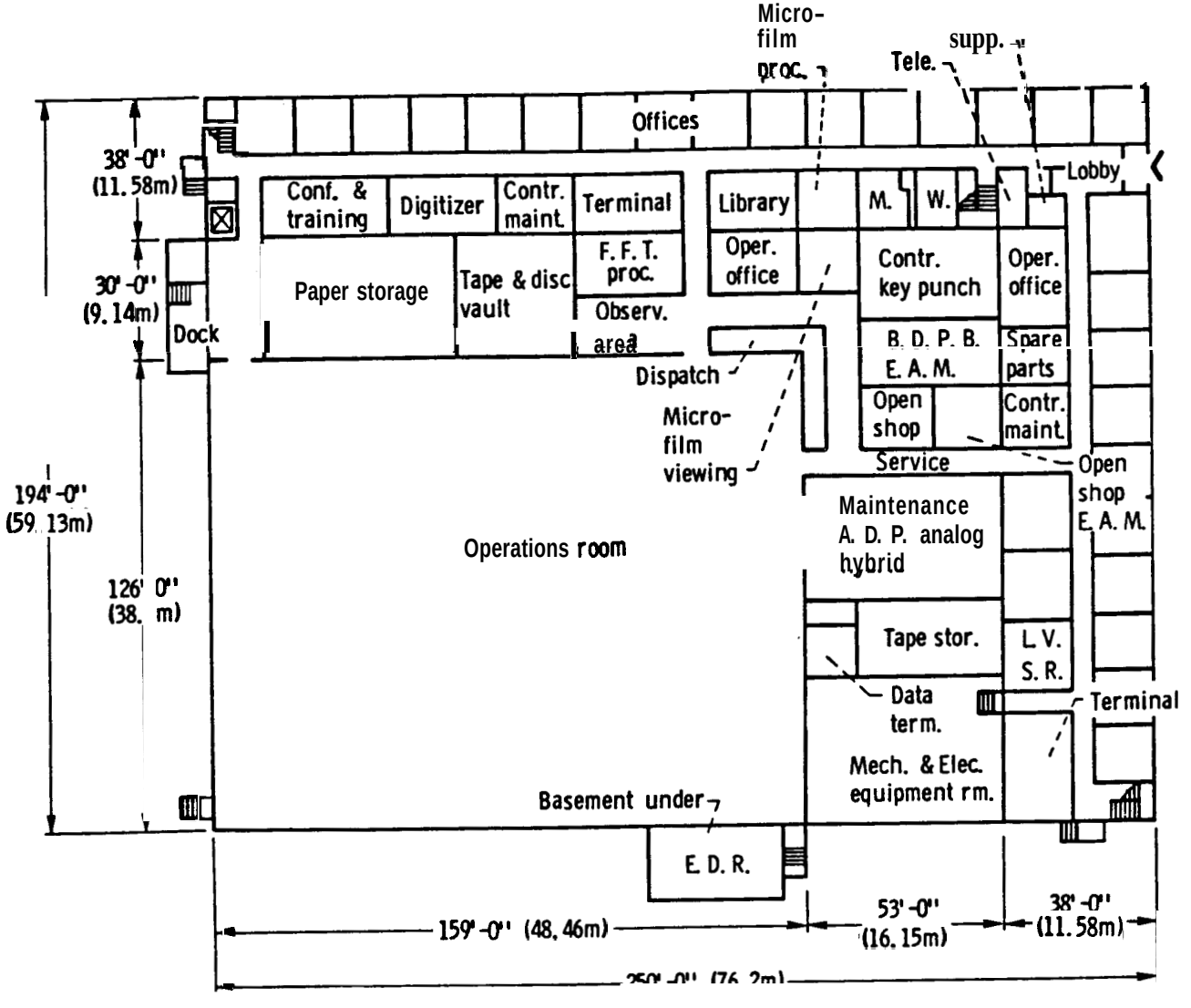
FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

There are no currently foreseen future funding requirements to complete this project.

LEWIS RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

CONSTRUCTION OF THE RESEARCH ANALYSIS CENTER



1st floor plan

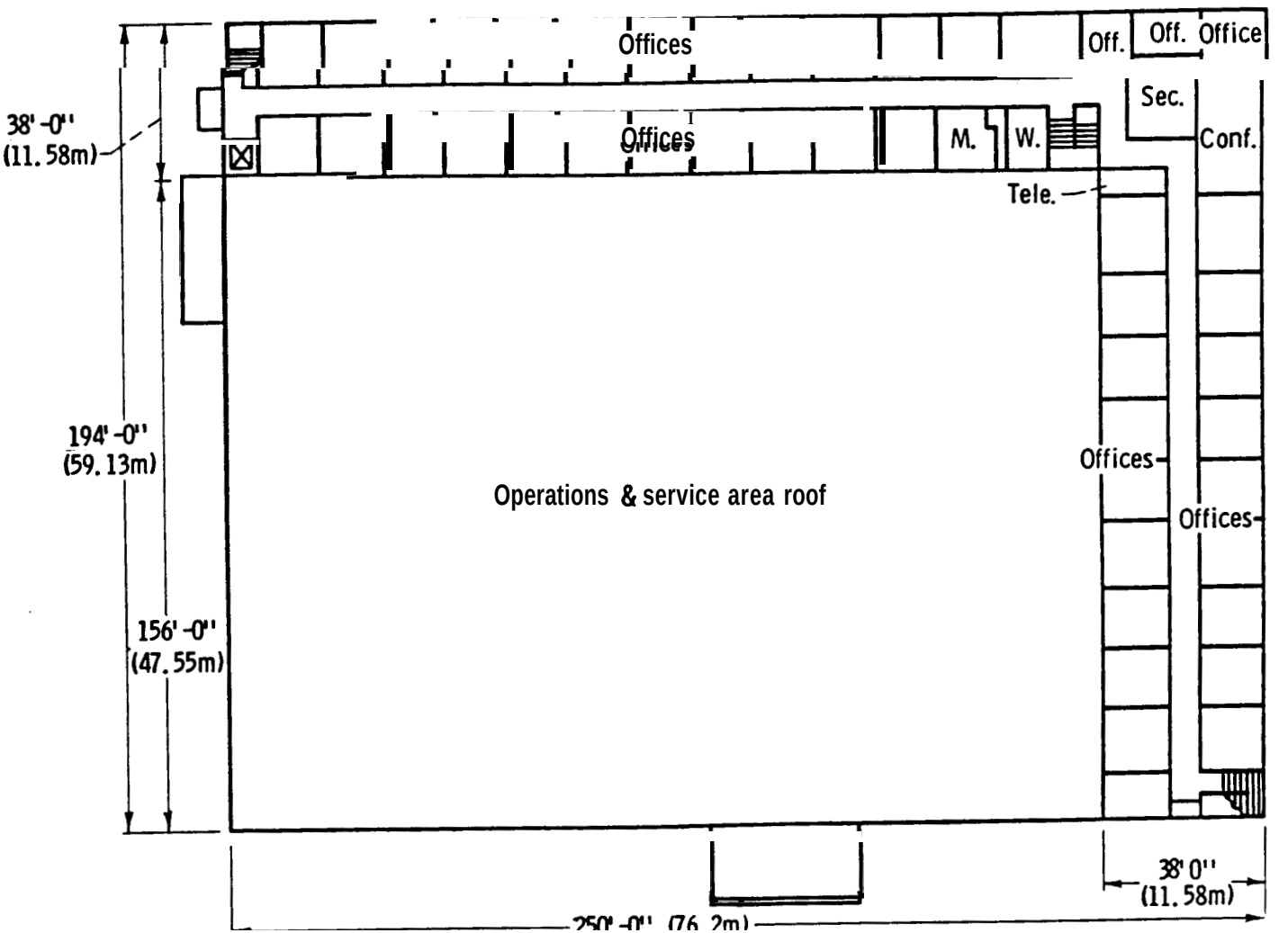
FIGURE 2

CF 5-6

LEWIS RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

CONSTRUCTION OF THE RESEARCH ANALYSIS CENTER



2nd floor plan

FIGURE 3

CF 5-7

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

SUMMARY

LARGE AERONAUTICAL FACILITIES

	Amount	Page No.
Office of Aeronautics and Space Technology:		
Construction of national transonic facility (NTF)	24,500,000	CF 6-1
Modification of 40- by 80-foot subsonic wind tunnel (ARC)	31,600,000	CF 6-17
Total	56,100,000	

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY
LOCATION PLAN

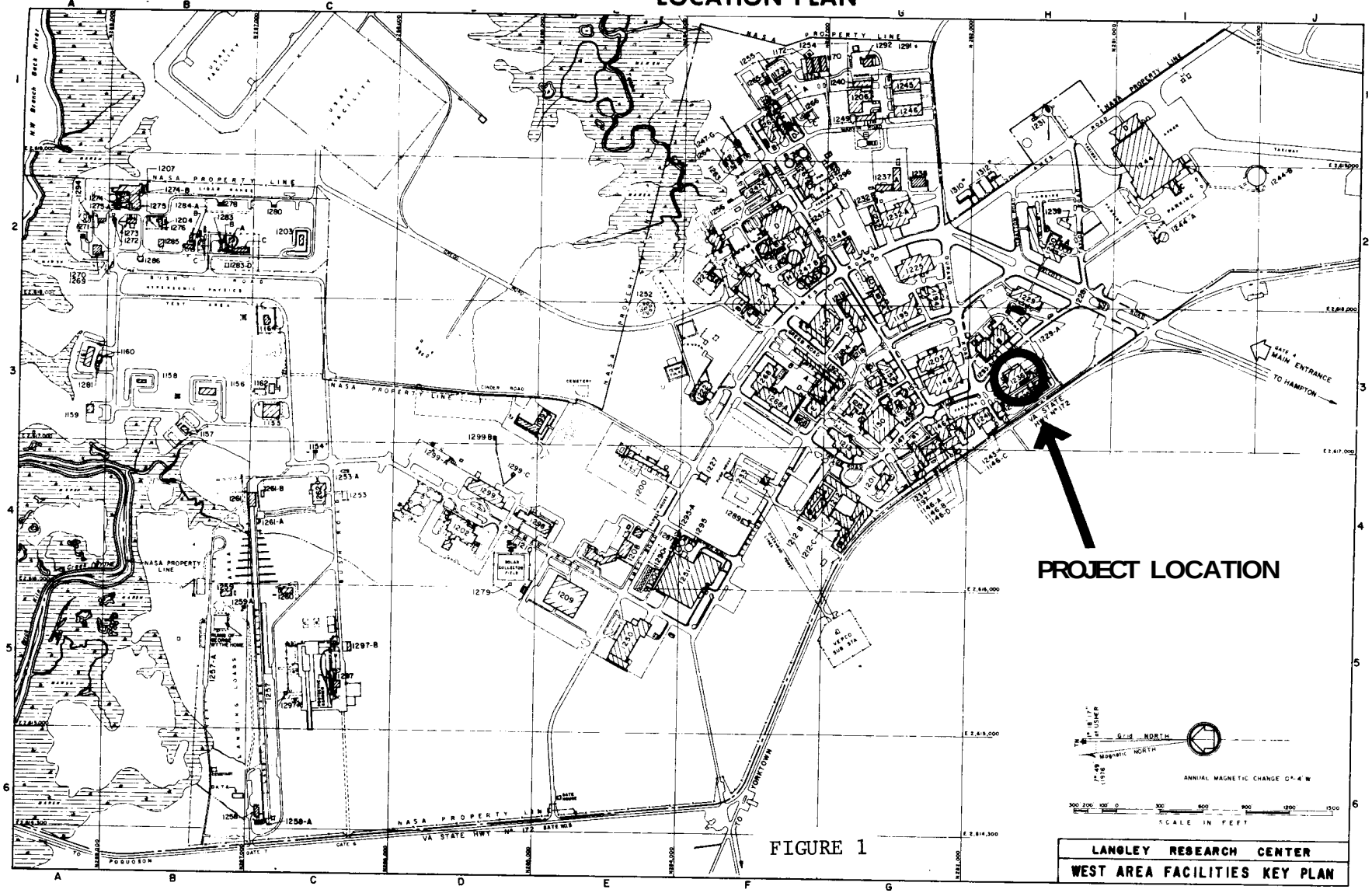


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLES: Construction of National Transonic Facility

INSTALLATION: Langley Research Center

FY 1979 CoF ESTIMATE: $24,500,000

LOCATION OF PROJECT: Hampton, Virginia

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	6,800,000	48,500,000	55,300,000
Other affiliated funding	---	4,942,000	4,942,000
Total	6,800,000	53.442.000	60.242.000

SUMMARY PURPOSE AND SCOPE:

Construction of the National Transonic Facility (NTF) at Langley Research Center (Figure 1) began with N 1977 and will continue with this requested funding. This facility, a transonic wind tunnel which will serve the research needs of NASA and the development testing needs of DOD and the aerospace industry, will provide a totally new and vital capability to test a broad spectrum of aeronautical vehicles, including civilian, commercial, military, as well as space vehicles, at full-scale Reynolds numbers. It will employ a cryogenic test medium for achieving high Reynolds numbers without excessive model loads or power requirements. This will involve injection and subsequent evaporation of liquid nitrogen to develp the extremely low temperature test medium in an otherwise conventional fan-driven closed circuit wind tunnel. With temperature, pressure and speed independently controlled, the facility will permit clear separation of aeroelastic, Mach number and Reynolds

number effects on the aerodynamic performance of test configurations. The capability to separate these effects has heretofore been unattainable in ground facilities. Thus, when completed, the new tunnel will provide an entirely new realm of research capability geared not only to Reynolds numbers, but also to the ability to investigate other significant aerodynamic parameters independently of one another.

Funding requested for FY 1979 will be used to complete both the tunnel pressure shell and fabrication of the tunnel structural components. It will also provide for installation of the tunnel insulation and liner, as well as continuation of work on the special piping system, tunnel drive system, and fan components. It will support the beginning of construction on almost all of the remaining NTF work packages. These include the site work and building; installation of the tunnel structural components; the cooling coil; the process control system; the data acquisition/research instrumentation system, and the electrical systems.

The relationship of the FY 1977, FY 1978, FY 1979, and future funding requirements is summarized in (Figure 8).

Analysis of project schedules and project management capabilities indicate that scheduling resources in several consecutive years as is done for this project, will not adversely affect the operational schedule for this large facility. At present, the NTF is expected to be operational in early to mid-1982. Considerable preliminary engineering, special studies and design have been completed and final design was begun in October 1975. Actual construction was initiated in late 1976.

PROJECT JUSTIFICATION:

World leadership in aircraft design and the superiority of U.S. military flight vehicles are heavily dependent upon ongoing research and new technology. In recent years, an urgent need has developed for several new ground facilities for aerodynamic testing at transonic speeds and at flight Reynolds numbers. This need is supported by the Department of Defense, the U.S. aerospace community, and by the North Atlantic Treaty Organization Advisory Group for Aerospace Research and Development (AGARD). In spite of spectacular advances in aerodynamics during the last 20 years, a number of leading aircraft developments have encountered difficulty because of misleading or inadequate wind tunnel testing data in the transonic regime. Experimental data obtained from existing low Reynolds number transonic wind tunnels often is inadequate to predict flight vehicle performance. This is because a vehicle traveling at transonic speed experiences supersonic air flow velocities over portions of its surface area, thereby leading to unsteady flow conditions where Reynolds number sensitive shock/boundary layer interaction effects occur. While the transonic flight environment is common to a broad spectrum of flight vehicles--such as civilian, commercial, military, and space--this "Reynolds number sensitive" aerodynamic environment generally does not lend itself to analytical study and thus requires accurate experimental data at or near flight Reynolds numbers for an adequate solution.

A wind tunnel permitting accurate experimental measurement at transonic speeds approaching flight Reynolds numbers is therefore necessary for the continuing development of new technology. This will allow increases in

the efficiency, performance, size and range of civil and military aircraft. Thus, the urgency of the new testing capability suggests that this facility be completed at the earliest possible time.

When operational, the NTF will provide the test capability to meet the high Reynolds number, transonic speed regime technology development requirements of NASA, DOD and industry. Current planning projects that NASA programs will use approximately 40% of the test time available, DOD also 40%, and industry 20%. To meet these program needs the tunnel will be operated on a two-shift basis. Cryogenic operation of the NTF is expected to amount to about 75% of the total annual usage, and consume on the order of 90-120 thousand tons of liquid nitrogen per year.

The capability to simulate full-scale Reynolds numbers on a model in a wind tunnel at Mach numbers near 1.0 requires a workable test section size of 8.2 x 8.2 feet (2.5 m x 2.5 m) with a maximum operating pressure of about 130 psia (896,000 newtons per square meter). It also requires run times long enough to permit accurate data measurements in all areas of aerodynamic research. The quality of the test air flow should be of the highest practical level. There are no known wind tunnels in the United States or Europe that will satisfy these requirements. The need for an aeronautical test facility with these capabilities was confirmed in FY 1977 and again in FY 1978 in which years $25 million and $23.5 million, respectively, were made available for construction of the NTF. The FY 1979 request is for resources to continue work already begun on this facility.

PROJECT DESCRIPTION:

FY 1979 resources will provide the third sequential funding element for the construction of a fan-driven closed circuit wind tunnel as shown in (Figure 4). It will be 200 feet (61 m) long, 48 feet (14.6 m) wide, will vary in diameter from 40 feet (12.2 m) to 11 feet (3.4 m), and will have an operating pressure range from 14.7 psia (101,400 newtons per square meter) to a maximum of 130 psia (896,000 newtons per square meter) and an operating temperature range from 155°F to - 300°F (341.5°K to 88.7°K). Cryogenic temperatures will be obtained by evaporating liquid nitrogen that has been injected into the tunnel circuit. The cryogenic approach is now the most effective energy conserving technique for achieving high Reynolds numbers without excessive model loads. The tunnel pressure shell will be fabricated from stainless steel and will be insulated internally to contain the cold gas. A fixed-pitch single-stage fan will drive the tunnel air flow through an 8.2 x 8.2-foot (2.5 m x 2.5 m) slotted test section to produce Mach numbers ranging from 0.2 to 1.2.

A three-dimensional model support system (Figure 5) having an angle of attack range of 30 degrees will be installed in the test region. A roll mechanism will be an integral part of the support system, capable of rolling the model through 180 degrees. Windows in the walls of the slotted test section will be provided for remote television viewing of the model under test.

The NTF is being constructed on the site of the recently demolished 4 x 4-foot (1.2 m x 1.2 m) Supersonic Wind Tunnel (4-foot SWT) (Figure 2) and will incorporate the electric motor drive system of that tunnel. These motors, which will provide approximately half the total operating power required, are rated at 47,000 HP (35,062 kW) for continuous duty. They are capable of 70,000 HP (52,220 kW) for run times up to 10 minutes. A two-speed gear system (Figure 6) will be provided to match the fan with motors at both ambient and the full-range of cryogenic temperatures. A speed control system will be provided to achieve a constant torque from the motor over a wide range of revolutions per minute to improve the power characteristics of the motors for this new application. A new 60,000 HP synchronous drive motor (44,760 kW) (10 minute rating) will be installed to provide the additional power required to achieve the higher Reynolds numbers. The facility will use the existing cooling tower, pumps, auxiliary equipment and buildings. A new two-story shop addition (Figure 3) of approximately 33,500 square feet (3,112 m^2) will accommodate the larger transonic test section. The shop will include space for a control and data acquisition room, and for an improved model preparation area. Adequate controls, process monitors, and data acquisition systems are included in this project.

A liquid nitrogen storage and supply system will accommodate nitrogen flows to the tunnel at rates up to about 1,100 pounds per second (499 kg per second). This is required to remove the heat generated by the fan during constant cryogenic temperature operation. Additionally, a pressure control and venting system is provided to maintain constant pressure during data gathering. The vent will feed into an exhaust stack acoustically designed to satisfy environmental standards.

Both the design and construction of this project are being managed on a "work package" basis. Each of the "work packages" contains all elements of work to be accomplished through separate procurement, scheduling, and cost control. This approach is particularly effective for an extremely complex facility such as this because it results in better project management, improved competition, and better functional and cost-effective designs.

FY 1977 funding provided for the demolition and removal of nonreusable portions of a 4 x 4-foot (1.2 m x 1.2 m) Supersonic Wind Tunnel (located on the NTF site). It also provided for the driving of piles and construction of virtually all foundations required for the new tunnel, as well as the first increment of the tunnel pressure shell fabrication and erection. Additionally, initial funding provided for the first increment of the new drive system and fan components.

FY 1978 funding provided for completion of the foundations, continuation of the tunnel pressure shell fabrication and erection, purchase of the tunnel insulation and liner, and construction of the liquid nitrogen storage system. It also provided for the start of work on the tunnel structure components fabrication and the special piping system. The second funding element permitted continuation of work on the tunnel drive system and fabrication of the model support system.

FY 1979 funding will provide for the completion of the tunnel pressure shell fabrication and erection (Figure 3) and the tunnel structure internal components fabrication. The tunnel pressure shell will form the general

aerodynamic shape of the tunnel circuit and is being built of rolled and welded stainless steel plate **and forgings** designed to withstand the extreme temperature and pressure fluctuations that will occur during actual tunnel operations. The tunnel structure internal components (Figure 7), to be fabricated of aluminum, will define the actual flow boundaries in the test section and fan region. FY 1979 resources will also be used to start installation of these complex and difficult to install internal components.

Also to be started with FY 1979 resources is the site work and building. This work package includes a two-story building addition (Figure 3) to house controls, data acquisition and instrumentation systems, and the test model preparation area. Included is the vent stack (Figure 2) through which the high pressure exhaust nitrogen will flow and which will attenuate associated noise to environmentally acceptable levels. Also, installation of thermal insulation and liner will begin. Insulation will be applied in layers to the inside of the tunnel pressure shell and covered with a fiberglas liner, a system that will prevent heat flow through the shell and save considerable energy during cryogenic tunnel operations.

Equipment to be provided with FY 1979 resources includes the cooling coil, the process controls, the data acquisition and research instrumentation system and the electrical systems. The cooling coil (Figure 4), an aerodynamically shaped heat exchanger, will be fabricated and installed upstream of the test section. It will serve during noncryogenic operations to remove heat generated by the fan from the flowing test medium. Also included in this work package are provisions to suitably expand the capacity of the supporting cooling tower.

Fabrication and installation of the process control system will begin. This preprogrammed, computerized system will be used to operate the tunnel in an efficient and energy conservation mode. The system will provide integrated control of fan speed, liquid nitrogen injection rates, model angle-of-attack, tunnel pressure, and the geometry of the test section cabin.

Additionally, work will start on the fabrication and installation of the data acquisition/research instrumentation system. This system will remotely sense and record tunnel operating conditions and corresponding research data from the model under test.

Finally, FY 1979 resources will be used to start fabrication and installation of electrical systems that will bring power to the facility and route it to the proper locations in the tunnel and building.

Previously started work, to be continued using this funding, includes the special piping system, the drive system, and the fan components. The special piping system includes the lube oil system, the cooling water system, the high pressure compressed air system, the vacuum system, and the nitrogen admission and venting systems. The drive system includes the new synchronous *60,000* HP *(44,760* kW) drive motor (Figure *6);* the drive shaft; associated gear boxes, clutches, couplings and bearings; and the rewinding of the existing 4-foot SWT motors. Fan components to be provided are the fiberglass fan blades and the attachment assemblies that connect the blades to the shaft-mounted fan disk assembly.

The 1982 milestone operational data is heavily contingent on this FY 1979 element of funding. Engineering estimates and the results of the first three contract solicitations indicate that the total cost of this facility may be about $82.8 million. However, the current total project cost target is $85 million. Maturing design and refined cost estimates have lent credibility to this revised total cost target of $85 million. Awards of three work package contracts (drive system; tunnel pressure shell; and demolition, piles, and foundations) for amounts within the present budget estimate have fostered even greater confidence in these current cost estimates.

However, as design is incomplete and some potential "risks" still exist, a project estimate range of $85-90 million is still considered to be realistic. Prime among the potential problem areas is the fabrication and installation of the tunnel structure internal components. As can be seen in (Figure 7), these componentsarevery large, consist of many compound curved surfaces, and must be put in place as the tunnel pressure shell is being erected. Other difficult problem areas are:

- Noise attenuation systems - fabrication and installation of vent system mufflers that will lower vent stack noise to acceptable levels; and fabrication of acoustic panels to be installed in the €an nacelle region to attenuate fan noise *so* that test section data is not adversely affected.

- Thermal insulation - fabrication and installation of the insulative liner to the tunnel pressure shell which will stand up to cryogenic tunnel operations over an expected 50-year life.

- Cooling coil - difficulties of fabricating an aerodynamically efficient cooling coil, especially the connections of elliptical coils to cooling fins and supports.

- Controls optimization - math modeling of the various systems (fan speed, liquid nitrogen injection rate, tunnel pressure, etc.) to develop the most efficient controls for rapid change of the test environment.

- Seals - development of seals, to be placed between movable components, that will render repeated good performance in the cryogenic environment.

There is growing confidence that these problems are manageable and can be solved within the target cost, but recognition of these "unknowns" at this time is prudent.

A final environmental impact statement (EIS) for this project has been prepared and fully circulated. As indicated in the EIS, proper design, construction, and controlled operation of the completed facility will mitigate possible environmental effects, such as noise, venting of large volumes of nitrogen gas, and the possible formation of ground fog caused by venting cold nitrogen gas.

Although several studies and final design pertaining to these areas of concern are not yet complete, findings to date indicate that acoustical treatments of the tunnel drive system and the vent stack will reduce noise to

acceptable levels. Similar efforts, including pilot vent stack operation, indicate that the nitrogen can be satisfactorily vented without adverse effects. However, there may be occasions when prevailing atmospheric conditions will require the mode of tunnel operation be somewhat modified to insure avoidance of a ground fog "problem" which might otherwise be caused by the venting of cold nitrogen gas. Work is continuing to develop the most effective combination of equipment and operational parameters to deal satisfactorily with these problems; however, it is not now felt that any of these will become impediments or offer any significant operational constraints.

PROJECT COST ESTIMATE:

The basis of this cost estimate is advanced final planning.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition	---	---	---	---
Construction				9,400,000
Site work and building	LS	---	---	3,900,000
Tunnel pressure shell: materials fabrication, and erection (Increment III)	LS	---	---	2,600,000
Tunnel structure components fabrication (Increment II)	LS	---	---	800,000
Tunnel structure components installation	LS	---	---	900,000
Insulation and liner	LS	---	---	1,200,000
Equipment	---	---	---	15,100,000
Special piping system (Increment 11)	LS	---	---	700,000
Cooling coil	LS	---	---	1,500,000
Tunnel drive system (Increment III)	LS	---	---	4,400,000
Fan components (Increment 11)	LS	---	---	900,000
Process control system	LS	---	---	3,800,000
Data acquisition and research instrumentation	LS	---	---	2,800,000
Electrical systems	LS	---	---	1,000,000
Fallout Shelter (not feasible)	---	---	---	---
Total				24.500.000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Perspective (Plan) View
Figure 3 - Second Floor Plan and Tunnel Layout
Figure 4 - Aerodynamic Lines
Figure 5 - Test Section Elevation
Figure 6 - Fan Drive System
Figure 7 - Tunnel Structure Components
Figure 8 - Funding Plan

OTHER EQUIPMENT SUMMARY:

Existing collateral equipment consisting mainly of the electric drive motors and a portion of the building for the 4x4-Foot Supersonic Wind Tunnel (4-Foot SWT) will be used in this facility. The estimated replacement value of this is about $14 million. Although no other noncollateral equipment is required to complete this facility and operate it for its intended purpose, it is anticipated that special mounting "jigs," data gathering devices, and related research and development computer software will be needed for activation of the facility and its aerodynamic test programs, These needs cannot be precisely identified until the tunnel construction is complete and actual tunnel flow parameters are found through startup operations. However, it is anticipated that the software will cost no more than $400,000 and that some of the equipment will be provided from existing inventories. Additional items will be purchased as the special need arises.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

To complete the construction of the National Transonic Facility, some $8-12 million additional probably will be required.

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY
PLAN VIEW

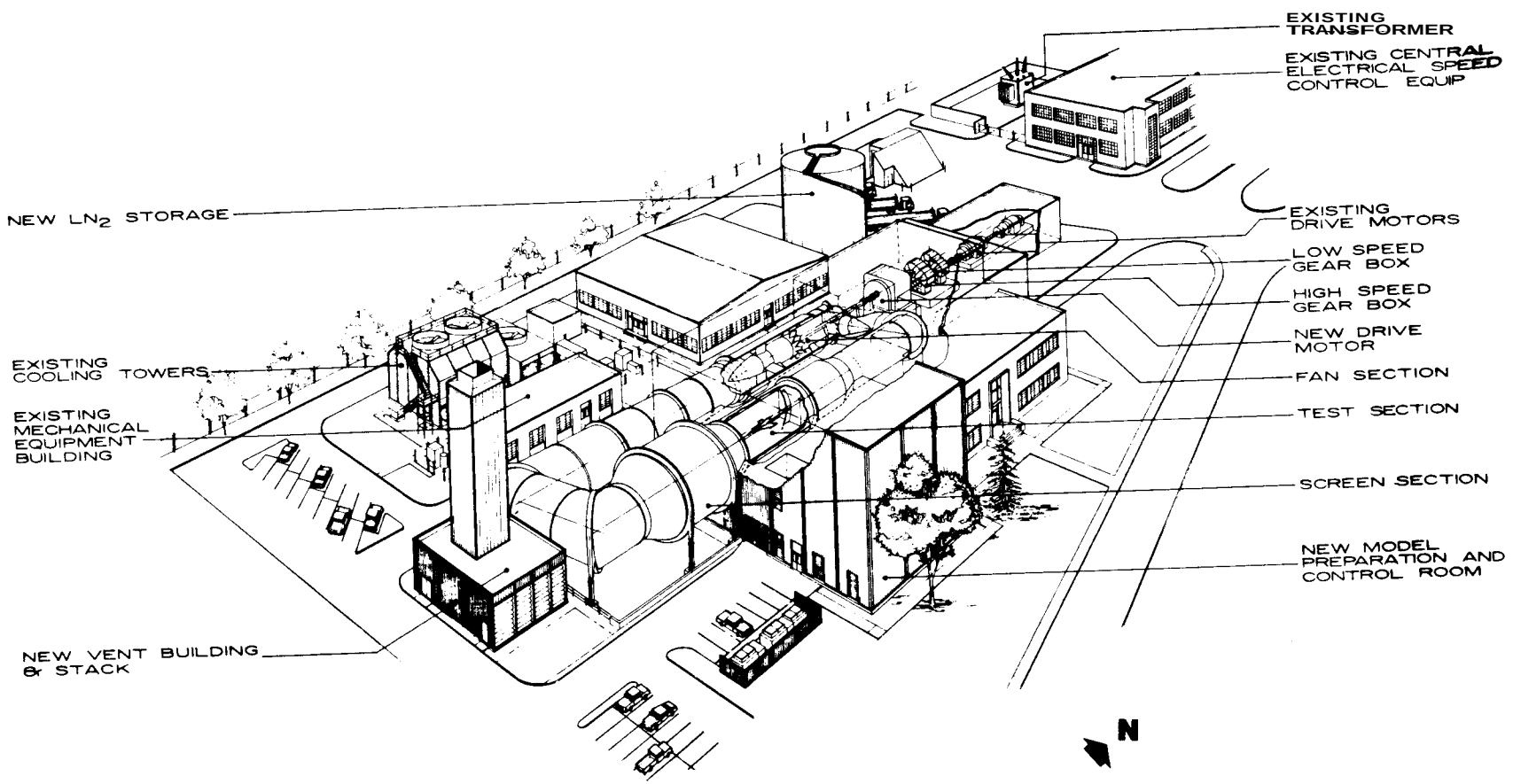


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FIGURE 2

LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY
SECOND FLOOR PLAN AND TUNNEL LAYOUT

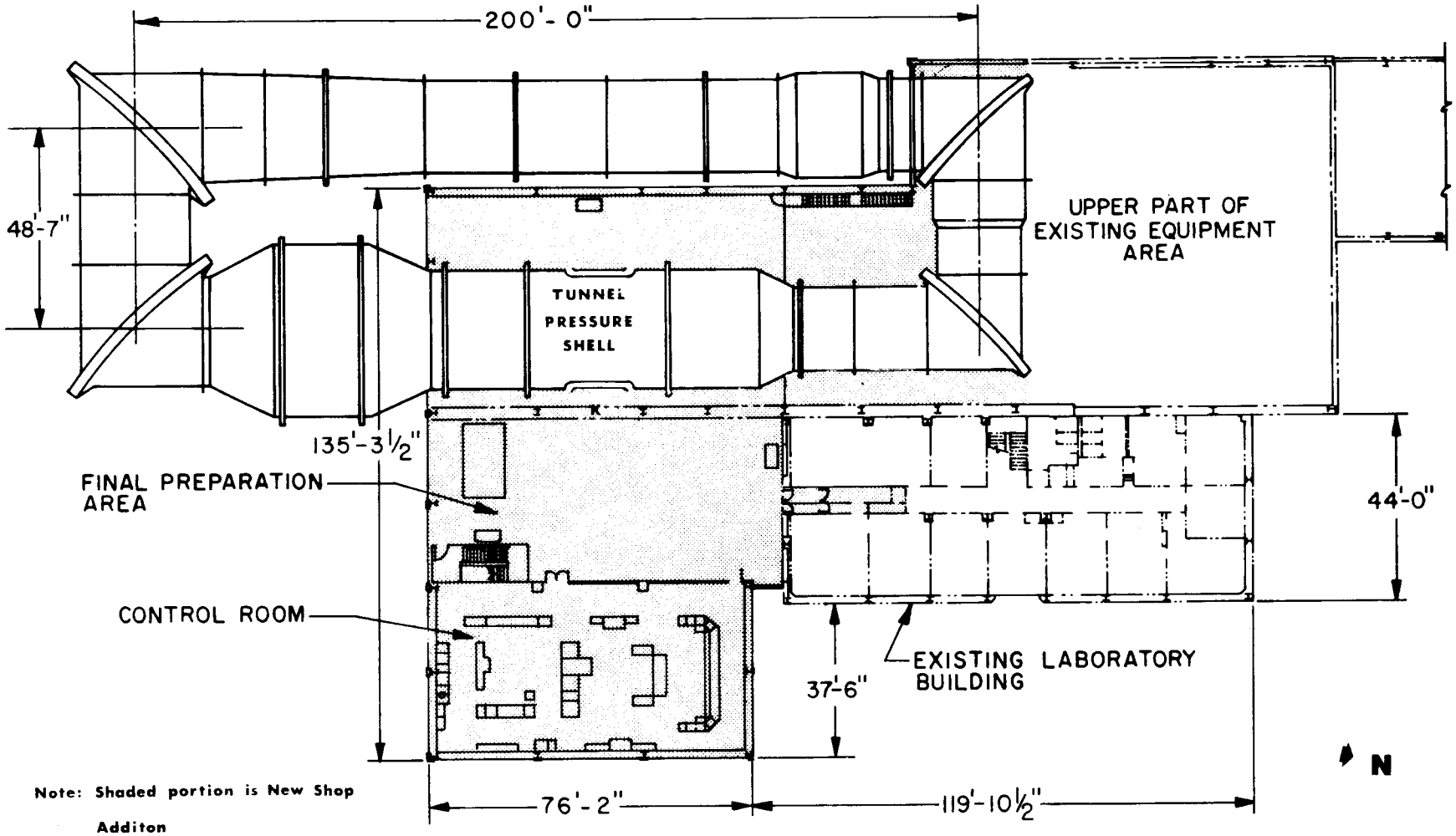


FIGURE 3

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY AERODYNAMIC LINES

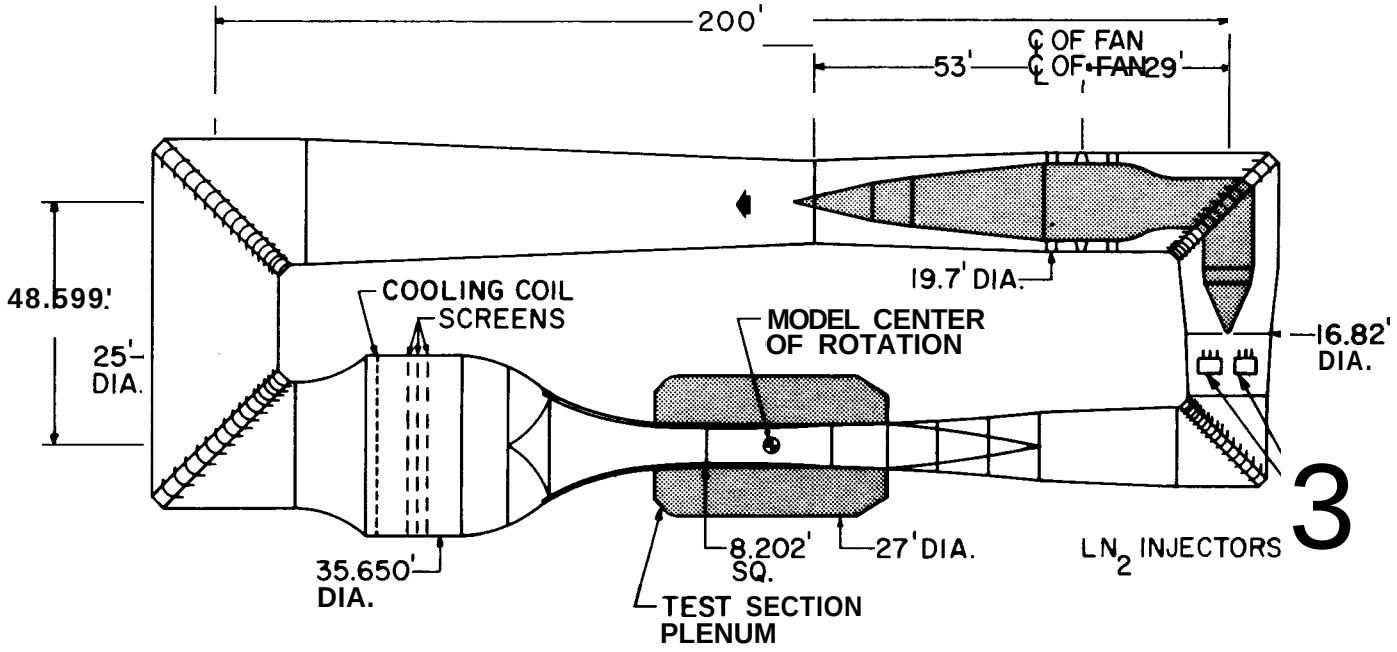


FIGURE 4

LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY
TEST SECTION ELEVATION

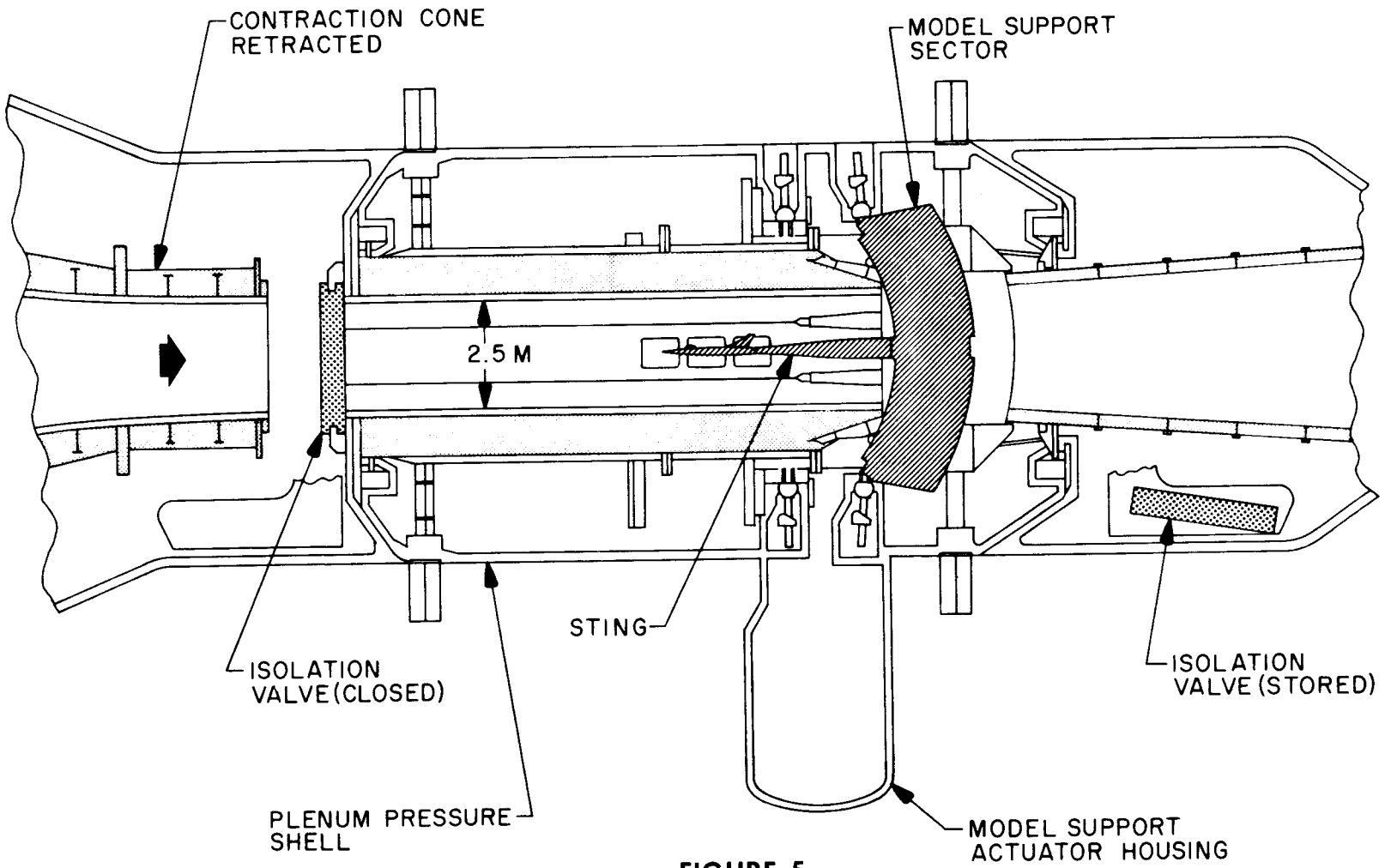
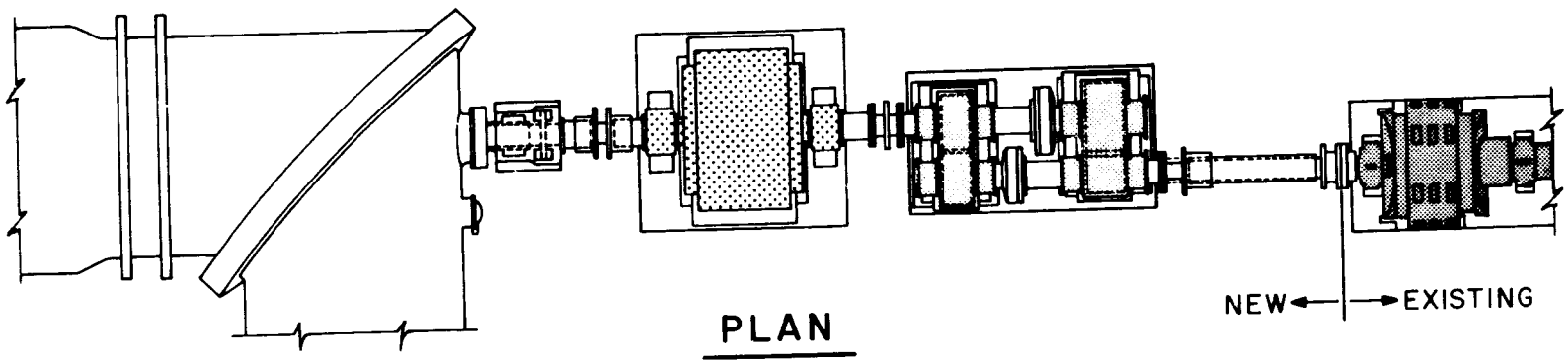


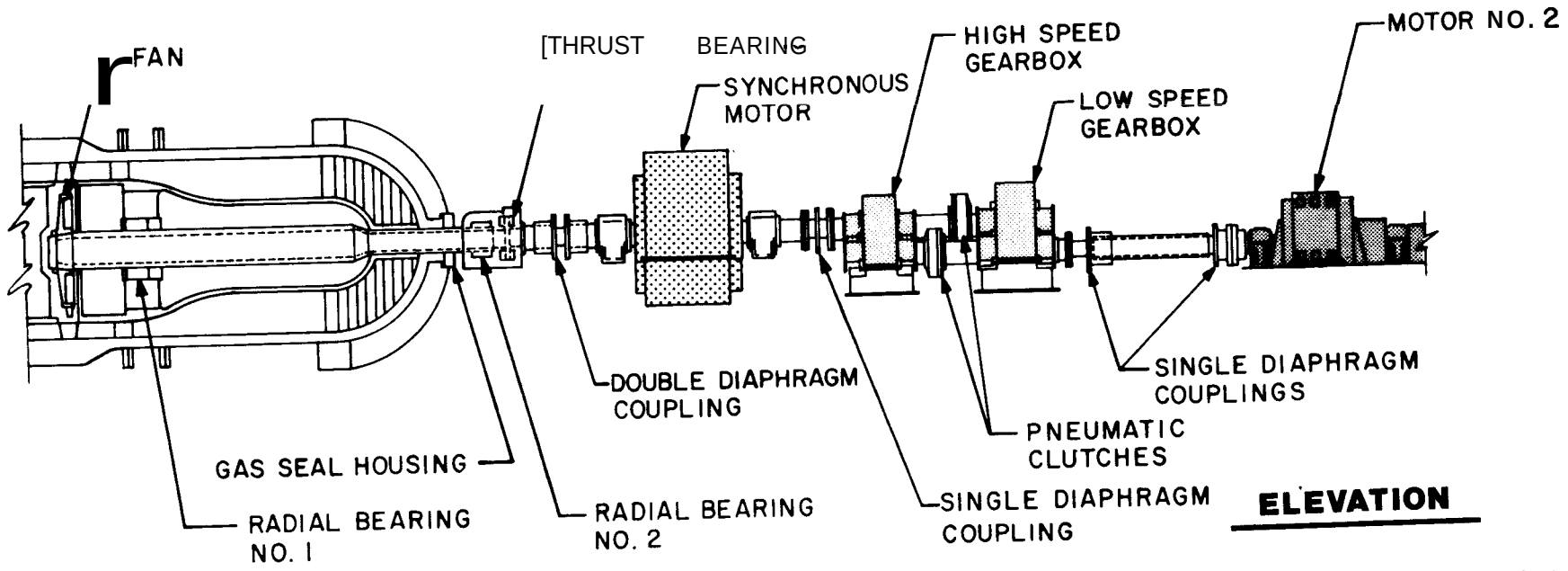
FIGURE 5

LANGLEY RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY
FAN DRIVE SYSTEM



PLAN



ELEVATION

FIGURE 6

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY
TUNNEL STRUCTURE COMPONENTS

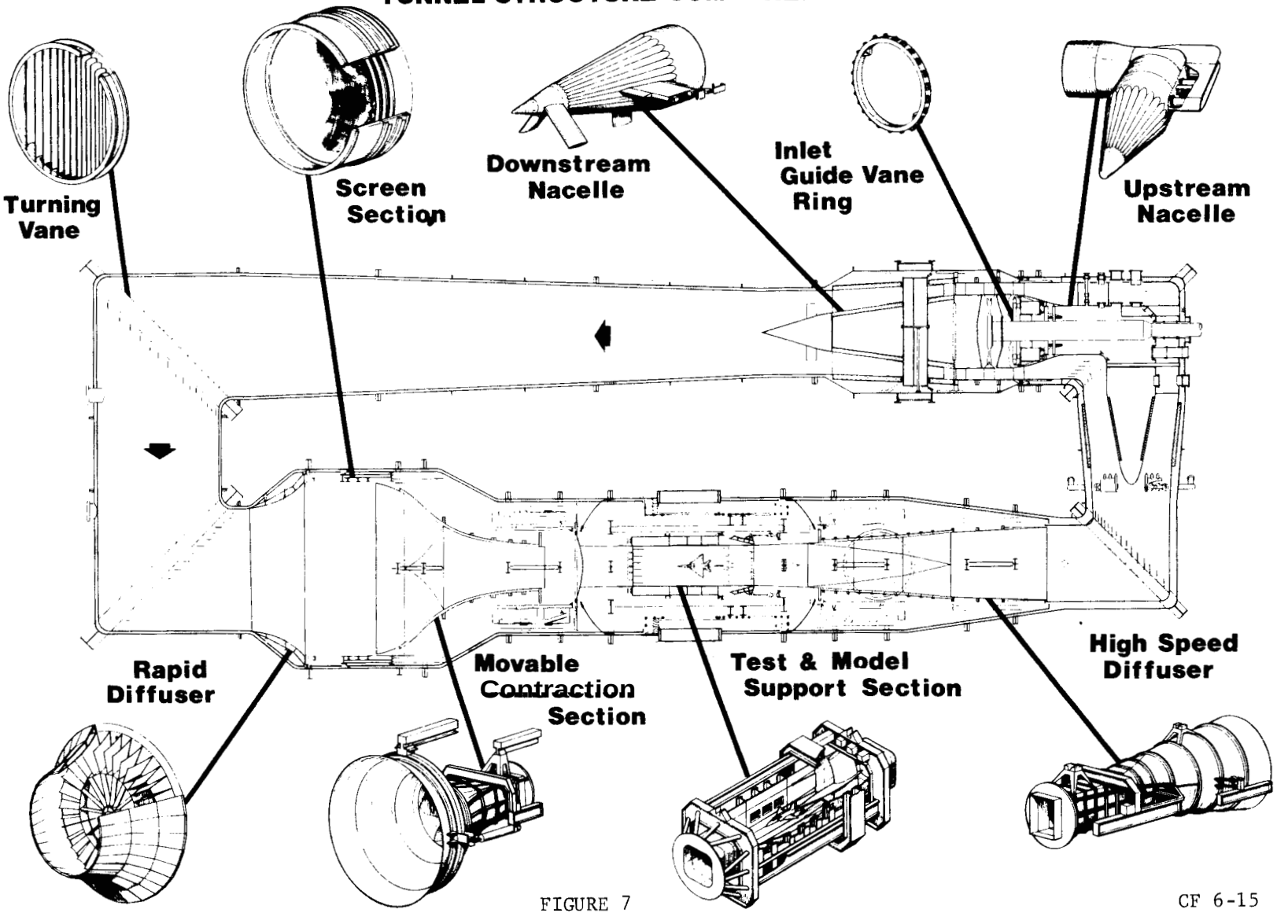


FIGURE 7

LANGLEY RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

CONSTRUCTION OF NATIONAL TRANSONIC FACILITY

FUNDING PLAN
(Millions of Dollars)

	FISCAL YEAR			
	1977 & 1978	1979	Future	Total
CONSTRUCTION	37.8	9.4	4.5	51.77
Demolition, piles, and foundations	1.2	---	---	1.22
Site work and building	---	3.9	.7	4.66
Tunnel pressure shell	22.3	2.6	---	24.99
Tunnel structure components fabrication	11.4	.8	---	12.22
Tunnel structure components installation	---	.9	2.4	3.33
Insulation and liner	2.2	1.2	1.4	4.88
Nitrogen storage	.7	---	---	.77
EQUIPMENT	10.7	15.1	5.3	31.11
Special piping system	3.4	.7	1.3	5.44
Cooling coil	---	1.5	.8	2.33
Tunnel drive system	5.2	4.4	2.7	12.33
Fan components	.6	.9	.1	1.65
Model support system	1.5	---	---	1.55
Process control system	---	3.8	---	3.83
Data acquisition and research instrumentation	---	2.8	.1	2.99
Test section side access system	---	---	.2	.22
Model handling equipment	---	---	.1	.11
Electrical systems	---	1.0	---	1.00
TOTALS				
By year	48.5	24.5	9.8	82.8
Cumulative	48.5	73.0	82.8	---

Figure 8

AMES RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES
LOCATION PLAN

MODIFICATION OF 40 x 80 FT.
SUBSONIC WIND TUNNEL

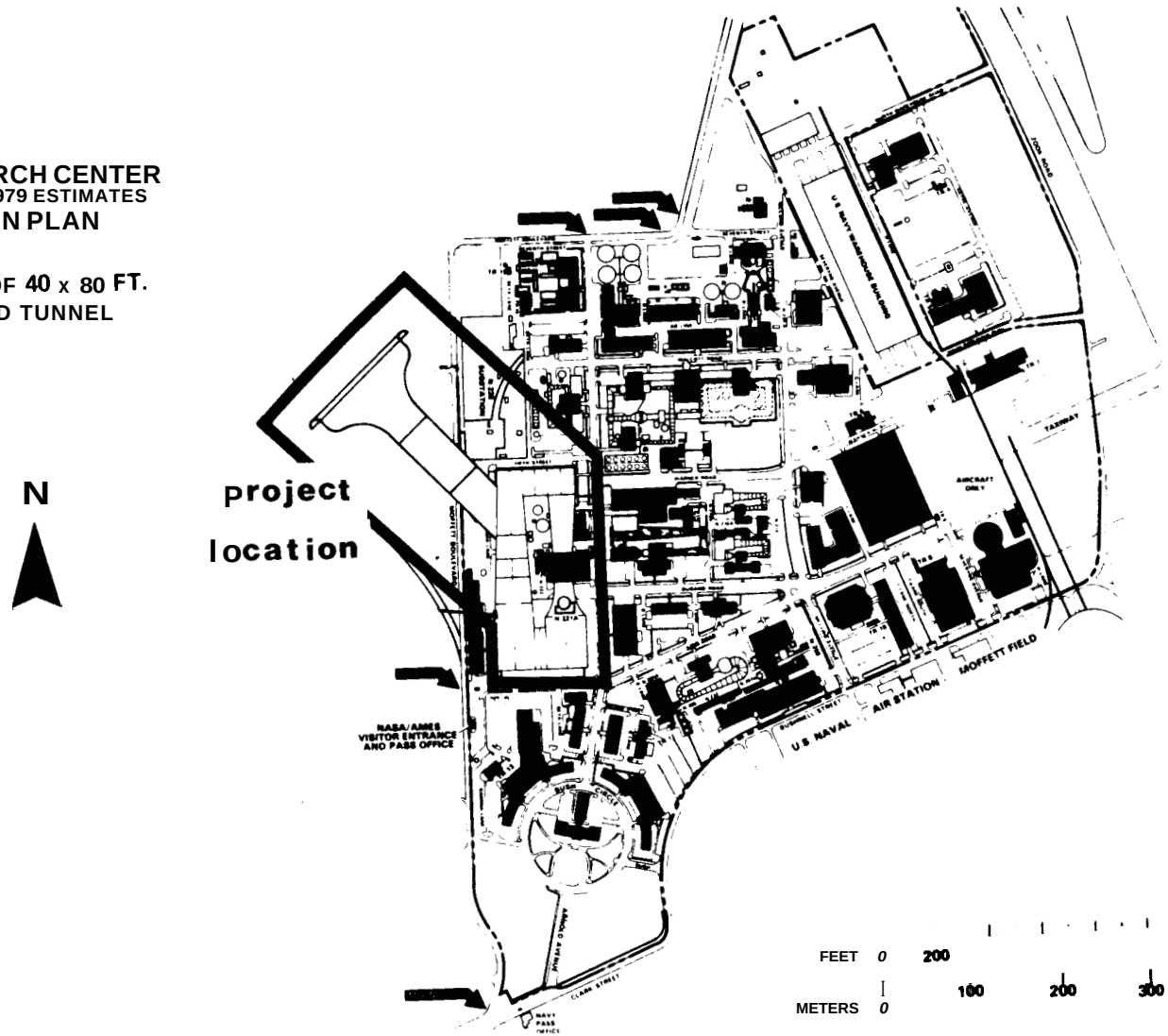


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FIGURE 1

CONSTRUCTION OF **FACILITIES**

FISCAL **YEAR** 1979 ESTIMATES

PROJECT TITLE: Modification of *40*- by 80-Foot Subsonic Wind Tunnel

INSTALLATION: Ames Research Center

FY 1979 CoF ESTIMATE: $31,600,000

LOCATION OF PROJECT: Moffett Field, Santa Clara County, California

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY *1978* AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	*3,870,000*	*19,500,000*	*23,370,000*
Other affiliated funding	---	16,747,000	16,747,000
Total	*3,870,000*	*36,247,000*	*40,117,000*

SUMMARY PURPOSE AND SCOPE:

These resources will provide for continuing the modification of the *40*- by 80-Foot (12.2 m X *24.4* m) Subsonic Wind Tunnel at Ames Research Center (ARC). The modified facility will permit the testing of rotorcraft at speeds up to 300 knots *(154* meters per second). Additionally, a new *80* X 120-Foot *(24.4* m X *36.6* m) test section, which is part of this total modification project, will allow for the testing of full-scale vertical and short takeoff and landing (V/STOL) aircraft in the speed range of 5 to 100 knots *(2.6* to 51 meters per second). The location of the *40* X 80-Foot Subsonic Wind Tunnel is shown in (Figure **1).** The major items of work involved in this total project are shown in (Figure 2). This project is being implemented with multi-year resources of which the FY *1979* estimate is the third increment. **It** is planned that one added year of funding will be necessary to complete the project.

PROJECT JUSTIFICATION:

Modifications to the *40-* by 80-Foot Subsonic Wind Tunnel will provide a national facility with a capability for research as well as development testing of full-scale rotorcraft and V/STOL aircraft. Both civil and military rotorcraft have advanced significantly in speed capability over the last decade and can no longer be adequately evaluated in any existing test facility. Furthermore, V/STOL technology exemplified by the Advanced Harrier AV-8B and the Navy Multi-Mission V/STOL aircraft has advanced to the extent that full-scale testing of flight configurations is now required. This manner of testing is essential to optimal solution of the complex problems of propulsion system/airframe structure/control interactions.

The usefulness of wind tunnel testing prior to flight testing has been demonstrated in a wide variety of test programs conducted in this facility in the past three to five years. These include V/STOL aircraft such as the OV-10A, XV-5, H-126, and AV8B; STOL aircraft such as the F-14, F-15, F-111B, and A-37; rotorcraft such as the XV-15, AH-56A, and ABC flight rotor; propulsion systems such as the Q-Fan and J-79; recovery devices such as the B-77 drogue chute and full-scale parawings; and the space shuttle orbiter. In spite of these successful testing programs, the growing limitations of current test facilities were recognized as early as 1967 by the Aeronautics and Astronautics Coordinating Board (AACB). It was AACB initiated studies that ultimately suggested a modification to the *40-* by 80-Foot Subsonic Wind Tunnel.

Initial studies addressed the feasibility of constructing a new full-scale wind tunnel which would accomplish defined testing requirements. The projected cost of $300 million (1973 dollars) was considered excessive and alternative solutions were then pursued. Subsequent studies showed that essentially the same capability could be achieved by retrofitting the *40* X 80 drive support structure with a new generation drive system and by the addition of a new test leg. Since this modified tunnel would satisfy most testing needs at considerable monetary savings, it was presented to and subsequently approved by the AACB in 1973. The tunnel will not be available for research for a period of 10 to 12 months starting in about May of 1980 when construction and calibration activities will be accomplished. The primary impact of this downtime will be on NASA's long-range test programs, which may be delayed with minimum program disruption, There are no known programs from other agencies which must be accomplished during this period.

The higher wind speed provided by the modified *40-* by 80-foot test section is necessary to properly evaluate high speed rotor systems presently under development for both civil transport and military mission roles. Aerodynamic response of rotorcraft systems, for instance, can be best understood by wind tunnel studies. These studies lead to economical and structurally acceptable designs while reducing noise levels and improving flight performance. The Rotor Systems Research Aircraft (RSRA) and the XV-15 typify the kinds of advanced rotorcraft which require the increased speed capability of the modified tunnel.

The large 80 x 120-foot subsonic test section is needed to eliminate the tunnel wall interference problems and the large wake "downwash angles" which are peculiar to powered lift. Conventional aircraft also require a large test section to study the performance of high lift devices which are Reynolds number sensitive and difficult to reproduce accurately at less than full-scale. Certain mechanical and structural aspects of high lift systems, such as air leaks and deflection under load, can significantly affect test results of aerodynamic performance. The main problem for V/STOL aircraft is usually the propulsion system and its interface with the aircraft. Certain components of the propulsion system (rotor or fan blades, inlets, vectoring devices, etc.) operate in the range of Reynolds numbers where significant variations in aerodynamics occur. Additionally, there are important aeroelastic, mechanical, and structural aspects of these propulsion systems that require extensive experimental studies using full-scale or flight hardware. The major technical risks of V/STOL aircraft employing low-disk-loading rotor systems are associated with dynamic loads, dynamic stability, and control of the rotor system. These characteristics are highly dependent on the unsteady aerodynamic force inputs to the rotor and on the dynamic characteristics of the rotor and its control system, including backlash, breakout forces, and nonlinear effects. V/STOL aircraft which employ high disk-loading, direct-lift propulsion systems develop problems in hovering and in the transition to wing-supported flight. The lift propulsion system, in the transition flight regime, is generally required to operate in a highly distorted unsteady and turbulent flow field. Resulting high vibratory loads on fan blades, may produce catastrophic failures in flight due to fan or engine stalling. It is therefore essential that the characteristics of the propulsion system, as installed in the aircraft, be determined in ground-based facilities prior to committing the hardware to flight. Again, the Tilt Rotor Research Aircraft (XV-15) now being developed is typical of a low disk-loading V/STOL aircraft which requires full-scale wind tunnel testing.

It is anticipated that approximately 70% of the available wind tunnel time will be devoted to such research work as: rotor aerodynamic/dynamic interactions; aerodynamic/propulsion interactions; engine/airframe integration; V/STOL propulsion control systems; and noise/gust alleviation. Developmental problems of rotor-craft and V/STOL aircraft will consume the remaining wind tunnel time. These developmental problems include configuration definition, system integration and evaluation, and performance improvement. NASA, in general, will sponsor the research activities with DOD and industry being largely responsible for the developmental areas of usage.

Additional program responsibilities recently assigned to Ames Research Center has altered the schedule requirements for the modified *40-* by 80-Foot Subsonic Wind Tunnel. A three,shift per day, 5-day week is now projected to meet these programmatic demands in 1982 rather than the initial 2-shift, 5-day per week condition. The available test time projected for this facility will be shared by NASA (70%), DOD (25%), and industry working on DOD programs (5%).

In summary, successful research and developmental testing of civil and military advanced rotorcraft and V/STOL aircraft now being scheduled require that the *40-* by 80-Foot Subsonic Wind Tunnel be repowered to increase the maximum wind speed and be modified to incorporate the new test leg by early FY 1981. Funding must

therefore be continued for those contracts whose procurement was initiated with prior year resources and for "new leg" construction which is to be accomplished in FY 1979. Additional resources will also be required in a subsequent year to complete this project.

PROJECT DESCRIPTION:

Repowering will increase the maximum wind speed of the 40 x 80-foot test section from 200 to 300 knots. This increased capability will be achieved through an increase in drive system power. The six existing 6,000 HP (4,500 kW) induction motors will be replaced with six new 22,500 HP (16,800 kW) synchronous motors, and the existing 6-bladed, fixed-pitch fans will be removed and new 15-blade, variable-pitch fans (see Figures 3 and 5) will be installed. The total drive system will be increased to 135,000 HP (101,000 kW) from 36,000 HP (27,000 kW). The wind tunnel will be repowered within the present drive-section structure. Frequency control for varying fan rotational speed will be provided by the existing motor generator set which will require some modification. This combination of variable-pitch fans and frequency control will provide a precisely controlled speed range of 5 to 300 knots (2.6 to 154 meters per second) within the 40 x 80-foot test section. The present wind tunnel framing will require structural reinforcement to support increased air loads.

Figure 2 shows the 80 x 120-foot test leg which will be added just upstream of the drive motor section. This new leg will include the new test section transition and flow-directing equipment, the entrance cone, and sound muffling treatment. Air will be inducted at the entrance cone, flow through the 80 x 120-foot test section, the drive motor section, and portions of the existing wind tunnel circuit and finally exhaust to the atmosphere through the new exist vanes. Air flow diversion vanes and louvers, together with adjustable turning vanes, will be installed to permit operation in either the 40 x 80 or in the 80 x 120-foot mode.

Proper siting of the new test section "leg" requires the relocation of a part of the Ames Electrical power substation together with the acquisition of approximately 5 acres of land belonging to the Pacific Gas and Electric Company (PG&E). It is planned that an equal amount of Government land will be exchanged for the PG&E property. The land adjustment has been agreed upon by both parties and is being processed by the General Services Administration. As illustrated in (Figure 4), NASA property, shown in Plot B, is to be exchanged for PG&E property, shown as Plot A. A portion of the electric power substation will be relocated to the vicinity of Plot B. NASA has obtained a "Land Use Agreement" with the Navy which allows for construction of a public road to the planned new PG&E location through the Navy's property, designated as Plot C.

The entire project is being funded over a period of several fiscal years. The funding plan for FY 1977, FY 1978, FY 1979, and the future is summarized by work packages and totals in (Figure 6). The FY 1977

increment provided for the initiation of procurement for the main drive motors and controls, the fan and stator blades, the fan hub and variable pitch mechanism and the relocation of the Ames' electrical power substation. These long-lead items are to be funded over the subsequent two or three fiscal years. The second increment of funding for the long-lead items was included in the **FY** 1978 estimates. Additionally, FY 1978 resources also provided for the initial sitework, structural modifications, and the new balance and model support system for the 80 x 120-foot test section. The FY 1979 budget request of $31,600,000 continues the funding of those contracts awarded with prior year resources. Funds are also included in the FY 1979 budget for the initiation of construction for the new 80 x 120-foot test leg addition or "new leg." This proposed level of funding in FY 1979 is austere, but is felt to be adequate to achieve a 1981 operational data for the modified facility. The application of intensive scheduling and cost control techniques to each of several work packages makes the austere level an acceptable increment which will also not jeopardize the $80-85 million ultimate cost for this facility. This approach is particularly effective for this type of large and complex project because it results in better project management, increased competition, and more cost effective designs.

Results of a number of engineering and feasibility studies have been included in the design process. Final design for the repowering phase was completed in early 1977. The new test section or "new leg" final design is scheduled for completion in late 1978.

The size and complex nature of this total facility project permits it to be adequately funded in progressive increments over several fiscal years. The first and second increments totalling $19.5 million, were provided in FY 1977 and FY 1978. Analyses of project schedules and project management capabilities indicate that a fiscal year funding schedule will not adversely affect the mid-1981 operational data for this modified facility. All engineering estimates to date indicate that the total estimated cost of this facility will be between $80 and $85 million. The exact cost is dependent on the details of the construction scheduling, the degree of cost escalation actually encountered, and the final resolution of any *yet* unidentified "problems" which, while not anticipated, might be encountered.

The **FY** 1979 budget request will provide for the continuation of the elements of the project initiated with FY 1977 and FY 1978 resources. Additionally, these funds will allow the award of contracts for the acoustical treatment, model handling and auxiliary systems, data acquisition and operational controls, and other miscellaneous items. Procurement of additional project elements will be required in a subsequent fiscal year.

The Ames Research Center Environmental Impact Statement has been amended to cover the Modification of the *40-* by 80-Foot Subsonic Wind Tunnel. The final statement was submitted to the Council on Environmental Quality (CEQ) and made available to the public on July 5, 1977. Comments received subsequent to publication revealed noise to be the only item of significance: Experimental tests have been performed which demonstrate that the noise generated by the modified facility will be less than that of the current configuration. It is probable that noise levels presently predicted are conservative and that the actual levels will be even lower than now estimated. Consequently, this earlier concern should not constitute *a* problem.

PROJECT COST ESTIMATE:

This cost estimate is based on varying degrees of final planning and is felt to be realistic and to reflect the most probable costs for this work.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition	---	---	---	---
Construction				9,400,000
Site work and utilities (Increment 11)	LS	---	---	100,000
Piles and concrete	LS	---	---	300,000
Structural modifications (Increment II)	LS	---	---	4,600,000
Structural erection (Increment II)	LS	---	---	2,400,000
Acoustical treatment	LS	---	---	2,000,000
Equipment	---	---	---	22,200,000
Main drive assembly and installation (Increment II)	LS	---	---	1,000,000
Main drive system (Increment III)	LS	---	---	3,900,000
Main drive power supply (Increment 11)	LS	---	---	1,200,000
Fan and stator blades (Increment III)	LS	---	---	3,700,000
Fan hub and variable pitch mechanism (Increment II)	LS	---	---	2,300,000
Nacelle, fairing, and spinner (Increment 11)	LS	---	---	1,700,000
Electrical installation	LS	---	---	1,700,000
Substation relocation (Increment III)	LS	---	---	1,800,000
Model handling system	LS	---	---	1,400,000
Model balance system (Increment II)	LS	---	---	800,000
Data acquisition and operational control system	LS	---	---	2,700,000
Fallout Shelter (not feasible)	---			
Total				31,600,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Plan View
Figure 3 - Vanes, Louvers, and Fan Drive System
Figure 4 - Land Transactions
Figure 5 - New Fan Drive Unit
Figure 6 - Funding Plan

OTHER EQUIPMENT SUMMARY:

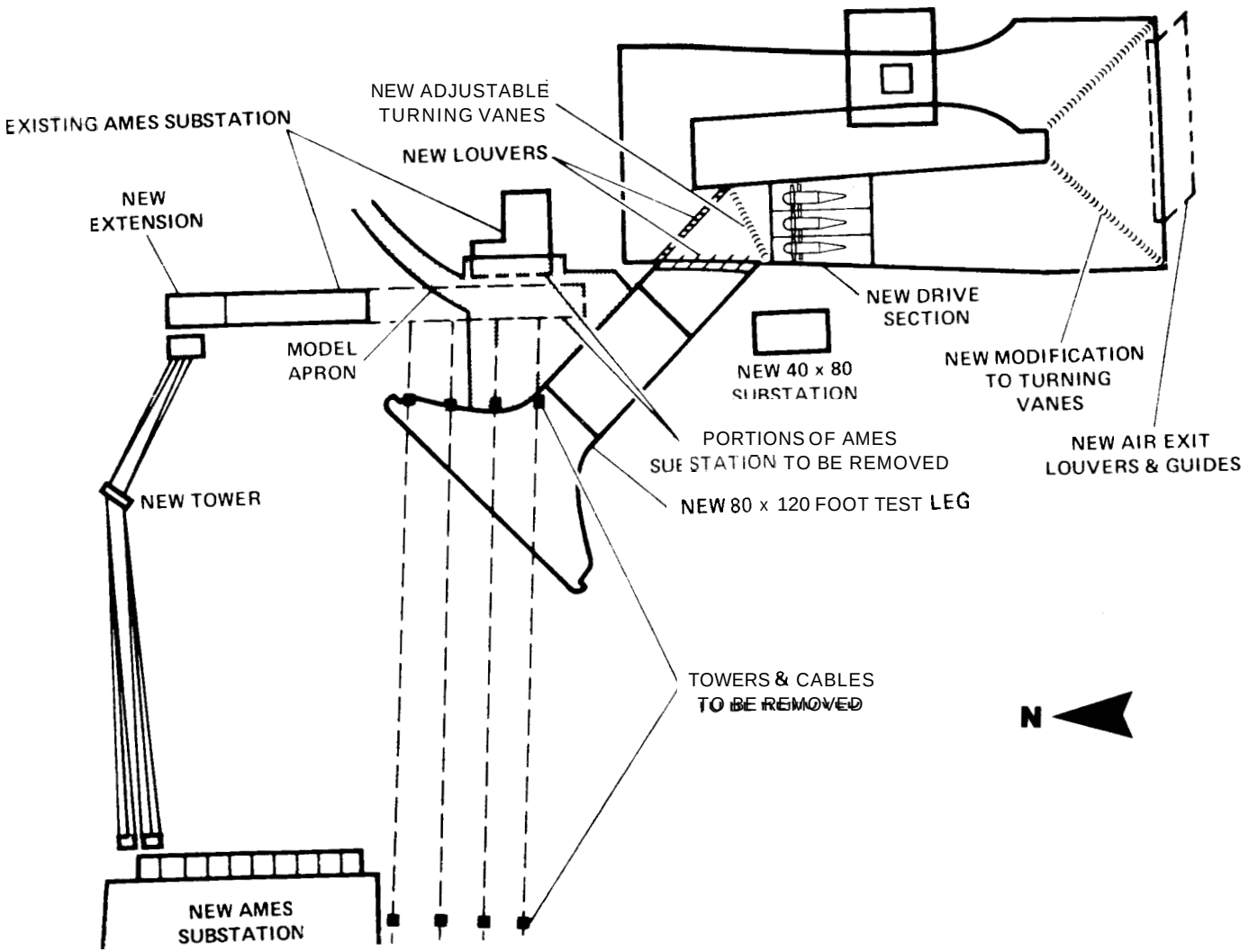
Existing collateral equipment consisting mainly of the model support system, the balance, the motor generator sets, the rheostat, and other equipment of the present 40- by 80-Foot Subsonic Wind Tunnel will be used with this modification project. The total replacement value of the presently existing 40- by 80-Foot Subsonic Wind Tunnel is approximately $55 to $60 million. Existing noncollateral equipment valued at about $1.5 million, which consists primarily of computers, will also be used in the new facility. There is no major additional non-collateral equipment involved.

FUTURE COF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

It is estimated that $29 to $34 million will be required in the future to complete this project. The exact amount of additional funding required will depend on future bid experience and is expected to be included in a future budget request. The present estimate for the ultimate cost of this facility modification is $80 to $85 million.

AMES RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF 40 x 80 FT SUBSONIC WIND TUNNEL
PLAN VIEW

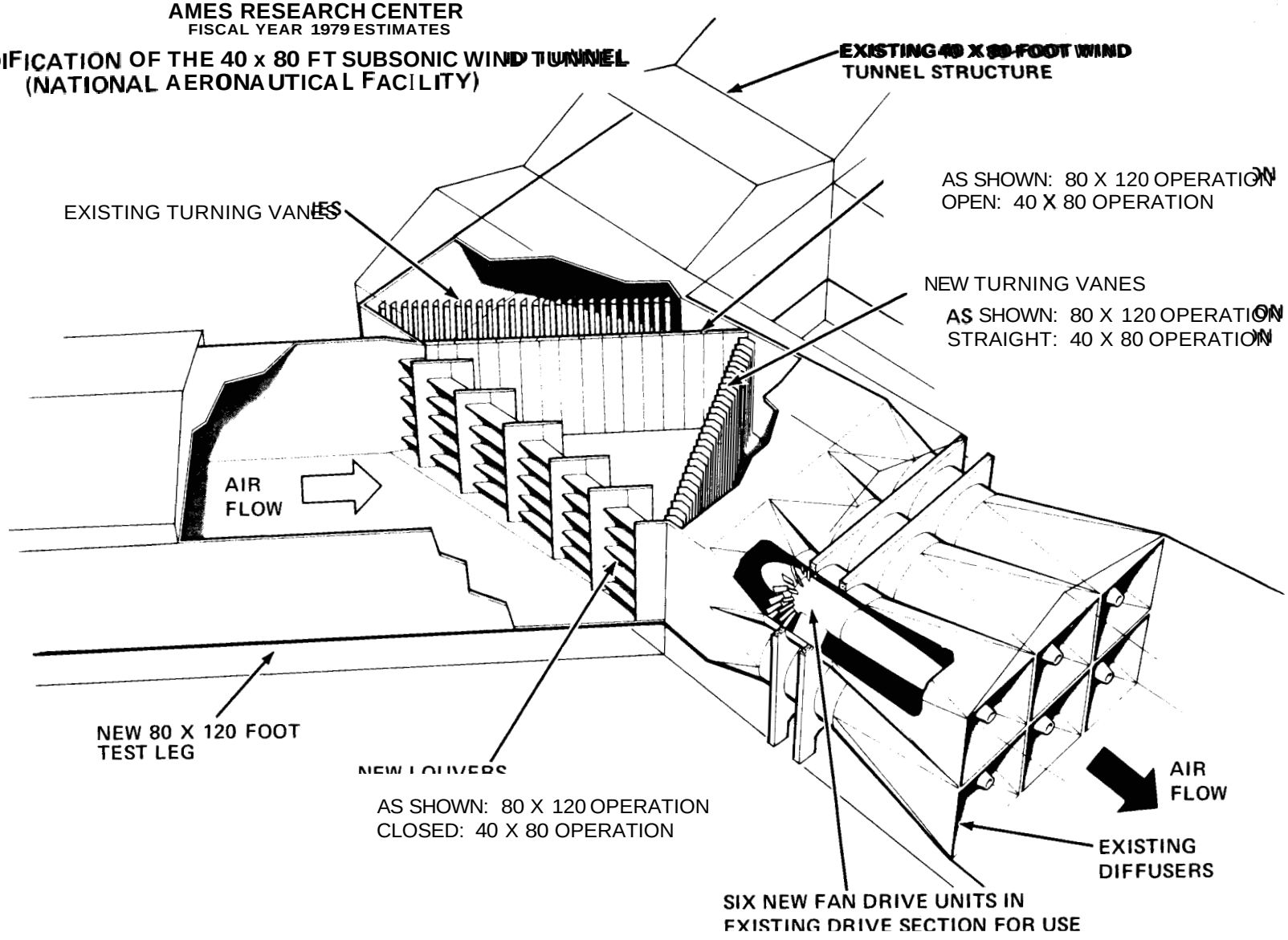


CF 6-25

FIGURE 2

AMES RESEARCH CENTER
FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF THE 40 x 80 FT SUBSONIC WIND TUNNEL
(NATIONAL AERONAUTICAL FACILITY)



PERSPECTIVE VIEW OF VANES, LOUVERS, AND FAN DRIVE SYSTEM

FIGURE 3

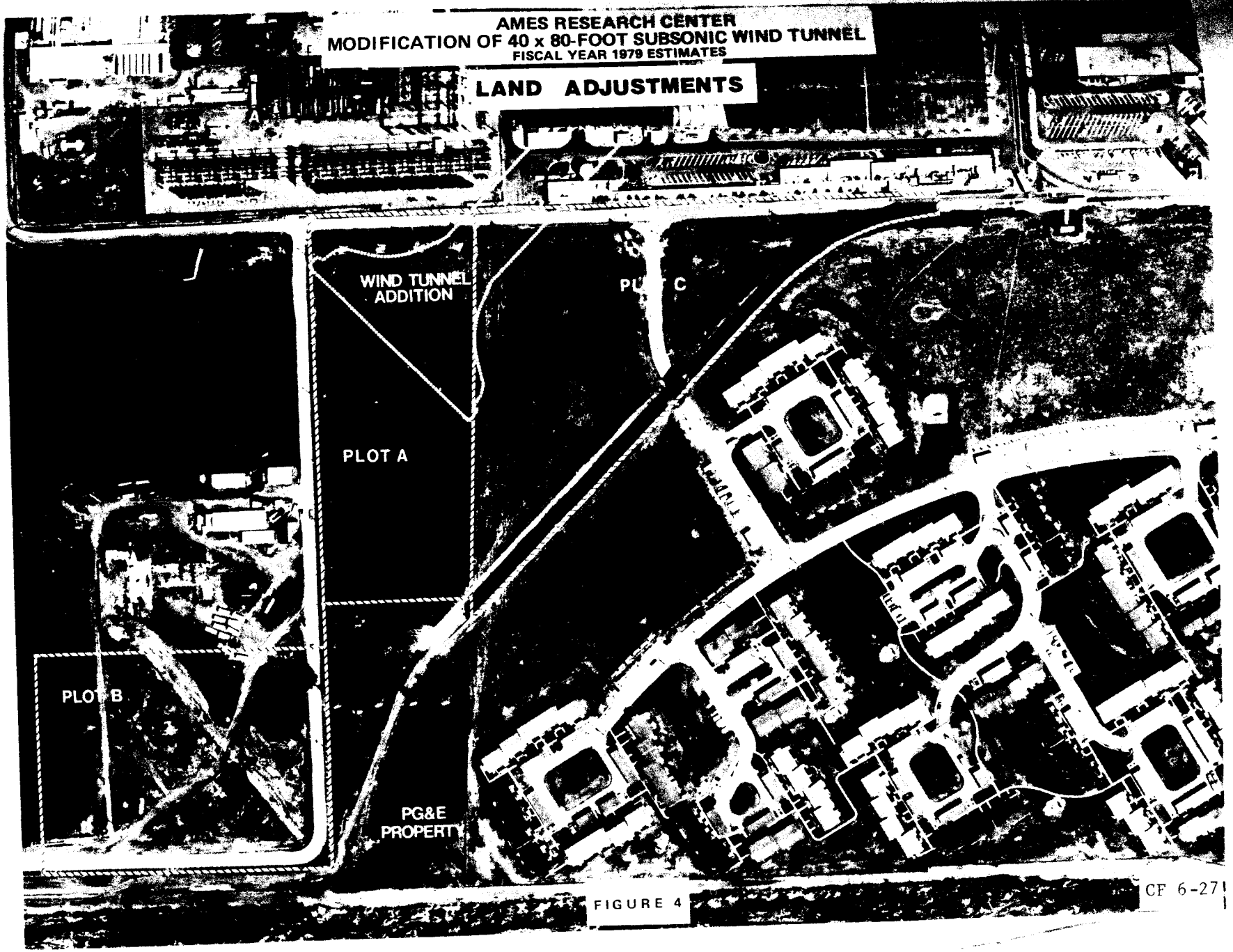

AMES RESEARCH CENTER
MODIFICATION OF 40 x 80-FOOT SUBSONIC WIND TUNNEL
FISCAL YEAR 1979 ESTIMATES
LAND ADJUSTMENTS
WIND TUNNEL ADDITION
PLOT A
PLOT B
PG&E PROPERTY

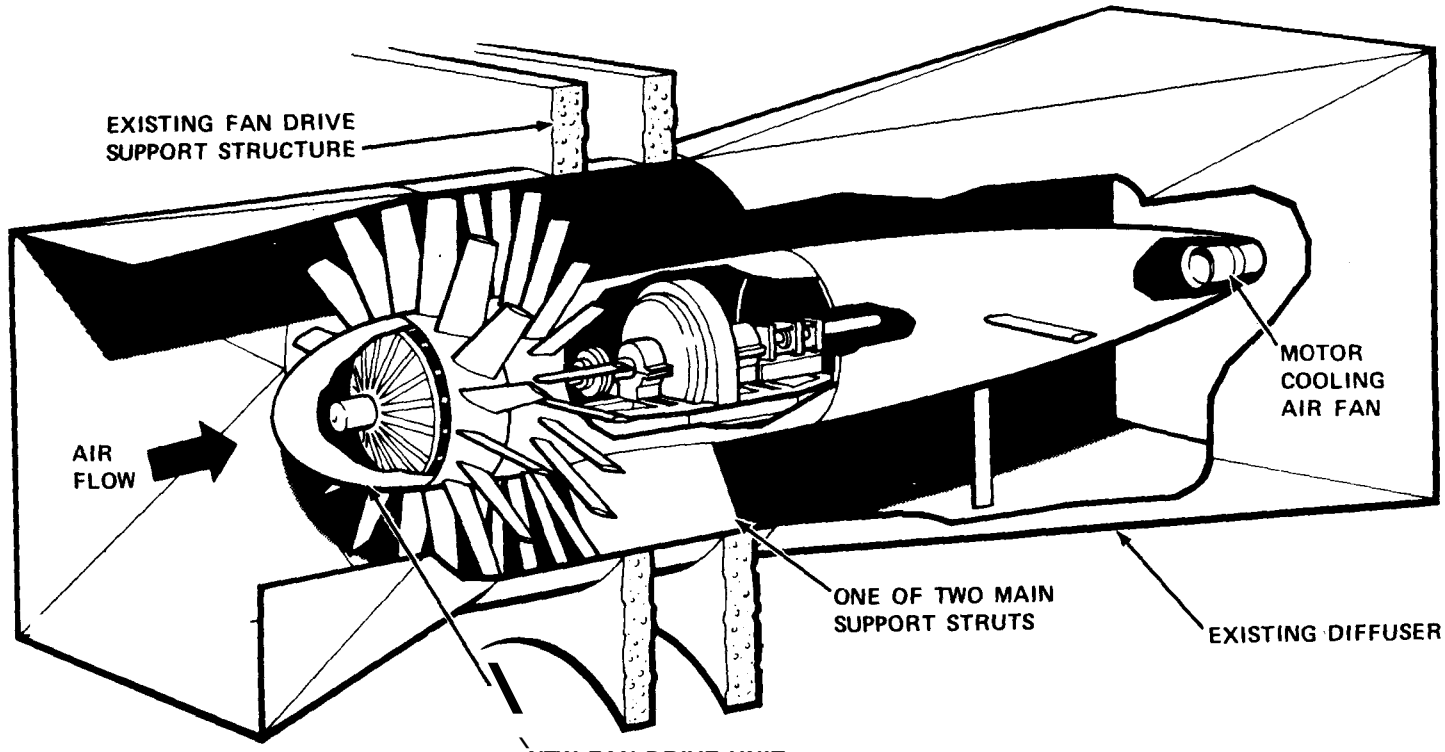
FIGURE 4

AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF THE 40 x 80 FT SUBSONIC WIND TUNNEL (NATIONAL AERONAUTICAL FACILITY)

NEW FAN DRIVE UNIT



22,500 HORSEPOWER ELECTRIC MOTOR
40-FOOT DIAMETER 15-BLADE VARIABLE-PITCH FAN, AND 23-BLADE STATOR
CENTER BODY – 17.5-FOOT MAX DIAMETER BY 138.5 FEET LONG
DRIVE UNIT WEIGHT: 400,000 LBS.

FIGURE 5

AMES RESEARCH CENTER

FISCAL YEAR 1979 ESTIMATES

MODIFICATION OF 40- BY 80-FOOT SUBSONIC WIND TUNNEL

FUNDING PLAN

(Millions of Dollars)

	Fiscal Year				
	1977	1978	1979	Future	Total
Construction	---	2.0	9.4	19.9	31.3
Site work and utilities	---	.1	.1	.4	.6
Piles and concrete	---	---	.3	.5	.8
Structural modifications	---	1.1	4.6	6.8	12.5
Structural erection	---	.8	2.4	4.9	8.1
Printing and finishing	---	---	---	.0	1.0
Fire protection	---	---	---	.4	.4
Acoustic treatment	---	---	2.0	5.5	7.5
Miscellaneous mechanical	---	---	---	.4	.4
Equipment	6.0	11.5	22.2	13.6	53.3
Main drive assembly and installation	---	.5	1.0	4.7	6.2
Main drive system	2.7	.9	3.9	1.1	8.6
Main drive power supply	---	.5	1.2	1.1	2.8
Fan and stator blades	1.3	1.3	3.7	1.9	8.2
Fan hub and variable pitch mechanism	1.5	1.0	2.3	---	4.8
Nacelle, fairings, and spinner	---	1.2	1.7	---	2.9
Electric installation	---	---	1.7	1.3	3.0
Substation relocation	.5	.7	1.8	---	3.0
Model handling system	---	---	1.4	---	1.4
Model auxiliary systems	---	---	---	.9	.9
Test section doors and floor panel	---	---	---	1.2	1.2
Model support and turntable	---	3.9	---	.2	4.1
Model balance system	---	1.5	.8	1.1	3.4
Data acquisition and operation control systems	---	---	2.7	.1	2.8
Total					
By Year	6.0	13.5	31.6	33.5	84.6
Cumulative	6.0	19.5	51.1	84.6	---

Figure 6

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

SPACE SHUTTLE FACILITIES

	Amount	Page No.
Office of Space Transportation Systems:		
Summary		CF 7-1
Launch and Landing Facilities:	13,570,000	
Modifications to launch complex 39 (KSC)	13,570,000	CF 7-4
Manufacturing and Final Assembly Facilities:	15,900,000	
Modification of manufacturing and final assembly facilities for external tanks (MAF)	13,980,000	CF 7-13
Modifications for solid rocket motor manufacturing and assembly facilities, Thiokol Plant, Wasatch, Utah (MSFC)	1,920,000	CF 7-30
Minor Facilities:	1,600,000	
Minor shuttle-unique projects, at various locations	1,600,000	CF 7-41
Total	31.070.000	

CONSTRUCTION OF FACILITIES

FISCAL YEAR *1979* ESTIMATES

PROJECT TITLE: Space Shuttle Facilities

INSTALLATION: Various Locations

FY *1979* CoF ESTIMATE: *$31,070,000*

LOCATION OF PROJECT: Locations are identified in the following documentation.

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY *1978* AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	*13,251,700*	*149,432,000*	*162,683,700*
Other affiliated funding	---	*637,602,000*	*637,602,000*
Total	*13.251.700*	787,034,000	*800,285,700*

The above data summarize only the projects included in this submittal. Before FY *1979, $29.9* million was made available for Shuttle planning and design in addition to *$324.4* million for Shuttle facilities construction.

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to rehabilitate, modify, and add to existing Government-owned facilities, and to construct those limited new facilities necessary to meet unique requirements supporting the Space Shuttle Program. As in prior years, this Shuttle facility package includes all major facility requirements unique to the Space Shuttle Program. In FY *1979,* the proposed Shuttle facilities are again primarily for launch and landing requirements at John F. Kennedy Space Center (KSC). The work consists primarily of continuing

modifications to Launch Complex 39 which were initiated with FY 1978 resources to support Space Shuttle flights planned for late CY 1982 and beyond. FY 1979 requirements at other locations include modifications of external tank manufacturing and final assembly facilities at Michoud Assembly Facility and modifications of solid rocket motor manufacturing and assembly facilities at the Thiokol Wasatch plant in Utah. Also included are minor rehabilitation and modification projects which are required to support the Space Shuttle Program and are therefore considered unique Space Shuttle projects.

PROJECT JUSTIFICATION:

Prior years CoF projects for the Space Shuttle Program authorized modification and construction of facilities for technological development, Space Shuttle main engine tests, ground tests, manufacturing, and launch and landing. These facilities--except for the manufacturing and launch and landing facilities, are mostly complete and in operation. A large portion of the manufacturing and launch and landing facilities is also complete or nearing completion. Those facilities provided with FY 1977 or FY 1978 resources are in the final phases of design or construction.

The FY 1979 request is intended primarily to continue modifications to provide launch capability for the Space Shuttle vehicle at KSC. The primary element in this request is a continuation of Pad "B" modifications. Pad "B" is planned to be operational by January 1983, at which time it will be needed to support the planned launch rate as well as to provide needed operational reliability and flexibility.

The remaining projects in the FY 1979 CoF budget are intended to support the manufacture and final assembly of the Space Shuttle external tanks at Michoud Assembly Facility and modification of solid rocket motor manufacturing and assembly facilities in Utah. A project for rehabilitation and modification of existing Shuttle-unique facilities is also included.

Current Space Shuttle planning is based on achieving a first manned orbital flight in mid-CY 1979 and attaining a flight capability of approximately 18 missions in CY 1982 at KSC. This FY 1979 request is necessary to meet specific milestones directly related to these major milestones. The individual project descriptions specify the respective milestone to which the facility is related.

PROJECT COST ESTIMATE:

Launch and Landing Facilities	13,570,000
Modifications to Launch Complex 39, Kennedy Space Center, Florida	13,570,000
Manufacturing and Final Assembly Facilities	15,900,000
Modification of Manufacturing and Final Assembly Facilities for External Tanks, Michoud Assembly Facility	13,980,000
Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities (Thiokol Plant)	1,920,000
Minor Facilities	1,600,000
Minor Shuttle-Unique Projects, Various Locations	1,600,000
Total	31,070,000

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1979 ESTIMATES

MODIFICATIONS TO LAUNCH COMPLEX 39

LOCATION PLAN

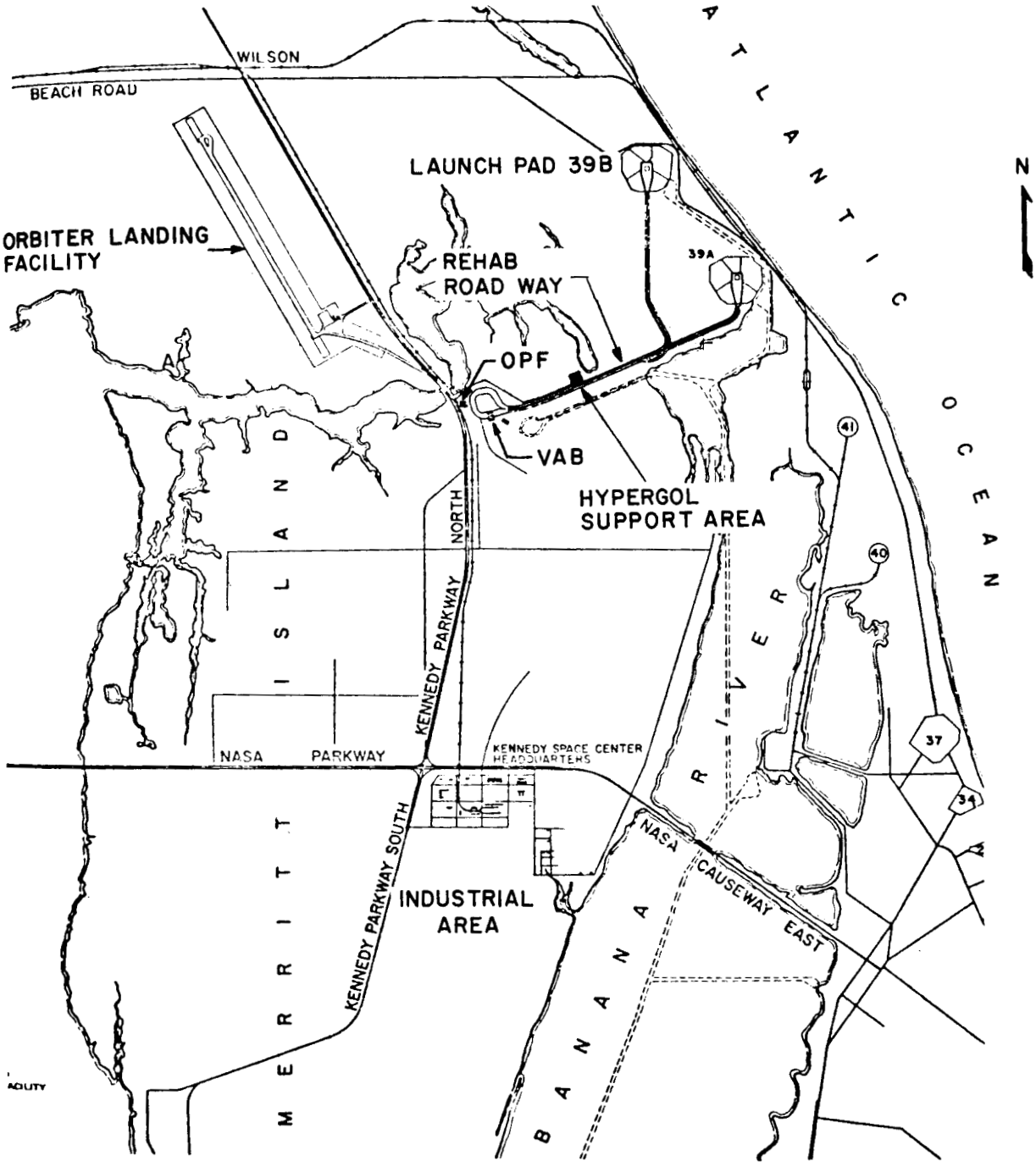


FIGURE 1

CONSTRUCTION OF **FACILITIES**

FISCAL **YEAR** 1979 ESTIMATES

PROJECT TITLE: Modifications to Launch Complex 39

INSTALLATION: John F. Kennedy Space Center

FY 1979 CoF ESTIMATE: $13,570,000

LOCATION OF PROJECT: Merritt Island, Brevard County, Florida

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	9,080,000	109,960,000	119,040,000
Other affiliated funding	---	501,538,000	501,538,000
Total	9,080,000	611,498,000	620,578,000

SUMMARY PURPOSE AND SCOPE:

This project continues modifications to Launch Complex 39 (LC 39), begun with FY 1975 resources and continued with FY 1976, FY 1977, and FY 1978 resources, to support Space Shuttle operations. The FY 1975, FY 1976, and a portion of the FY 1977 projects provided for modifying two high bays in the Vehicle Assembly Building (VAB), the Launch Control Center, one mobile launch platform, and Launch Pad "A". **The** balance of the FY 1977 project coupled with FY 1978 resources provided for modifying the second mobile launch platform and the two remaining high bays in the VAB, and to begin modifications to Launch Pad "B". This year's project provides primarily for continuing Launch Pad "B" modifications and secondarily for certain short lead time LC 39 associated facilities work such as construction of freon recovery and hypergol support facilities, and rehabilitation of roads in the LC 39 area.

PROJECT **JUSTIFICATION:**

After the first six Space Shuttle development flights, planned for CY 1979 and CY 1980, the Space Shuttle operational phase will begin. The launch rate from Kennedy Space Center (KSC) will increase gradually from five operational flights per year in 1980 to the rate of *40* flights per year in 1985. During this operational phase, two launch pads will be needed to support the planned mission rate. Prior year resources have provided for the first phase of modifications to Launch Pad "B" with the objective that it be operational by early 1983, at the latest.

The requirement for Pad "B" to be operational by not later than early 1983 is a critical milestone for the Shuttle operations. For more than three years before that, operations will depend on a single launch pad (Pad "A"). If that pad is damaged during a launch, all scheduled launches will have to be delayed while repairs are made. In addition, turnaround procedures and schedules for higher launch rates can only be developed early in the operational phase. The present Shuttle processing schedules do not account for any large variations in on-pad operations. The times required for Air Force "factory-to-pad" programs, Jet Propulsion Laboratory planetary missions, and adverse weather are presently unknown. Consequently, the need for Pad "B" rapidly becomes more pressing and urgent as launch rates move upward and these factors compound normal scheduling problems. As the launch rate increases, these unknowns present a growing potential for delay, and the need for a second pad becomes even more critical. BY 1982, when 18 flights per year are projected, a significant risk emerges until Pad "B" is operational. Therefore, modifications begun with prior years funding must be continued *so* the Shuttle operations are not unnecessarily burdened with this added risk.

The Space Shuttle will undergo vital operations on the launch pad before final countdown and launch. These activities include performing final checkout of vehicle systems, loading propellants in the external tank, loading hypergolic propellants in the auxiliary propulsion system pods and reaction control system, loading power reactants and cooling and life support fluids, changing or inserting payloads, and boarding the crew. The proposed second phase of the modifications to Pad "B" will support these vital prelaunch operations. They involve extensive and complex efforts to construct a massive rotating bridge structure which contains the payload chanegout room, and associated support facilities.

The payload changeout room must have a clean environment because it will be used to remove or insert payloads into the orbiter. Some missions will require that payloads be assembled in this room. Vital checkout operations and servicing of payloads will also take place there. An elaborate system of fixed platforms capable of extension and retraction will be necessary. These platforms must retract when a payload is brought into the room, extend while the payload is processed or serviced, and retract to allow the payload to be placed into the orbiter. This configuration is complicated by the payload's size: It may be any size up to 60 feet long by 15 feet in diameter (18.3 m by *4.6* m). A service elevator must connect the platforms *so* that various pieces of equipment can be moved between the levels of the payload changeout room.

External access to the orbiter, solid rocket boosters, and external tank will be required for last minute inspection and possible repairs at various times while the Shuttle vehicle is on the pad. Platforms, swinging ramps, and other devices that will not damage the vehicle are required.

The provisions of the CoF related launch systems is deferred to future years. This work interrelates with associated R&D funded noncollateral equipment which should be installed and checked out concurrently. (Figure 3) indicates the integrated requirements for resources to modify Pad "B". It indicates the major facility work will be acquired with the prior FY 1978 funding. This request and that envisioned in future years will total $48.0 million as previously reported.

Other facilities generally associated with the total LC 39 complex must also be provided or modified with FY 1979 resources. A freon recovery facility and a hypergol support facility are thus required in this time frame. Roads in the LC 39 area must also be rehabilitated as a consequence of the heavy use during the modifications for the Space Shuttle. These additional facilities or repairs must be funded during FY 1979 primarily to support operations on Pad "A" in CY 1980 and 1981, and later to also support activation of Pad "B" by not later than early 1983.

During the Shuttle development phase, the launch pad hypergol piping system must be flushed with freon after each launch to remove toxic vapors and residuals that could cause an explosion between launches. During the operational phase of the program, it is estimated that an average of four system flushes per pad per year -- or a total of eight per year when both pads are operating -- will be required. Some 65-70 percent of the freon used in the flushes can be reclaimed. If it is not recovered, the contaminated freon must be disposed of, thus creating potential environmental problems and the need for a treatment facility. It is estimated that by 1982 the freon reclamation system will have paid for itself and that it will save an additional $4 million over the life of the Shuttle program.

The hypergol support facility is needed to stage and store Government-furnished equipment that will transport the large quantities of hydrazine and ammonia for servicing the orbiter. This is due to the tremendous increase in hypergols over that previously required for the Apollo program.

The roads from the VAB to Pads "A" and "B" have settled extensively in certain areas primarily as a consequence of heavy traffic primarily associated with modifications to the LC 39 for the Space Shuttle. They now require entensive repairs and resurfacing. Delaying the repairs and resurfacing will lead to future rapid deterioration when the launch rate and attendant traffic are higher, and consequently it is most prudent to undertake this work now.

PROJECT DESCRIPTION:

This project provides for continuing modifications to Launch Pad "B" begun with FY 1978 funds. Prior year resources will provide for heavy site work and the constructing of a fixed service tower, a flame deflector,

and an acoustic reduction system; and modifying existing structural, mechanical, and electrical systems. This FY 1979 project provides a bridge structure mounted on the surface of the pad and attached to the fixed service tower as can be seen in (Figure 3). Supported by the rotating bridge is the payload changeout room, where payloads will be processed, installed, and removed. The payload changeout room will be approximately 52 feet wide by 50 feet deep by 76 feet high (15.8 m by 15.2 m by 23.2 m). A room 32 feet wide by 27 feet deep by 30 feet high (9.8 m by 8.2 m by 9.1 m) on top of the payload changeout room will provide access to the Shuttle forward reaction control system. Platforms providing access to the Shuttle aft propulsion system will be underneath the payload changeout room.

The freon recovery facility will consist of a concrete pad which will support freon distillation equipment, two large storage tanks (one for contaminated and one for reclaimed freon), and four additional smaller tanks to support the distillation process. The distillation equipment will consist of a still and supporting units. The hypergol support facility will consist of two 9,000-square foot (810 m^2) concrete pads and two small pre-engineered storage sheds.

The roads in the LC 39 area will be rehabilitated by removing and replacing approximately 300-square yards (245 m^2) of flexible pavement, resurfacing approximately 76,000 square yards (61,560 m^2) of flexible pavement, 28,000 linear feet (8,535 m) of traffic stripes, and regrading of pavement shoulders.

PROJECT COST ESTIMATE:

The basis of this cost estimate are the final design for the Pad "B" portion and preliminary engineering reports for the balance of the work.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition	---	---	---	---
Construction	---	---	---	13,570,000
Payload changeout room	---	---	---	12,810,000
Basic structure	LS	---	---	(7,790,000)
Internal access	LS	---	---	(1,070,000)
External access	LS	---	---	(1,790,000)
Elevator	LS	---	---	(1,310,000)
Egress stairs	LS	---	---	(340,000)
Air lock	LS	---	---	(280,000)
Anteroom	LS	---	---	(140,000)
Electrical platform	LS	---	---	(90,000)

	Unit of Measure	Quantity	Unit cost	Total Cost
Other LC 39 facility work	LS	---	---	760,000
Freon recovery facility	LS	---	---	(390,000)
Hypergol support facility	LS	---	---	(150,000)
Rehabilitation of roads	LS	---	---	[illegible])
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	
Total				13,570,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan at KSC
Figure 2 - Perspective - Launch Pad "B"
Figure 3 - Payload Changeout Room
Figure 4 - Funding Schedule, Pad "B"

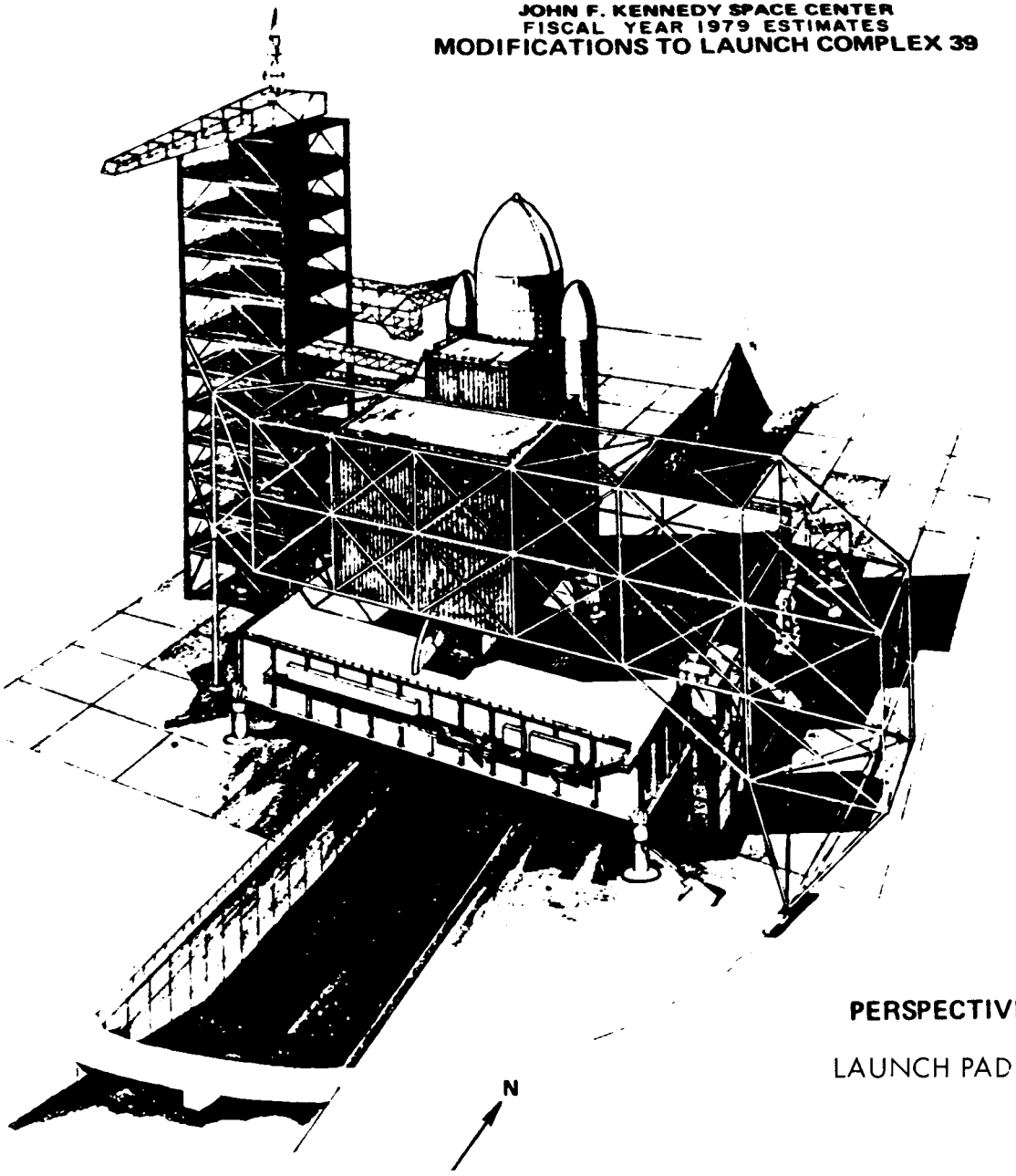
OTHER EQUIPMENT SUMMARY:

It is anticipated that approximately $25 to $30 million of R&D resources will be required to provide non-collateral equipment for initial operation of facilities included in this project.

FUTURE COF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

It is estimated that future year's funding of approximately $8.0 million will be required to complete this project. The major portion of the remaining amount will be for launch systems and other minor residual Pad "B" facilities work. Other LC 39 requirements may be later validated such as the need to modify a third mobile launcher. Should this requirement be validated, this cost will he additive to $8.0 million previously mentioned.

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1979 ESTIMATES
MODIFICATIONS TO LAUNCH COMPLEX 39

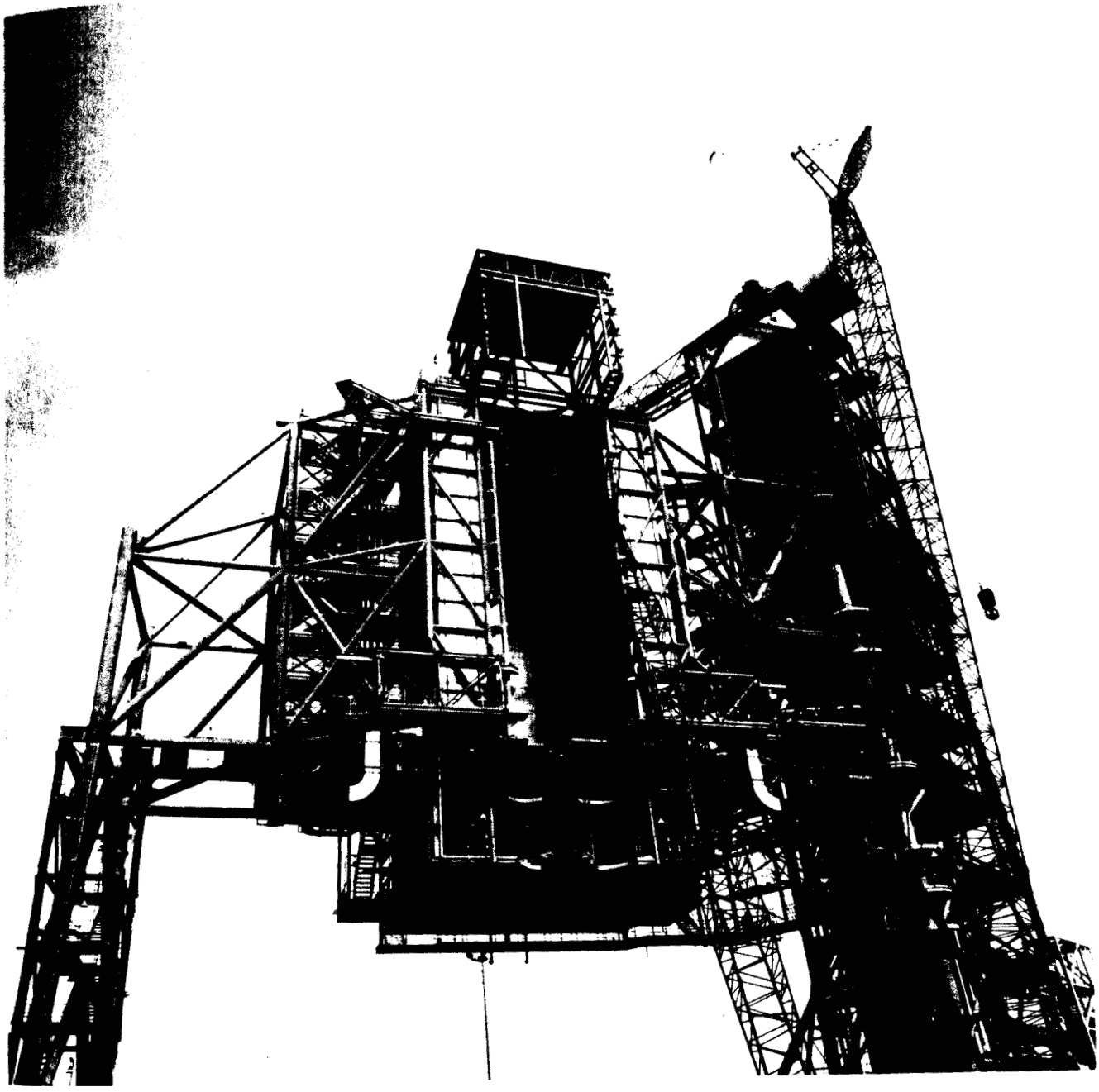


PERSPECTIVE

LAUNCH PAD "B"

FIGURE 2

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1979 ESTIMATES
MODIFICATIONS TO LAUNCH COMPLEX 39



PAYLOAD CHANGEOUT ROOM
(SHOWN IN RETRACTED
POSITION AT PAD "A")

FIGURE 3

KENNEDY SPACE CENTER

Fiscal Year 1979 Estimates

MODIFICATIONS TO LAUNCH COMPLEX 39

Funding Schedule - Launch Pad "B"

	FY 1978	FY 1979	Future	TOTAL
	(Millions of Dollars)			
CONSTRUCTION				
Site preparation, piles and foundations.....	8.45	---	---	8.45
Field service tower.....	5.63	---	---	5.63
Install pad elevators and hammerhead crane..	.36	---	---	.36
Modify and construct flame deflectors and containers..	3.90	---	---	3.90
Refurbish storage vessels..	.29	---	---	.29
Lightning protection and emergency egress.....	.89	---	---	.89
Acoustic reduction system..	7.58	---	---	7.58
Payload changeout room.....	---	12.81	.79	13.60
Launch systems..	---	---	6.30	6.30
Work support and miscellaneous facility needs.....	---	---	1.00	1.00
TOTALS.	27.10	12.81	8.09	48.00

Figure 4

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1979 ESTIMATES

LOCATION PLAN

1. NEW - ABLATOR SPRAY FAC. FOR LH_2 TANK
2. MODS. TO THE VAB - 110
   CRANES
   TPS CELL "C"
   REFURB. BLDG. SYSTEMS
3. MODS. TO MAIN MFG. BLDG. - 103
   TPS COMPONENT APPL. FAC.
   TPS EQUIP. SERVICE ELEVATOR
   LH_2 & LO_2 TANK WELD AREA BARRIER
4. ADDED HVAC FOR HI BAY ADD'N - 114
5. ENVIRONMENTAL MODS. - 420 & 451
6. REPLACEMENT/MOD. GN_2 SYSTEM
7. REHABILITATION AND MODIFICATION OF BOILER PLANT, BLDG. - 207

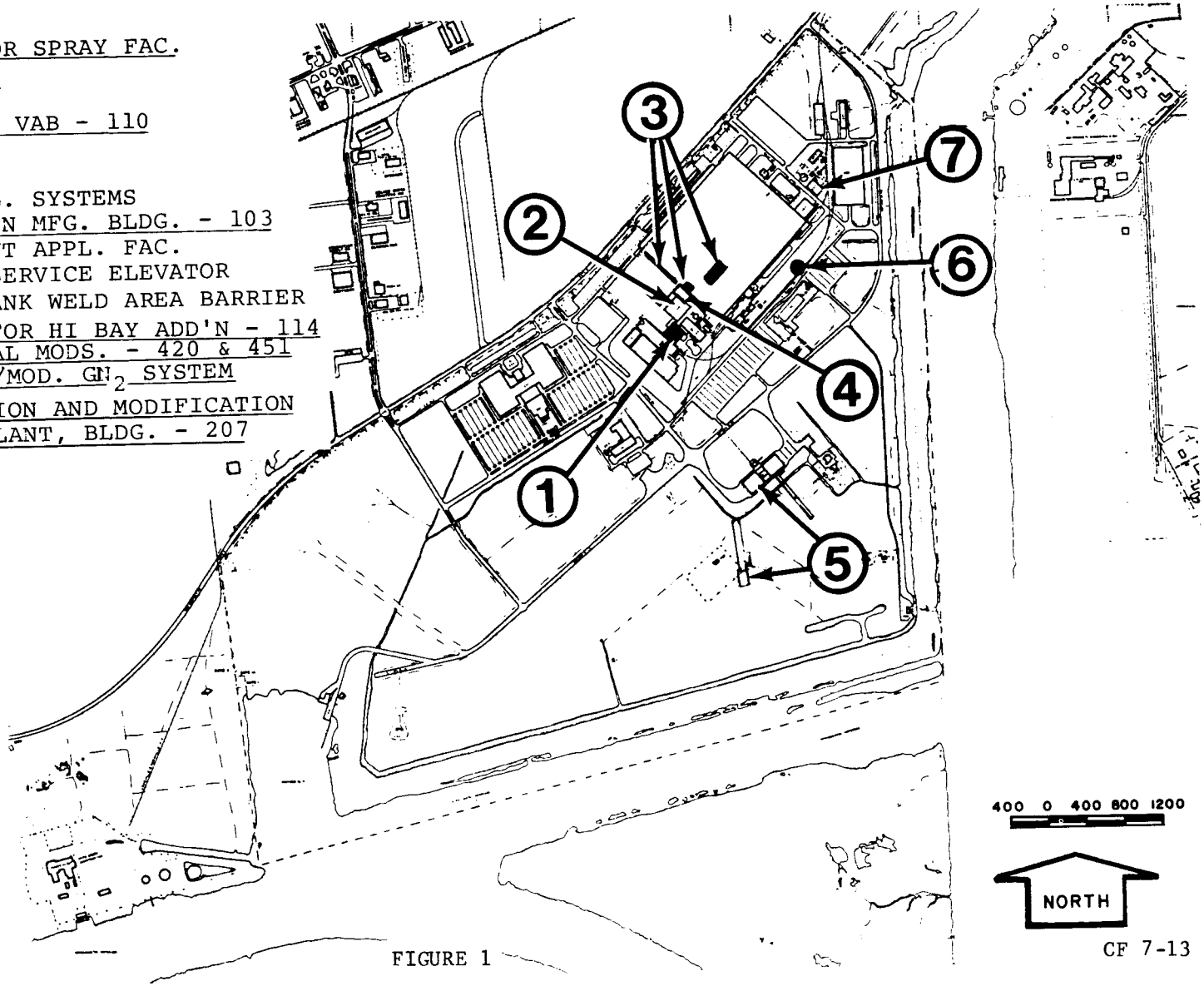


FIGURE 1

CF 7-13

PROJECT TITLE: Modification of Manufacturing and Final Assembly Facilities for External Tanks

INSTALLATION: Michoud Assembly Facility

FY 1979 CoF ESTIMATE: $13,980,000

LOCATION OF PROJECT: New Orleans, Orleans Parish, Louisiana

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY 1978 AND PRIOR YEARS FUNDING: The fcllowing prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	3,681,000	35,062,000	38,743,000
Other affiliated funding	---	132,716,000	132,716,000
Total	3.681.000	167.778.000	171.459.000

SUMMARY PURPOSE AND SCOPE:

This project continues work begun with FY 1973 and other prior years resources, including FY 1978. This work involves the modification of manufacturing and final assembly facilities at the Michoud Assembly Facility (MAF) for space shuttle external tank (ET) production. The external tank is an essential component of the Space Shuttle system in that it supplies propellants to the orbiter's main engines. Each ET is made up of three major components: a liquid oxygen (LO_2) tank and intertank and a liquid hydrogen (LH_2) tank. The prior year resources provided certain modifications to the Main Manufacturing Building (103), the Vertical Assembly Building (VAB) (110), and the Final Acceptance and Checkout Building (420); for the construction of an addition (now designated Building 114) between Buildings 103/110 and for a proof test facility for the liquid hydrogen tank (Building 451). The overall facility work at Michoud is required to provide the facilities necessary to fabricate and assemble the ET components, test and clean them, apply a thermal protection system (TPS) to their

surfaces, and assemble the major components into a complete ET. The tank will then be equipped with plumbing and electrical systems, checked and approved, and shipped to the launch site, where it will be mated with the orbiter and solid rocket boosters.

The FY 1978 estimates were mainly directed toward providing necessary additional facilities associated with TPS application. These estimates envisioned completing facilities adequate to provide for a 24 to 28 ET per year capability. This rate was then planned as an intermediate production target goal which would satisfy shuttle needs through the early operational phase of the program. However, in early CY 1977, it became necessary to make certain changes in many facets of TPS application, especially as applied to the LH_2 tank. Further details as to the source of requirements for and impacts of these TPS changes are included under the Project Justification section. Therefore, while the FY 1978 facility work will still provide for a 24-28 production capability for most ET components, it is estimated that TPS application constraint of some 8-10 ET's per year will apply to the LH_2 tank. It is clear that the difficulties and complexities of the total TPS matter, including application techniques, have greatly matured and were not completely understood when the FY 1978 estimates were presented. Since that time further testing and application experience have provided a better basis for planning and estimates. As a consequence of this evolution in TPS development and minor adjustments in the projected shuttle early flight rates, it is now planned that this FY 1979 estimate for MAF include those additional facilities needed to attain a 20 to 24 ET production rate per year as a present appropriate intermediate goal. This level of production will support the projected shuttle flight rates into CY 1983-1984.

This FY 1979 project provides certain additional production facilities as now needed to support ET manufacture and final assembly at this revised rate of 20-24 per year, It includes adding an ablator spray facility; refurbishing structural, mechanical, and electrical systems in Building 110; adding a crane in Building 110 and a crane transfer system between Building 110 and Building 114; modifying Building 103 to provide a small component TPS foam application area and a tank weld barrier; adding heating and air conditioning capacity in Building 114; modifying the environmental control systems in Buildings 420 and 451; modifying the existing gaseous nitrogen (GN_2) system; and rehabilitating and modifying the central chilled water systems in the Boiler Plant, Building 207.

PROJECT JUSTIFICATION:

The facility work included in these FY 1979 estimates for MAF involves:

a. Construction of the first phase of a new Ablator Spray Facility for the application of ablator to the LH_2 tank portions of the ET. This work all relates to the pressing need to expand TPS application capabilities for the reason detailed immediately below.

b. Further modifications to existing buildings; Main Manufacturing Building, Building 103 and the Vertical Assembly Building, Building 110; as well as work on other buildings and systems to complete short lead-time efforts following the earlier projects.

c. Rehabilitation and Modification of the Main Boiler Plant, Building 207, which is a key facility to reliable ET production. This work is necessary to enhance its reliability and economy of operation.

It is appropriate at this point to address the matter of recent developments in TPS technology and application experience. ET production facilities approved in previous years as stated above were planned to produce 24-28 tanks per year. This rate was then viewed as being sufficient to support the flight missions from Kennedy Space Center up to CY 1982. As noted in prior year budget estimates for MAF, a major problem existed in the development and "learning" effort associated with thermal protection system (TPS) materials and application. Prior to the submission of the FY 1978 program, it had been learned that the single material, foam, could not solve all of the TPS problems, both those on the pad and during ascent. Two materials were found necessary, a foam and an ablator. As the materials technology matured, it was established that the two materials (foam and ablator) could not be sprayed in a common area due to an incompatible problem between sprayed foam and sprayed ablator. At the time of the formulation of the FY 1978 project these facts were known and based on the need to spray ablator (not bond) and spray foam to the liquid oxygen (LO_2) tank, it was necessary to request additional cells to be located in the new addition Building 114. The FY 1978 project, will then be built as presented in the estimates and sufficient facilities will then be available to produce 24-28 LO_2 tanks per year.

At the same time the FY 1978 project was formulated, it appeared that all other facilities at MAF would be sufficient to support the 24-28 ET's per year. In the case of the liquid hydrogen (LH_2) tank, the best available heat prediction data at that time required only a nominal application of ablator TPS to the sides and aft dome of the tank. The foam spraying for the sides and top of the LH_2 tank was planned to be conducted in Cell "C" of the VAB, in which cell the performed sheets of ablator were also to be bonded to the same tank areas. Ablator required on the aft dome of the LH_2 tank was planned to be applied in a remote area in the bottom of this cell. As noted above, this isolation is necessary because spray foam and spray ablator materials are not compatible and these spraying operations must be completely isolated at all times.

As previously described, at that point in time, these TPS facilities were planned to support 24-28 flights per year. Concurrently, with the developments of techniques and the associated facilities, predictions of the heat conditions to the tank both during launch, liftoff and ascent were being refined. These refined predictions were based on improved theoretical calculations and wind tunnel tests. The result of these refinements was a revised prediction of the heating environment, which dictated an increased area of the ET on which ablator must be applied. Evaluation of the capability to apply ablator to the LO_2 and intertank indicated sufficient facilities would be provided through the FY 1978 project to support required tank production. In evaluating the capability to support these increased ablator TPS requirements on the LH_2 tank, however, other limiting material characteristics and operation techniques were brought to light. Adhesives to be used to bond ablator were restricted by toxic working limitations and ultimately the most suitable adhesive which evolved was one with a very short "shelf life". This limiting time factor required that the bonding of ablator operations be accomplished with smaller size, yet a larger number of individuals panels. The method of adhering these panels also became more complicated due to the fact only half the panels can be applied during one application cycle. This

was coupled with a need to vacuum pressure each panel to secure a firmbond. Each panel must also be provided with a physical vent to allow escape of gases that build up under the ablator when foam is applied as the outer coat. These factors added to the greatly increased areas to which ablator must be bonded on the LH_2 tank and revealed that projected capabilities in the existing cells had been drastically reduced, to some 8-10 LH_2 tanks per year. This factor now critically limits the production capability of the entire ET operation. Extensive evaluations and tradeoffs have been made to determine alternate solutions. Consideration was given to modifying existing cells, providing other positions in other existing facilities and other alternatives. In all cases, the economics indicated that it is prudent to provide spray ablator capability for the LH_2 tank as early as possible. The early implementation of such a spray ablator capability for this tank, rather than expanding the earlier bond capability, will result in minimum "lost" facilities or tooling investments and produce substantial manpower savings. At low production rates, before the spray ablator facility for the LH_2 tank as provided in this project becomes operational, the function of applying ablator will be accomplished by bonding in Cell "C". Once the new spray capability does come on line, Cell "C" will then be fully utilized for foam spraying.

LH_2 Ablator Facility

As a result of the developments outlined above it is necessary that additional new facilities be provided to permit the more rapid and economical application of ablator to the LH2 tanks by mechanical spray means. To provide for the present 20-24 intermediate production target rate these estimates include the construction of a facility to accommodate the two spray cells, only one of which will be immediately equipped with R&D tooling, and foundations for a future third cleaning cell. (See Figures 3 and *4)* This constitutes a major item of work in this FY 1979 request.

Various alternatives to the construction of a new ablator application facility were considered. In many of the options the predicted production capability could not meet planned ET requirements. In other options, although production capability could meet planned ET requirements, interim facilities or tooling would be necessary. In most cases replacement would ultimately be required. In all cases to effectively meet production rates beyond 20 to 24 tanks per year a new ablator application facility will be necessary and must be planned for. Beginning the new ablator application facility at this time will result in significant cost savings in both facilities, toolings and also recurring operational costs.

Main Manufacturing Building, Building 103

Two modifications are required in FY 1979 in Building 103. The first is to provide an environmentally controlled TPS area adjacent to the present one *so* that foam insulation can be applied to minor ET components. This requirement was identified some time ago and was included in the FY 1978 estimates for MAF as a future CoF cost. The second is to provide a protective barrier at the entrance to the tank weld area so that dust contamination is avoided when the hangar doors are open to allow tank movement. During the lower production rate, this contamination will not be a problem because the doors can be opened when welding is not in progress.

When the production rate increases, however, the hangar doors will be opened frequently, and this barrier will be necessary to prevent the entry of dust particles.

VAB, Building; 110

The VAB contains six cells as shown in Figure 4. It is presently served by a 180-ton (163,300-kg) capacity crane. This crane is being modified with prior years resources so that it can support a production rate of about 15 ET's per year. To support higher production rate up to 60 ET's per year, a second crane of 60-ton (54,400-kg) capacity is needed. This crane is not only required for the increased production rates of the early 1981 time frame, but also must be installed with FY 1979 resources to avoid a later major impact of production caused by interference of construction operations associated with its installation. In addition, a crane transfer system must be installed between Buildings 110 and 114 so that LO_2 tanks can be transferred between buildings. Originally, it was planned to use a crane to place the tank onto a transporter, transfer the tank to the other building, and use another crane to unload the tank. Installing the crane transfer system will reduce the number of handling steps and thus less time is required.

Certain structural, mechanical and electrical systems rehabilitation in Building 110 must also be provided. The earlier phased work did not include elements of these systems which were not then involved in the specific work projects. As a consequence, since all six cells in the VAB are complete or, in the case of Cell "D", nearly so, it is now necessary that these elements best be rehabilitated as one cohesive work effort. This work is required for reliability and safety purposes.

High Bay Addition, Building 114

The recently revised TPS configuration and application requirements have increased heating and air conditioning requirements in the cell where ablator will be applied to the LO_2 tanks. Additional air conditioning capacity over that which it is possible to provide in the FY 1978 project for this building is now needed to support a production rate of 20 to 24 ET's per year.

Final Acceptance and Proof Test Facilities, Buildings 420 and 451

Buildings 420 and 451 both require effective environmental control systems. One cell in Building 420 is to be used for final acceptance of the external tank. In future years, two cells will be used for this purpose. Chilled water from the central boiler plant (approximately 2,000 ft. away) is used to dehumidify this building. Over the years the underground feed and return lines have progressively necessitated greater and more frequent repairs. Currently these lines are in very poor condition and not able to adequately cool the building to the necessary operating temperatures and thus the humidity levels and temperatures are not satisfactory for final acceptance testing. Trade-off studies show that a new separate system is the best approach. Building 451 will be used as the proof test facility for the LH2 tank. Temperatures in this facility must be carefully controlled in order to keep the tank free of moisture inside and out during test operations. Currently no environmental

control system exists in Building 451, thus limiting production rates. Recent test data indicates that this has become an urgent and pressing matter, and these requirements will also be provided by the new system.

Gaseous Nitrogen System

The existing GN_2 distribution system must be rehabilitated to support ET production. The existing lines from the bulk storage area to Building 103 are in poor condition and need rehabilitation. An old GN_2 storage vessel must also be rehabilitated to increase its storage capacity.

Boiler Plant, Building 207

This rehabilitation and modification applied to the central chilled water supply system in the MAF Boiler Plant, Building 207. Basically these FY 1979 resources will be used to replace old and unreliable steam turbine-driven chillers with electrically-driven chillers. Three 2,500-ton electrically-driven chillers will replace the existing seven 1,100-ton steam-driven chillers now in this central and key utility plant. Related adjustments in piping and services are also involved as is a new electrical substation.

These seven existing 1,100-ton chillers are now more than 25 years old; the eighth, a 4,000-ton unit, was installed with FY 1973 resources and will be retained. Because spare parts for the old units are no longer available or require considerable time to procure, one of the seven units has been disassembled to provide parts to keep the other old units operating. Those residual six units are capable of producing only 800 tons of refrigeration each instead of the rated 1,100 tons. Unreliable operation of these chillers will not provide enough air conditioning to support Shuttle external tank production during higher production periods and at the same time the needs of other Government programs.

Extensive studies have evaluated methods for providing overall central dehumidification. The results clearly indicate that electrically-driven chillers are preferable to steam-driven chillers. Replacement with electrically-driven chillers is more economical than operating the existing inefficient steam-driven chillers and maintaining the steam boilers for cooling purposes. Assessment of the availability of energy resources in the New Orleans area indicates electricity may well be more readily available than natural gas for future MAF requirements. Acquiring and installing the chillers is necessary to avoid shutting down air conditioning systems during the higher rate production of Space shuttle external tanks.

The electrically-driven chillers will require a new double-end substation, the associated switchgear, and primary and secondary distribution systems to supply the new load. The existing substations in the boiler house are inadequate for the projected load.

PROJECT DESCRIPTION:

This project continues work authorized in prior years. It includes constructing an ablator spray facility; modifying Buildings 103, 110 and 114; modifying and adding to the environmental systems in Buildings 420 and 451; modifying the GN_2 system; and modifying the central cooling system/boiler plant.

Construction of Ablator Spray Facility, LH_2 Tank

A 150-foot long by 120-foot wide by 48-foot high (45.7 m by 36.6 m by 14.6 m) addition will be constructed in the vicinity of the VAB. (See Figures 3 and 4) It will have the capacity to house two horizontal TPS cells where ablator will be sprayed onto the LH_2 tank. This FY 1979 project provides for one complete cell and the "shell" for a second cell. Pile and concrete foundations for three cells, a building "shell" for two of these cells and collateral equipment for one of the two cells are included in this work. A future extension of the building will accommodate a later cleaning cell. Work platforms, stairways, and doors will be installed; and various mechanical systems (process heating and air conditioning, fume abatement, fire detection, sprinkler, crane, vacuum and utilities) will also be provided for one cell.

Modifications to the Main Manufacturing Building, Building 103

A new foam insulation application booth 16 feet wide by 36 feet long by 8 feet high (4.9 m by 11.0 m by 2.4 m) will be constructed for insulating small components. A double waterwash spray booth, a 130°F (54.5°C) preheat room, a machining room, and a preparation area will be provided. An exhaust system, an environmental control system, a vapor recovery system, and associated utilities will also be provided. A nonstructural weld barrier with the associated utilities will also be provided.

Modifications to the Vertical Assembly Building, Building 110

A new 60-ton (54,400-kg) bridge crane will be installed in the VAB, and a crane transfer system will be installed between the VAB and the high bay addition (Building 114). The existing structural, mechanical, and electrical systems in the VAB will be refurbished. A number of structural members, piping sections, and electrical fixtures will be replaced. Additional lighting between the walls of the building and the cells will be installed. The existing restroom facilities and offices adjacent to the LO_2 tank proof test cell and the concrete floor of the building will also be refurbished,

Additional Process Heating and Air Conditioning Capacity, Building 114

Additional process heating and air conditioning capacity for the High Bay Addition Building 114 will be provided. This additional capacity will include a new chiller, additional chilled water piping, a boiler and steam piping, and additional air handling units to increase the existing capacity from 375 tons to the current requirement of 525 tons.

Environmental Modifications, Buildings 420 and 451

A new chiller, cooling tower, and hot water boiler with the associated pumps and controls will be provided in Building 420; ducting, valving, and utilities will be extended to Building 451. A valving system will also be installed so that the main plant chilled water and steam can be used as backup systems.

Rehabilitation and Modification of Gaseous Nitrogen System

New GN_2 distribution lines will be installed above and below ground from the bulk storage area to Building 103. The underground portion of the lines will be buried 2-4 feet (0.6-1.2 m) below the surface. The above ground portion will be supported on steel structures. The existing nitrogen storage vessel will be modified to provide new access; it will be hydrostatically tested and connected to the existing GN_2 system manifold.

Rehabilitation and Modification of Boiler Plant, Building 207

This project will provide resources for replacing seven of the old 1,100-ton chillers with three new 2,500-ton chillers; modifying the piping systems to accommodate the new chillers; and providing a new 10,000-KVA double-ended substation to furnish electrical power. New dual switchgear will be installed in the existing substation switchgear room. The new switchgear is to be fed through a three-position switch from the existing transformer. This arrangement will improve the system's reliability, adding backup capacity for both the chillers and the plant lighting and power load.

PROJECT COST ESTIMATE:

The cost estimate for the ablator spray facility is based on a completed preliminary engineering report and on unit costs derived from past experience. All other costs are based on completed preliminary engineering reports.

	Unit of Measure	Quantity	cost	Total Cost
Land Acquisition	---	---	---	---
Construction	---	---		13,980,000
Construction of ablator spray facility, LH_2 tank	---	---	---	5,895,000
Building	CF	1,350,000	1.20	(1,622,000)
Cell structure	LS	---	---	(910,000)
Foundations	LS	---	---	(440,000)
Process heating and air conditioning	LS	---	---	(725,000)
Fire protection system	LS	---	---	(373,000)
Mechanical systems	LS	---	---	(495,000)
Utility systems	LS	---	---	(985,000)
Site work	LS	---	---	(345,000)
Modifications to main manufacturing building 103	---	---		1,140,000
TPS applications booth	LS	---		(890,000)
LH_2/LO_2 tank weld area basis	SF	30,290	8.25	(250,000)
Modifications to VAB, building 110	---	---	---	2,570,000
Provisions of 60-ton crane	LS	---	---	(1,760,000)
Construction of crane transfer system	LS	---	---	(420,000)
Rehabilitation of utility system	LS	---	---	(390,000)
Provisions of additional heating/cooling, building 114	TON	150	5,000.00	750,000
Environmental systems modifications, building 420 and 451	TON	550	1,100.00	605,000
Rehabilitation and modification of GN_2 system	LS	---	---	410,000
Rehabilitation and modification of boiler plant, building 207	---	---	---	2,610,000
Chillers (2,500 tons each)	EA	3	553,000.00	(1,659,000)
Piping, insulation, etc	LS	---	---	(298,000)
Double-ended substation	LS	---	---	(206,000)
Electrical feeders	LS	---	---	(223,000)

	Unit of Measure	Quantity	cost	Total Cost
13.8-kV switchgear	LS	---	---	(100,000)
Foundations and building modifications	LS	---	---	(48,000)
Demolition	LS	---	---	(76,000)
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				~~13,980,000~~

LIST OF RELATED GRAPHICS:

Figure 1 - MAF - Location Plan
Figure 2 - MAF - Aerial Photograph
Figure 3 - Ablator Spray Facility
Figure 4 - Perspective and Elevation, TPS Areas
Figure 5 - ET Weld - Main Manufacturing Building
Figure 6 - Cells with LH2 Tank in Vertical Assembly Building
Figure 7 - Boiler Plant Layout

OTHER EQUIPMENT SUMMARY:

Special tooling (e.g., spray tooling, assembly tooling, unique work platforms, and special dollies) will be needed to meet initial operations. They will be funded from R&D resources. Existing additional Apollo tooling, with modifications as required, will be used to the maximum extent possible.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

Some $13 to 15 million of CoF resources may be required in the future to provide storage capacity for the deionized water used to clean ET's, storage for 8-10 completed ET's, an additional final acceptance and check-out station, two additional TPS cells for the LO_2 tank and intertank in Building 114, an additional TPS cell for the LH_2 tank and one additional cleaning cell for the LH_2 tank as extension of the FY 1979 estimates, as well as conversion of another TPS cell to accommodate the LH2 tank and other support facilities. These estimates are somewhat greater than those projected in the FY 1978 estimates mainly because of additional TPS requirements outlined in this project justification and possible further expansion of ablator application requirements.

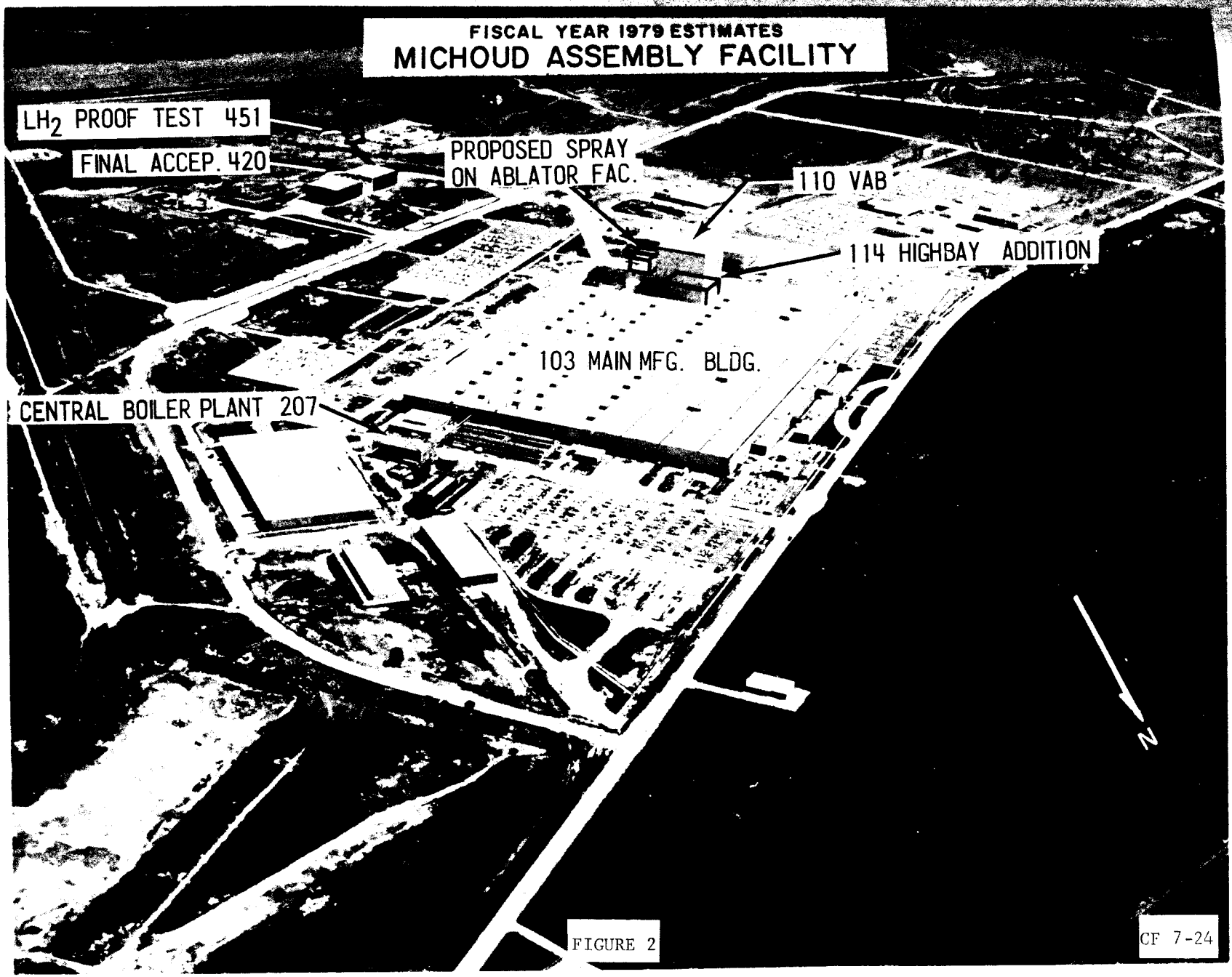
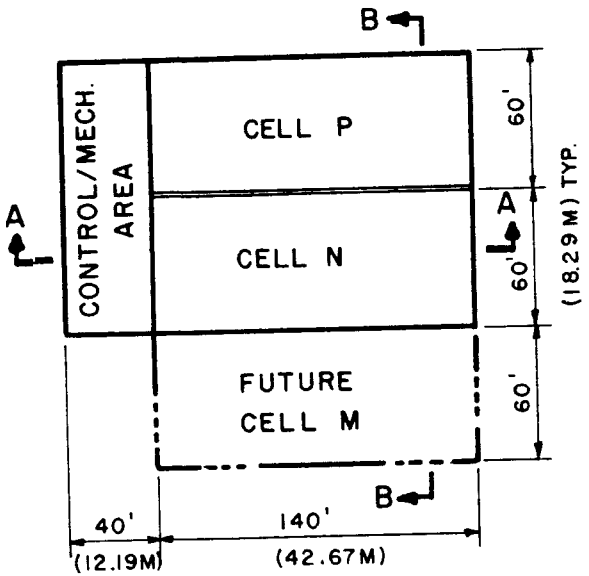


FIGURE 2

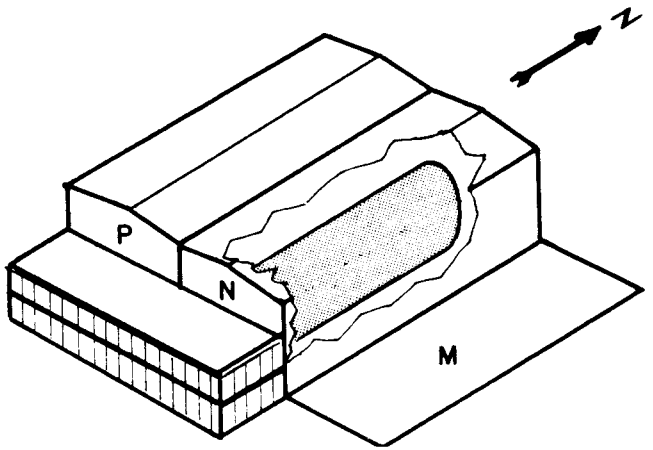
CF 7-24

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1979 ESTIMATES

MODIFICATION AND ADDITIONS OF MANUFACTURING AND FINAL ASSEMBLY FACILITIES FOR EXTERNAL TANKS

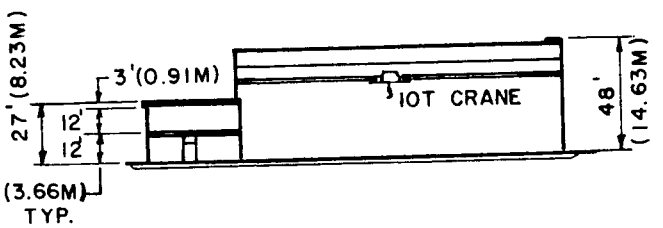


LAYOUT PLAN



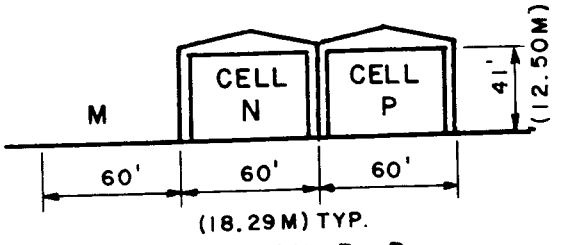
PERSPECTIVE

GRAPHIC SCALE
40 20 0 40 80 FT
0 5 15 25 35 METERS



SECTION A - A

ELEVATIONS



SECTION B - B

NEW ABLATOR SPRAY FACILITY

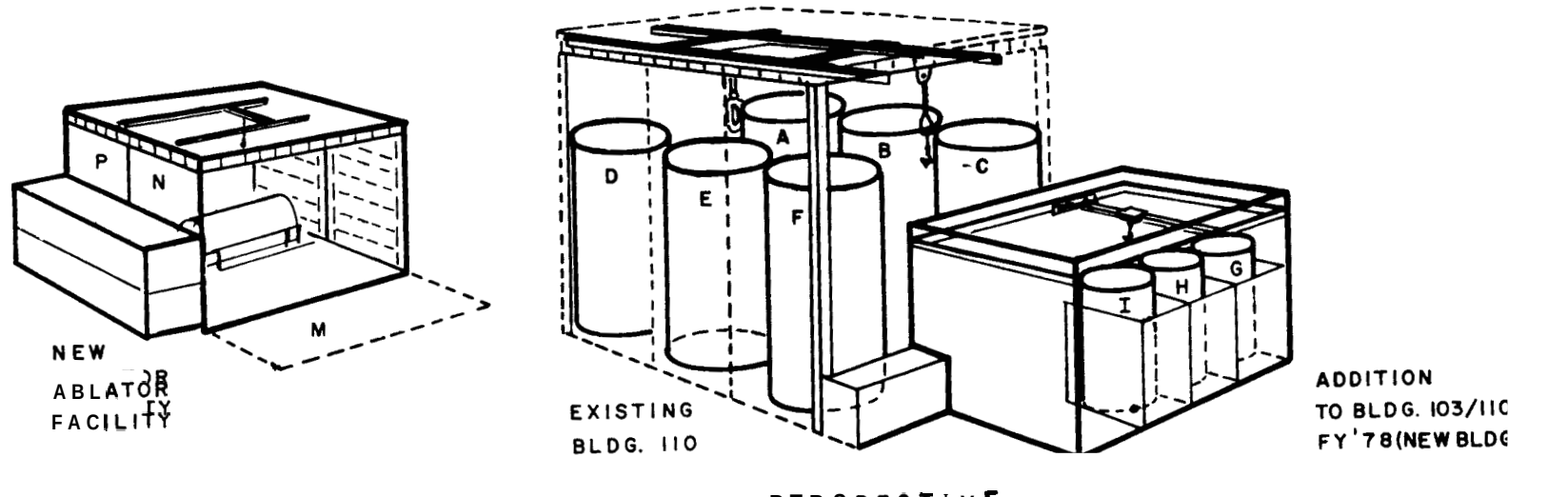
CF 7-25

FIGURE 3

MICHOUD ASSEMBLY FACILITY

FISCAL YEAR 1979 ESTIMATES

MODIFICATION AND ADDITIONS OF MANUFACTURING AND FINAL ASSEMBLY FACILITIES FOR EXTERNAL TANKS



PERSPECTIVE

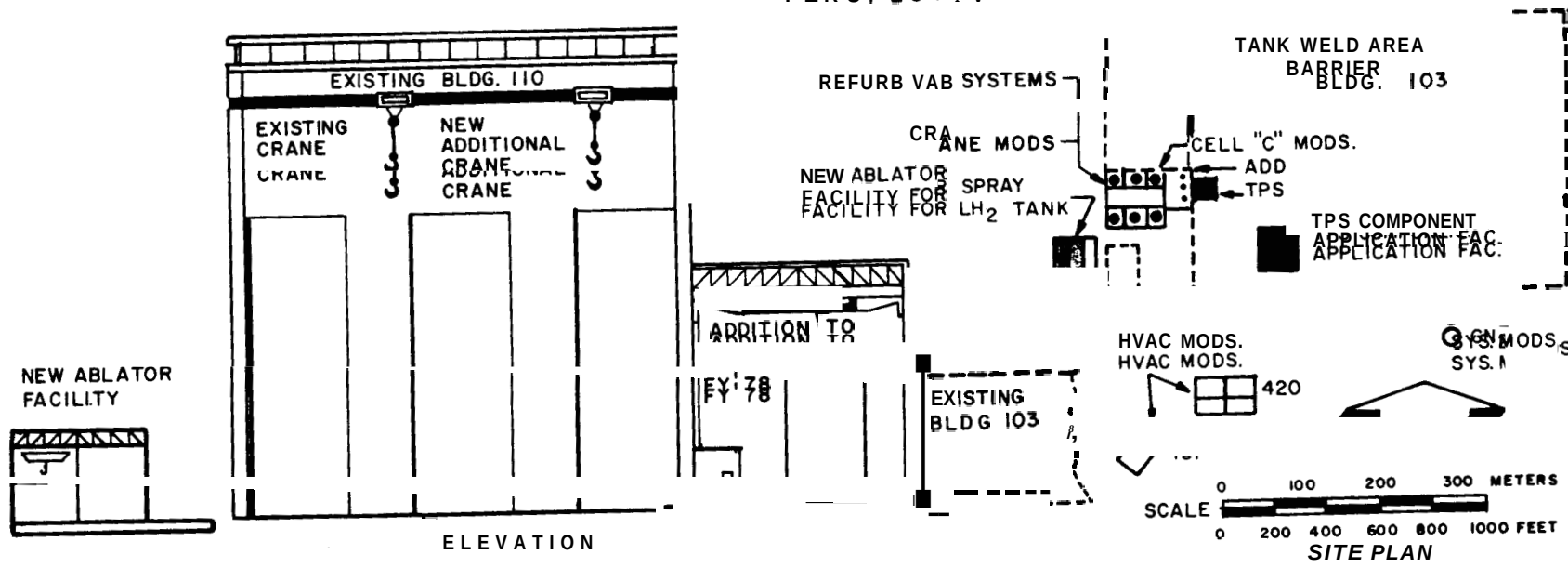


FIGURE 4

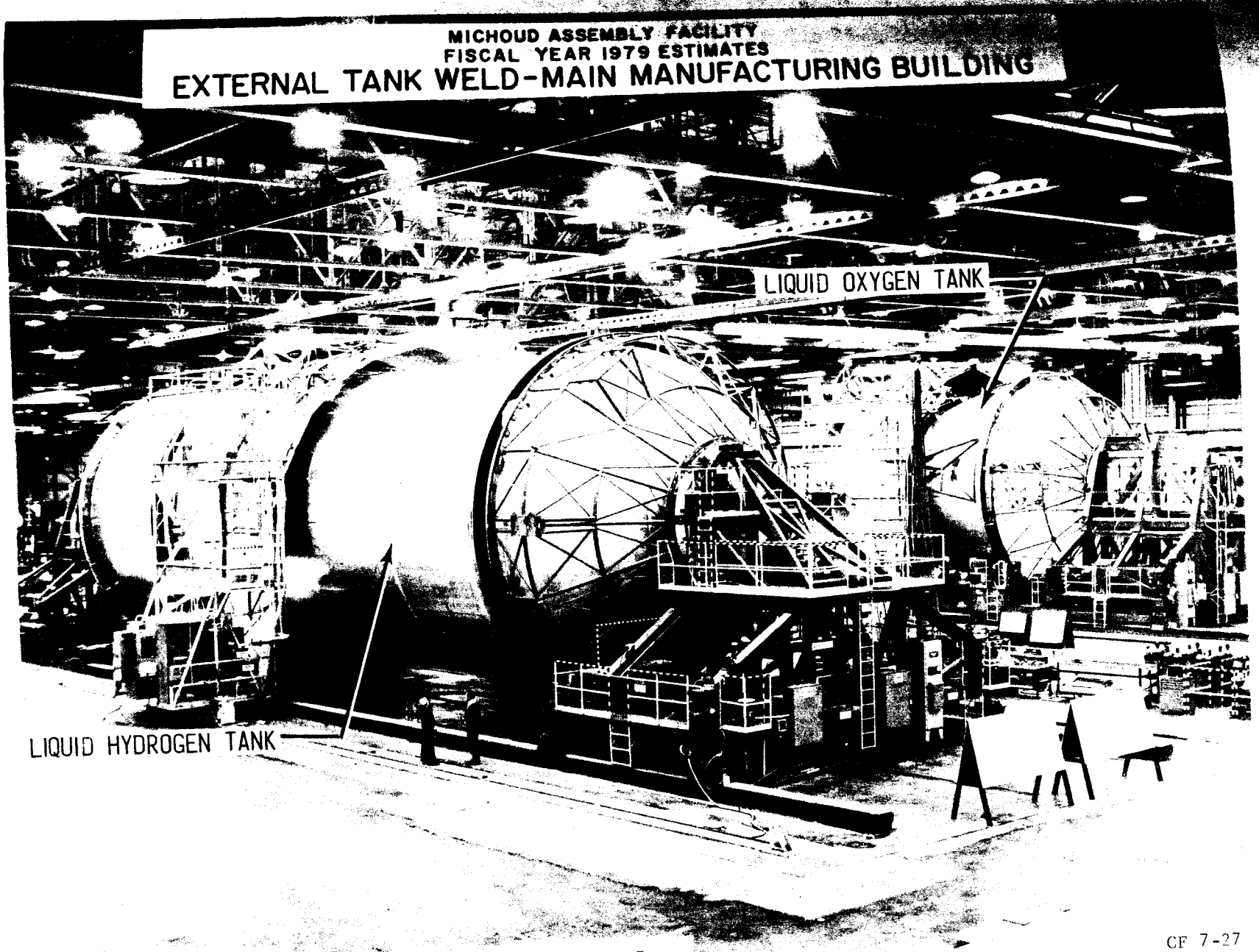

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1979 ESTIMATES
EXTERNAL TANK WELD-MAIN MANUFACTURING BUILDING
LIQUID OXYGEN TANK
LIQUID HYDROGEN TANK

FIGURE 5

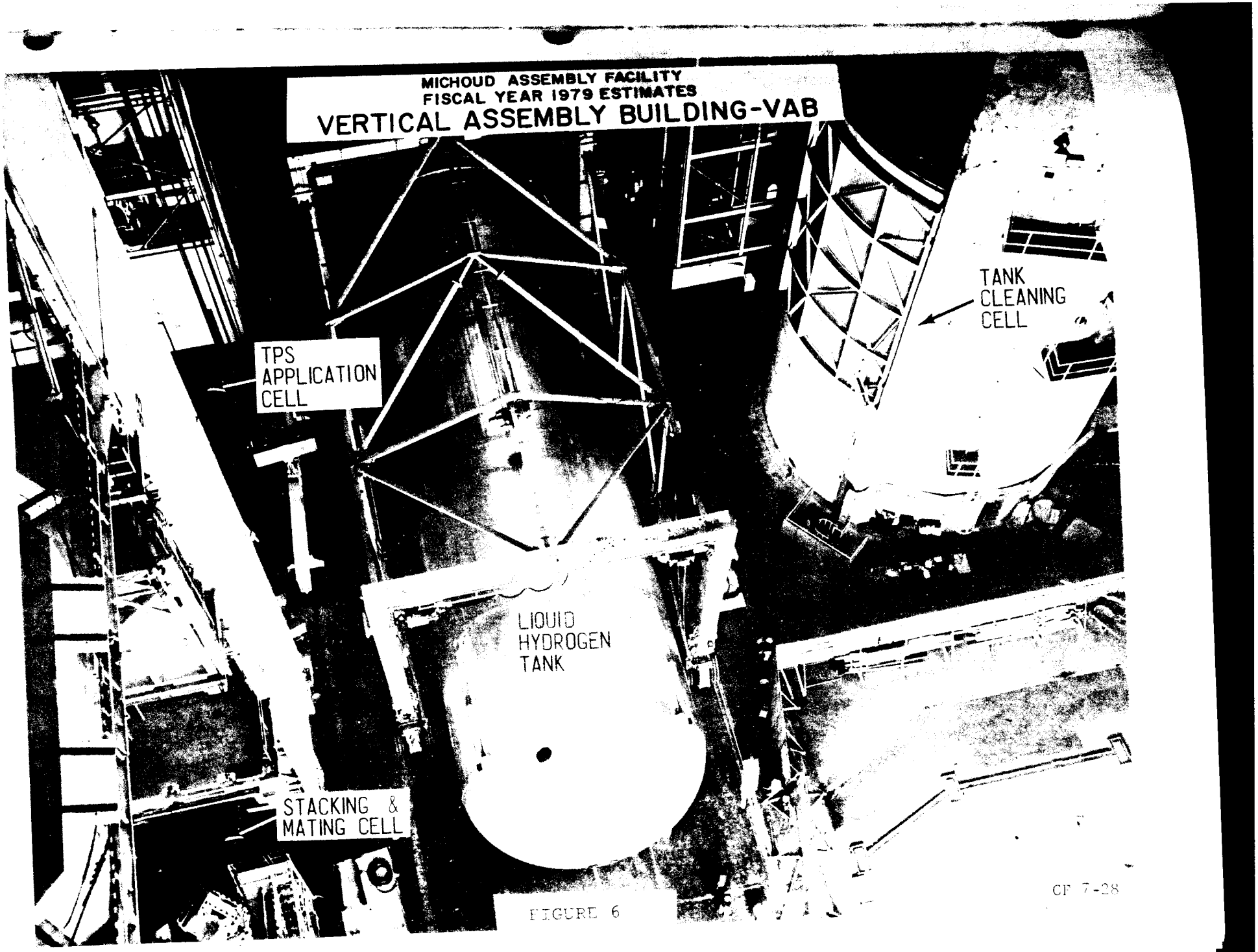
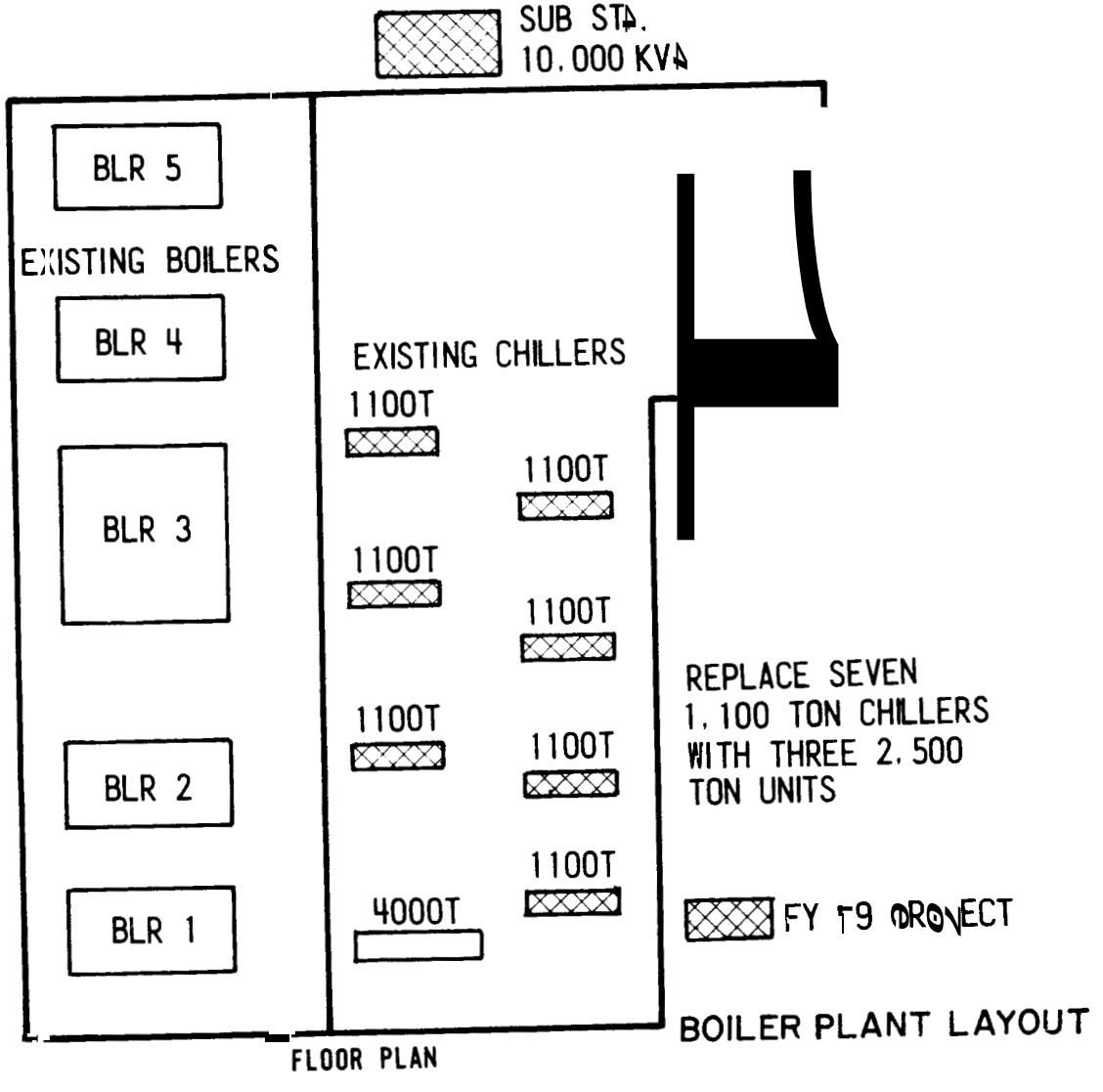

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1979 ESTIMATES
VERTICAL ASSEMBLY BUILDING-VAB
TPS APPLICATION CELL
TANK CLEANING CELL
LIQUID HYDROGEN TANK
STACKING & MATING CELL

FIGURE 6

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1979 ESTIMATES

MODIFICATION AND ADDITIONS OF MANUFACTURING AND FINAL ASSEMBLY FACILITIES FOR EXTERNAL TANKS



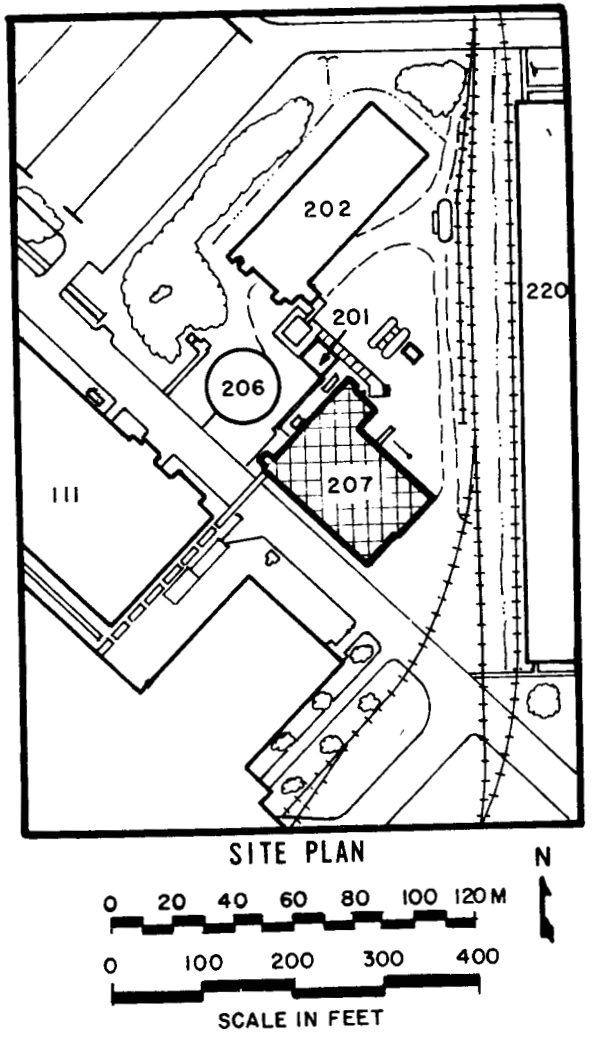


FIGURE 7

FISCAL YEAR 1979 ESTIMATES

MODIFICATIONS TO SOLID ROCKET MOTOR MANUFACTURING AND ASSEMBLY FACILITIES

THIOKOL, WASATCH, UTAH

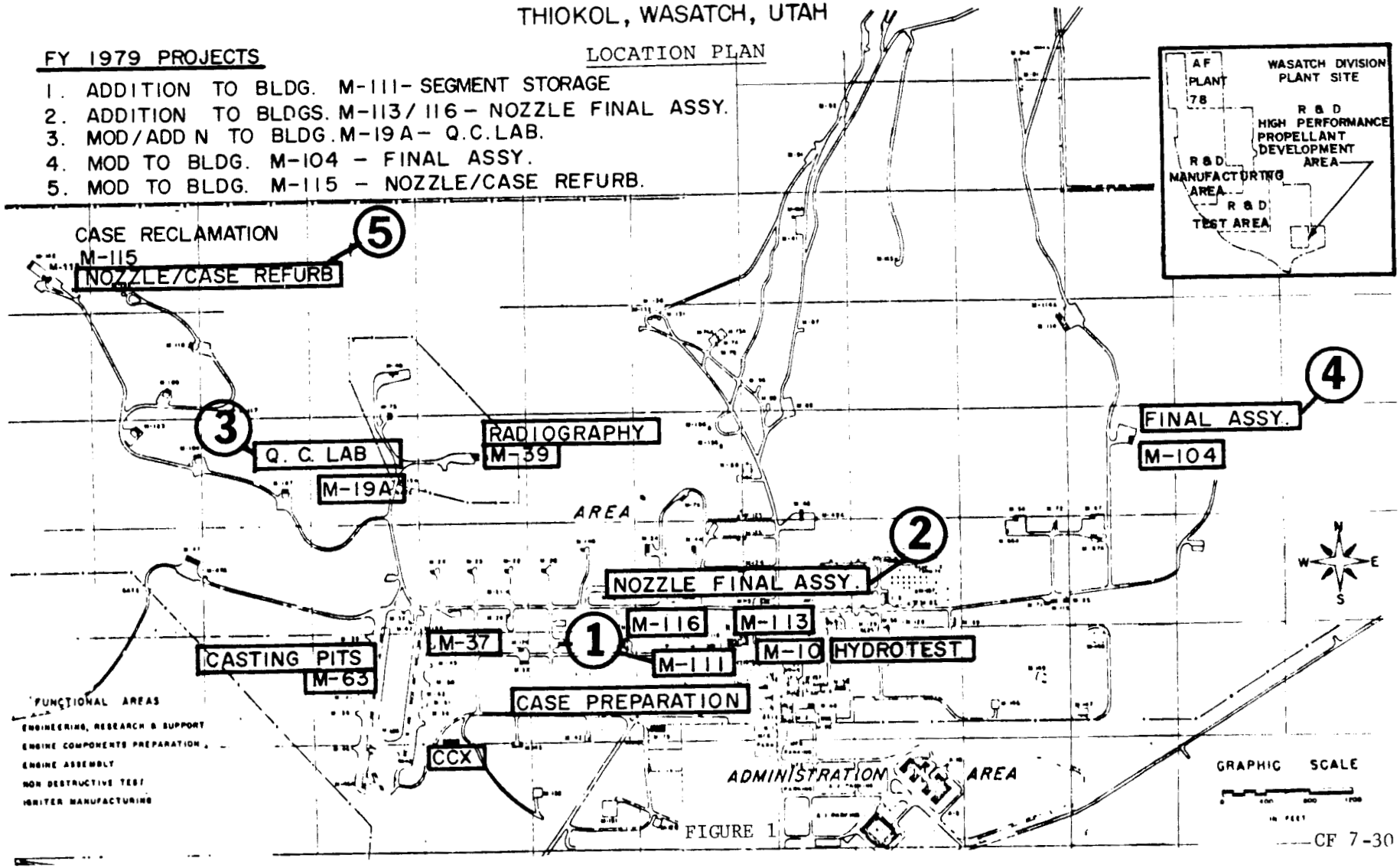


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE: Modifications to SRM Manufacturing and Assembly Facilities

INSTALLATION: Thiokol Plant, Wasatch Division

FY 1979 CoF ESTIMATE: $1,920,000

LOCATION OF PROJECT: Wasatch, Utah

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

COGNIZANT INSTALLATION: Marshall Space Flight Center

FY 1978 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	134,000	---	134,000
Other affiliated funding	---	1,983,000	1,983,000
Total	134,000	1,983,000	2,117,000

SUMMARY PURPOSE AND SCOPE:

This project continues work begin with FY 1975 resources to provide Space Shuttle solid rocket motor (SRM) production capability in Government-owned facilities at the Thiokol Plant, Wasatch Division, Wasatch, Utah. The facilities involved are portions of Air Force Plant No. 76 which are involved in SRM production and the cost of the basic plant facilities is not included in the prior years funding data above. The prior year NASA resources provided modifications to the oxidizer grinding, case preparation and reclamation, radiographic inspection, nozzle joint testing, and casting facilities to support up to 10 Shuttle flights per year and this earlier

work is complete. This FY 1979 project will provide for modification of additional Government-owned facilities to provide that production capability necessary to support 24 flights per year.

The proposed work includes an addition to the case preparation facility (Building M-111) for in-process storage of casting segments; an addition to the nozzle assembly facility (Buildings M-113 and M-116); and modifications to Building M-113 to accommodate nozzle fabrication and assembly operations; modifications to the quality control laboratory (Building M-19A) for propellant batch sampling and testing; modifications to the SRM final assembly facility (Building M-104); and modifications to the nozzle/case refurbishment facility (Building M-115).

PROJECT JUSTIFICATION:

Prior year resources were used to modify existing Government-owned buildings at the Thiokol/Wasatch plant in Utah to develop and manufacture Space Shuttle solid rocket motors. These modifications were geared to 10 Shuttle flights per year or facilities sufficient for the test phase and the early operational phase of the Shuttle program. This level of production will be achieved. This FY 1979 project will then provide resources to further modify Government-owned facilities at Thiokol/Wasatch to support the Shuttle increased launch rates and is especially focused on support of the 18 flights per year planned for CY 1982. Since these basic modifications, to be provided with FY 1979 resources, are not too sensitive to flight rates in the 18 to 24 range, it is prudent to provide For the 24 flight per year capability as indicated.

The Space Shuttle vehicle consists of the orbiter, a large external tank, and two solid rocket boosters (SRB's). Each SRB consists of four 146-inch (370.8-cm) diameter SRM's and various structural components. The 152-inch long by 148-inch diameter (386.1 cm by 375.9 cm) nozzle is the primary structural element. The nozzle consists of three major components: the flexible bearing, the throat assembly, and the exit cone. The flexible bearing is fabricated in the inert processing complex. The nozzle is assembled in Building M-116.

SRM case segments are assembled, insulated, lined. and painted in the inert operations complex. Assembled segments, called casting segments, are then move? to the casting pits, where they are loaded with solid propellant. After the propellant is loaded, the segments are moved to the final SRM assembly area. There they are weighed, and the center of gravity is determined. The systems tunnel, nozzle and igniter, instrumentation, and handling harness rings are installed. The segments are inspected and determined to he ready for shipment.

Four of the facilities to be modified by this FY 1979 project will increase the SRM production capability, and the fifth will support the refurbishment of nozzles that are to be returned for reuse.

Addition to Building M-111

SRM casting segment storage adjacent to the case preparation facility is necessary. It will provide a holding area for segments awaiting inspection. Storage is also needed to accommodate SRM production that occurs

between the test phase and the operational phase. It is projected that up to eight casting segments must be stored in this facility at one time for periods of at least four weeks. They cannot be stored outdoors because of adverse weather conditions in Utah.

Addition to Buildings M-113 and M-116

Originally, Buildings M-113 and M-116 were to be used for nozzle fabrication and assembly. Since then, however, the weight of the nozzle has almost doubled because more insulation (ablator) is needed and because the expansion ratio has been increased. These factors in turn have increased the time required for fabrication. Accordingly, more floor space is needed to meet the production rate of *48* nozzles per year *(24* flights at 2 per flight). Additional floor space and foundations for the installation of five wrapping machines are also required in Building M-113. A structure joining Buildings M-113 and M-116 will provide the necessary work area to meet nozzle manufacturing rates supporting *48* SRB's or *24* flights per year.

Modifications and Addition to Building M-19A

During SRM segment casting, propellant must be tested and approved to ensure that good quality propellant is used. This testing must be done quickly so that casting operations are not delayed. Samples must be drawn from each propellant batch, and physical properties and burning rate determined. During the Shuttle development phase, propellant will be tested in AF Plant 78, 5 miles (8 km) away. As the production rate increases during the operational phase, however, this travel will become time-sensitive and expensive. Modifying Building M-19A, which is close to the casting area, will provide a less expensive alternative for propellant testing. The facility must also accommodate new and more frequent sampling requirements for the propellants which are not presently provided by AF Plant 78.

Modifications to Building M-104

Originally, Buildings M-66 and M-67 were to be used for SRM final assembly operations. Since then, the decisions to modify casting configurations, and the associated requirement for larger casting segments (50,000 pounds (22,500 kg) heavier, 30 inches (76.2 cm) longer, and *4* inches (10.2 cm) wider) have emerged and have increased the time and floor space required. Modifying Building M-104 to accommodate these increased requirements will satisy this need.

Modifications to Building M-115

Originally, it was planned to remove the nozzle ablative liner and to disassemble the flexible bearing by using heat. It has since been determined that disassembly can be accomplished more quickly if high pressure water is used in the same manner as that used for case cleanout. Using the water technique rather than heat should increase the life of the nozzle metal components. During the Shuttle development phase, the existing case washout facility can also be used to disassemble the nozzle. When the flight rate increases, however,

washout capability specifically for the nozzle will be required. Modifying Building M-115 will provide this capability and it can accommodate nozzle reclamation for up to 24 launches per year.

The most sensitive year of requirement is CY 1982 when launch rates will build up to 18 per year. Allowing for fabrication and shipment as well as KSC onhand lead time requires that this facility work be completed, checked out, and operational by the second half of CY 1980. To achieve this target date requires that construction be initiated by not later than early in CY 1979; therefore FY 1979 funding is necessary.

PROJECT DESCRIPTION:

This project provides for an extension of the work provided with FY 1975 resources and will augment SRM manufacturing and assembly facilities to support up to 24 Shuttle flights per year. The proposed work includes additions and/or modifications to Buildings M-111, M-113, M-116, M-19A, M-104, and M-115.

Addition to Building M-111

The addition to Building M-111 will be used to store SRM casting segments and tools, and to inspect SRM segments. A 7,650-square foot by 20-foot high (690 m^2 by 6.1 m) addition to building M-111 will be built. The associated site work; foundations; and structural, mechanical, and electrical systems are included in the project.

Addition to Buildings M-113 and M-116

The addition to buildings M-113 and M-116 will be used for nozzle fabrication and assembly. A 6,900-square foot by 43-foot high (620 m^2 by 13.1 m) addition to building M-116 will be provided; it will accommodate additional nozzle assembly work stations. The addition will connect Building M-116 with Building M-113. The Building M-116 crane rail system and mechanical and electrical systems will be extended. Minor modifications to Building M-113 will be required to provide for the installation of five new vertical boring mills.

Modifications and Addition to Building M-19A

Modifications to Building M-19A will support propellant testing. Modifications include a new, explosion-proof electrical system and an exhaust system in the existing heating and ventilating system. Other work includes providing concrete floors and walls, exterior walls of wood studs with corrugated fiberglass panels, and a builtup roof. The new addition will house two casting bays and a liner replacement bay.

Modifications to Building M-104

Modifications to Building M-104 will support SRM final assembly. They include demolition, enlarging doors, modifying structural components, adding a 6-inch (15.2 cm) concrete air pallet floor over the existing floor and a 14-inch (35.6 cm) thick exterior concrete air pallet, and the necessary mechanical and electrical work.

Modifications to Building M-114

Building M-115 will be used to refurbish nozzles. A new addition with an overhead crane, water supply and disposal system, and the required mechanical and electrical work are included in the project.

PROJECT COST ESTIMATE:

This cost estimate is based on a completed preliminary engineering report.

	Unit of Measure	Quantity	Unit cost	Total cost
Land Acquisition	---	---	---	---
Construction	---	---	---	1,920,000
Addition to case preparation facility, Building M-111	---	---	---	480,000
Site work and paving	LS	---	---	(38,000)
Foundations and slab	CY	900	100.00	(90,000)
Building structure	SF	7,650	25.00	(192,000)
Heating and ventilation systems	LS	---	---	(89,000)
Electrical power and lighting	LS	---	---	(71,000)
Addition to nozzle final assembly facility, Buildings M-113 and M-116	---	---	---	740,000
Site work and demolition	LS	---	---	(94,000)
Modifications to existing buildings	SF	480	37.50	(18,000)
Construction of new building foundations and slab	CY	2,000	109.00	(218,000)
Building structure	SF	6,900	36.40	(251,000)
Heating and ventilation systems	LS	---	---	(90,000)
Electrical power and lighting	LS	---	---	(69,000)
Modification/addition to quality control laboratory, Building M-19A	---	---	---	180,000
Modification to existing building addition	SF	2,000	24.00	(48,000)

	Unit of Measure	Quantity	Unit Cost	Total Cost
Foundations and slab.....	CY	185	102.70	(19,000)
Building structure.....	SF	1,200	60.80	(73,000)
Heating and ventilation systems...	LS	---	---	(17,000)
Electric power and lighting..	LS	---	---	(23,000)
Modifications to SRM final assembly facility, Building 104.....	---	---	---	110,000
Concrete pavement....	CY	690	71.00	(49,000)
Door modification.....	LS	---	---	(61,000)
Modifications to nozzle/case refurbishment facility, Building M-115.....	---	---	---	410,000
Demolition.....	LS	---	---	(66,000)
Modification of structure.....	SF	3,600	35.56	(128,000)
Heating and ventilation systems..	LS	---	---	(130,000)
Electric power and lighting.....	LS	---	---	(45,000)
Substation modifications.....	LS	---	---	(41,000)
Equipment.....	---	---	---	---
Fallout Shelter (not feasible).....	---	---	---	---
Total...				1,920,000

LIST OF RELATED GRAPHICS:

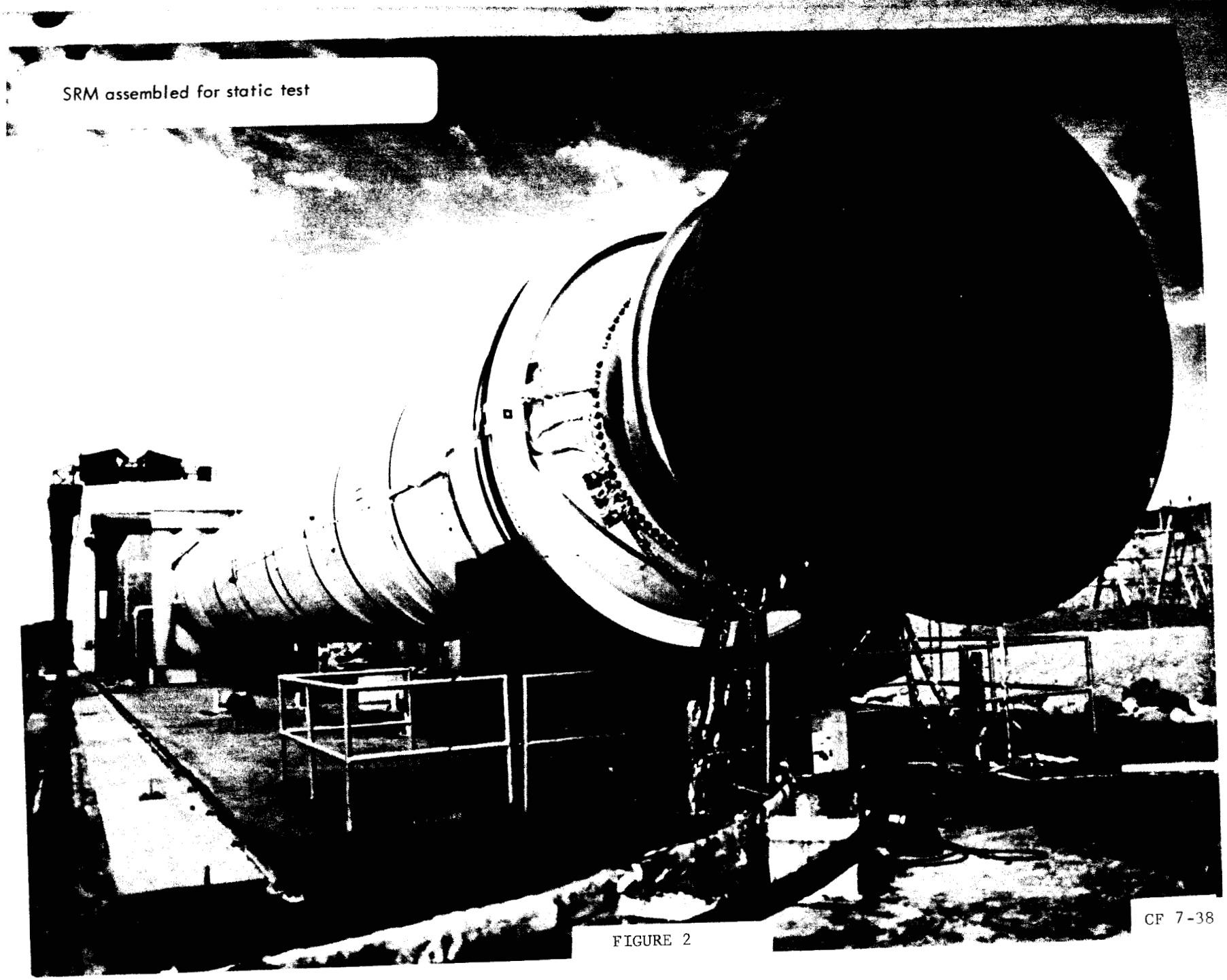
Figure 1, Location Plan
Figure 2, SRB Assembled for Static Test
Figure 3, Applying Carbon Tape to SRM Nozzle
Figure 4, Installing Insulation inside SRM Case Segment

OTHER EQUIPMENT SUMMARY:

Special tooling and equipment (e.g., handling rings, dollies, bearing tooling, disassembly tooling, mobile cranes, etc.) will be needed to support production. This Government-furnished tooling and equipment will be funded from R&D resources and is estimated to cost approximately $1.6 million.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

Some additional resources may be necessary to complete SRM manufacturing facilities to support 60 Shuttle missions per year, but the details and extent of these potential needs cannot be estimated until contractor proposals and/or selections are available.



SRM assembled for static test

CF 7-38

FIGURE 2

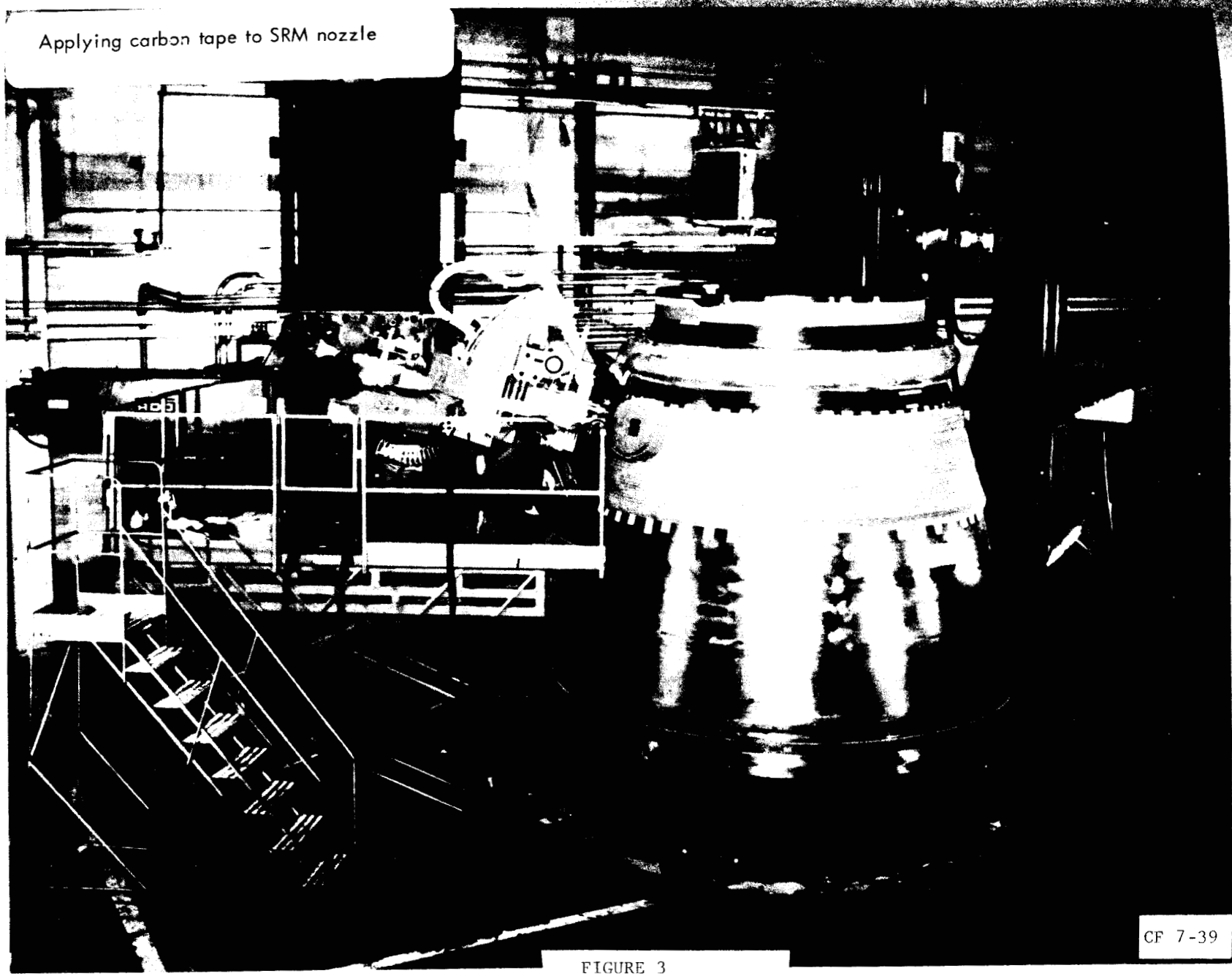


FIGURE 3

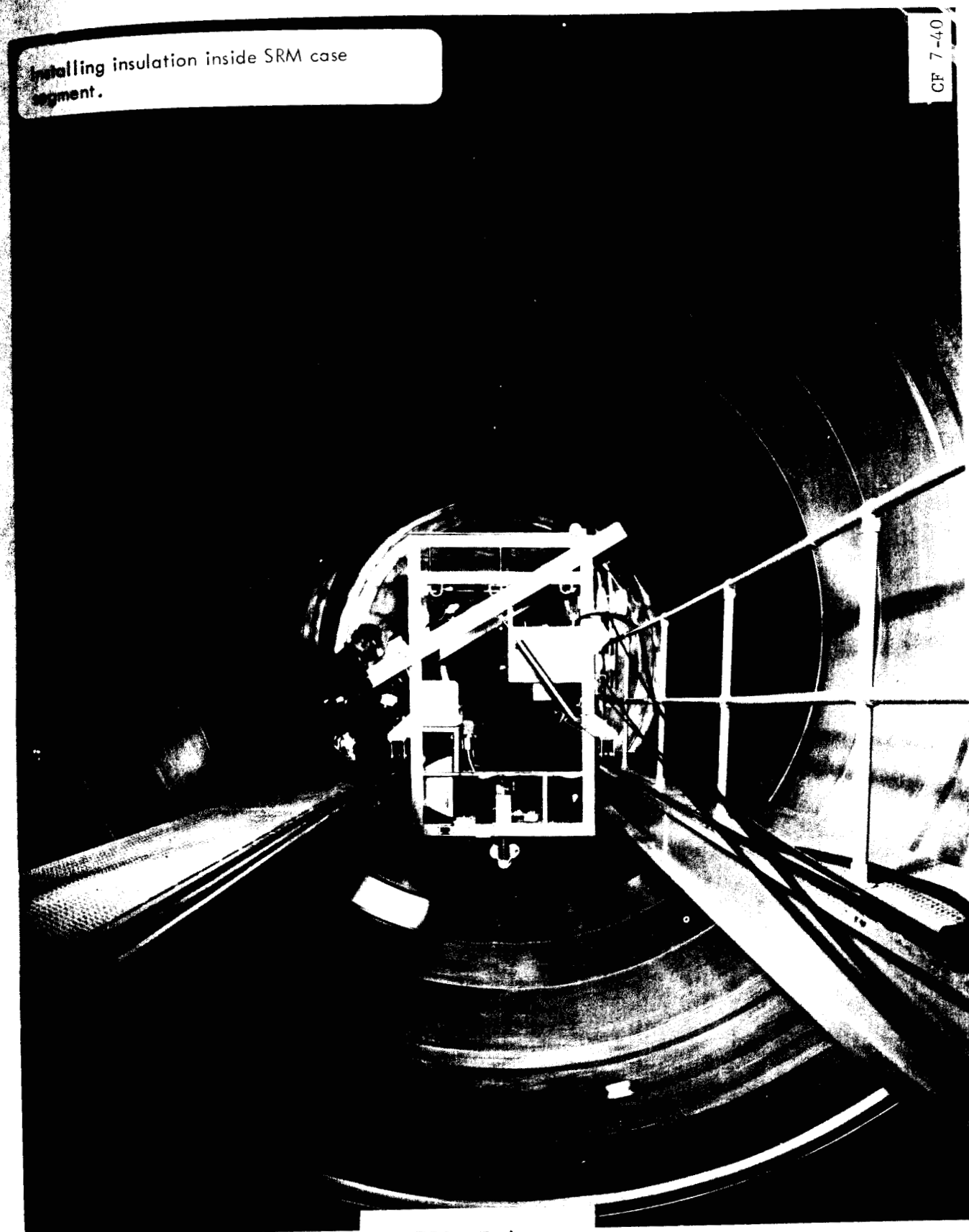


FIGURE 4

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR *1979* ESTIMATES

SUMMARY

MINOR SHUTTLE-UNIQUE PROJECTS, **AT VARIOUS LOCATIONS**

	Amount	Page No.
Office of Space Transportation **Systems**:		
Johnson Space Center	580,000	**CF** *7-43*
Marshall Space Flight **Center**	*480,000*	**CF** *7-44*
Kennedy Space Center..	*540,000*	**CF** *7-45*
Total	~~1,600,000~~	

REHABILITATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR *1979* ESTIMATES

PROJECT TITLE: Minor Shuttle-Unique Projects

INSTALLATION: Various Locations

FY *1979* CoF ESTIMATE: *$1,600,000*

LOCATION OF PROJECT: Various Locations

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY *1978* AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	356,700	*4,410,000*	*4,766,700*
Other affiliated funding	---	1.365.000	1,365,000
Total	356.700	5.775.000	6.131.700

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to provide for minor rehabilitation and modification of facilities necessary to support the Space Shuttle Program at NASA field installations. Included in this project are facility rehabilitation and modification projects estimated to cost less than $500,000 and minor construction projects estimated to cost less than $250,000. These projects are unique requirements of the Space Shuttle Program to achieve initial operational capability or to meet program milestones.

PROJECT JUSTIFICATION:

Space Shuttle development, assembly, and test requirements are being carried out to a large extent in existing Government facilities at the various NASA installations and industrial plants. The major modifications and new construction required at these locations are presented as discrete line items within an integrated Space Shuttle facilities project. In many instances, Shuttle support can be accommodated in existing facilities, or when only limited rehabilitation or modification is required to achieve the desired capability.

This project includes only Shuttle-unique facility rehabilitation and modification projects estimated to cost less than $500,000 and minor construction projects estimated to cost less than $250,000. Each work item is necessary to support a specific Shuttle requirement, ensure continued reliability, provide a safer environment, and/or improve the efficiency and economy of individual facilities supporting the Space Shuttle Program.

For clarity, full disclosure purposes, and better fiscal and technical control, all unique Space Shuttle facility requirements, both discrete individual line items and the smaller facility projects, are included in the total Space Shuttle CoF budget. The work covered in this project is of such a nature and magnitude that it is included under a single rehabilitation and modification Shuttle project for various locations. The cost of this project and all similar follow-on projects will be charged against the total Space Shuttle facilities commitment.

PROJECT DESCRIPTION:

This project provides for necessary rehabilitation and modifications to existing facilities and minor construction in support of the Space Shuttle Program. The justification, description, and cost estimate for each element are listed below.

A. Johnson Space Center (JSC) 580,000

1. Modifications to Flight Control Rooms and Support Areas, Building 30..... *460,000*

This project provides for reconfiguration of flight control rooms and support areas in the Mission Operations Wing (MOW) of the Mission Control Center (MCC), building 30. The third-floor work is necessary to convert the MOW flight control rooms and other operational areas from their originally designed single-mission capability *to* a configuration that will permit simultaneous support of several missions during Shuttle operations. Four flight control rooms, several multipurpose support rooms, and other related support areas must be provided. Expanding the first-floor tape library is required to meet the projected demand for increased storage area to accommodate the nearby real time computer complex, the Shuttle data processing complex, and the telemetry processing computer.

Approximately 17,180 square feet (1,550 m^2) on the third floor and approximately 2,240 square feet (200 m^2) on the first floor will be modified for these purposes. The third-floor changes are primarily in the flight control rooms. They consist of reconfiguring partitions, installing new floors and ceilings, replacing damaged flooring, redistributing electrical power, adding new lighting, modifying and rebalancing air conditioning, and altering the first detection/suppression systems. Similar changes will be made on the first floor to expand the existing tape library to meet operational storage requirements. These modifications include removing partitions, the suspended ceiling, and the raised floor platform; replacing damaged raised flooring; constructing 2-hour, fire-rated partitions and ceiling; adding a fire-rated foor; and modifying existing lighting, air conditioning, and fire detection/suppression systems as required. Existing movable storage shelf units will be relocated to the expanded tape library.

Additional funds may be required in subsequent years to reconfigure other areas for the Space Shutt e operational phase but these cannot be identified at this time.

2 Construction of Mezzanine for Shuttle Government-Furnished Equipment (GFE) Logistics, High Bay Wing, Building *44* 120,000

JSC must store communications equipment used with the Shuttle orbiter flight tests during most of the Shutt e Program in Building *44.* Equipment maintenance will be performed during crew training and operational flights, and stowable equipment will be tested before it is shipped to Kennedy Space Center. This equipment maintenance and testing was formerly accomplished offsite by contractors; however, it will now be performed at JSC. Additional physical space is required because of the quantities of equipment to be stored, tested, and maintained, and because existing laboratory space in the building is being used for other Shuttle-related communications activities.

This project provides for construction of a new *1,476* square foot *(133* m^2) mezzanine in the northwest corner of the high bay wing of the Electronic Systems Compatability Facility, building *44.* A concrete floor slab on metal decking supported by steel beams and columns will be provided. Gypsum board partitions, a suspended acoustical ceiling with flush mounted fluorescent fixtures, vinyl asbestos tile flooring, electrical wall receptacles, fire detectors, and *a* small bonded storage area will also be provided. Air conditioning ducts will be extended from existing air-handling units to diffusers in the new ceiling.

B. Marshall Space Flight Center ..... *480 ,000*

1. Rehabilitation of Existing Main Gas Line, MAF ..... *480 ,000*

This project provides for rehabilitating the main gas line which serves Michoud Assembly Facility (MAF). The work includes rehabilitating approximately 6,000 feet (1,830 m) of 10-inch *(25.4* cm) diameter underground gas pipe from the meter located at gage 7 to the main boiler plant, building 207. The work

includes installing valves in the line, excavating, back-filling, and paving. Rehabilitation of the line is needed to provide a more reliable gas supply to MAF, to conserve energy, and to avoid potential hazards from gas leaks. The existing gas line was installed about 35 years ago; it is badly corroded. Failure would cause a disruption of gas supply to MAF and could impact Shuttle external tank production operations and for this reason this project is considered appropriately designated as Shuttle unique.

C. Kennedy Space Center... 540,000

1. Rehabilitation of Cooling Towers, VAB Utility Annex 315,000

This project provides for repairs and general refurbishment required to rehabilitate two cooling towers at the Vehicle Assembly Building (VAB) utility annex. Areas of the fan deck, fan stocks, framing, drift eliminators, cement asbestos board, and distribution piping require patching. The fire protection sprinkler system requires rehabilitation. Sump screens need to be replaced. Metal parts and components require corrosion protection, and the timber-structured mist plenum requires protection against internal fungus attack. A cooling tower water bypass will be added to bypass condenser water during cold weather operations.

The cooling towers' general condition is marginal. Continued use will further increase normal deterioration because large volumes of water flow through the towers and because operations occur in a high humidity environment. The tower bypass systems for condenser water are required for economical chiller operation and maximum chiller efficiency during cold weather.

2. Rehabilitation of Controls on Three Boilers, VAB Utility Annex..... 225,000

This project provides for refurbishing or replacing worn-out components of existing high temperature hot water generator controls and instrumentation to achieve the original operating efficiency and reliability. The existing controls and instrumentation are worn and outdated. They require a greal deal of maintenance and are not reliable. Some spare parts are no longer available. Unless these systems are refurbished, breakdowns will occur more frequently. Failure of the controls will endanger the heating and humidity control systems for the Vehicle Assembly Building, the Launch Control Center, and the Orbiter Processing Facility thereby potentially affecting the Space Shuttle program.

Total.. ..... 1.600.000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

REHABILITATION AND MODIFICATION

Summary of Project Amounts by Location:	Amount	Page No.
Ames Research Center	1,225,000	CF 8-4
Dryden Flight Research Center	1.290.000	CF 8-5
Goddard Space Flight Center	1.765.000	CF 8-7
Jet Propulsion Laboratory	1.400.000	CF 8-9
Johnson Space Center	1.365.000	CF 8-10
Kennedy Space Center	825.000	CF 8-14
Langley Research Center	1.515.000	CF 8-15
Lewis Research Center	1.770.000	CF 8-16
Marshall Space Flight Center	1.660.000	CF 8-19
Michoud Assembly Facility	710.000	CF 8-21
National Space Technology Laboratories	1.100.000	CF 8-22
Wallops Flight Center	1.235.000	CF 8-23
Various Locations	740.000	CF 8-25
Miscellaneous Projects Less than $100.000 Each	1.200.000	CF 8-26
Total	17,800,000	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE:	Rehabilitation and Modification of Facilities not in Excess of $500,000 per Project
LOCATION:	Various Locations
	FY 1979 CoF ESTIMATE: $17,800,000
FY 1977: $17,875,000	FY 1978: $18,900,000

COGNIZANT INSTALLATIONS/LOCATION OF PROJECTS: Various Locations

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller

SUMMARY PURPOSE AND SCOPE:

This program is intended to provide for the rehabilitation and modification of facilities at NASA field installations and Government-owned industrial plants engaged in NASA activities. Included in this project are those priority rehabilitation and modification facility needs for FY 1979 that can be foreseen at the time of the submission of these estimates, and that are estimated not to exceed $500,000 per project. The purpose of this program is to protect, preserve, and enhance the capabilities and usefulness of existing NASA facilities, and to ensure the continued safe, economical, and efficient use of the physical plants. Each of the individual items contained in this year's request for facility rehabilitation and modification work is in itself a proper facility project. Each represents the consistent application of the approved and accepted definition, and, in this context, each includes all of the facility work that needs to be done in the budget time frame, or all of the facility work that can be done in that time frame, as limited by constraints other than availability of resources. Each individual item has been evaluated against applicable need dates, time lines, and the ability to place the planned work under contract in the budget time frame.

In addition to the usual rehabilitation and modification requirements to the physical plant, the Agency continues to emphasize the identification of projects that relate directly to the conservation of energy at the various field installations. This particular program is now specifically directed toward the general

nonprogrammatic or institutional segments of NASA facilities; however, additional attention is also now given to facility modification requirements generated by specific programs or projects.

The $17,800,000 request for FY 1979 is for those projects that must be done in direct support of critical programmatic and institutional requirements. This request also involves approximately $5 million for projects related to energy reduction which in itself testifies to the pressing nature of these needs.

PROJECT JUSTIFICATION:

At its initial cost, the existing NASA physical plant totals about $6.1 billion (September 30, 1977). A continuing program of rehabilitation and modification of these facilities is required to:

a. Protect the capital value represented by these facilities and to overcome the cumulative effects of wear and deterioration.

b. Ensure the continued and reliable availability of these facilities as well as their operational capabilities as applicable.

c. Improve the capabilities and usefulness of these facilities in terms of NASA mission accomplishment, and overcome the aggregate effects of obsolescence.

d. Provide a better and safer environment for all personnel.

e. Provide for significant reductions in energy consumption through the initiation of energy conservation projects and the provision of updated and improved utility control systems.

This project includes only facility rehabilitation and modification work having an estimated cost not in excess of $500,000. The work covered in this project is of such a nature and magnitude that it cannot be accomplished by routine day-to-day facility maintenance and repair activities, or by related routine facility work efforts that are provided for in other than CoF estimates. Rehabilitation and modification work estimated to cost more than $500,000 is reflected as a separate major CoF line item project. Not included in this project are the minor construction of facilities projects (new construction and additions) required in FY 1979. Provision for the major portion of this latter requirement is made under a separate project entitled "Minor Construction," which is also included in these CoF estimates.

PROJECT DESCRIPTION:

Proposed rehabilitation and modification items for FY 1979 are outlined under "PROJECT COST ESTIMATE"; they total $17,800,000. This request is for projects that must be done in this time frame and their

deferral would create high risks or consequences. These would impact on program schedules and critical institutional facilities requirements in support of Agency mission goals and objectives. Also included in this request are direct energy projects associated with building and other types of facilities.

Of the total projects listed, $16,600,000 represents discrete work packages at designated NASA installations. The remaining $1,200,000 relates to those smaller rehabilitation and modification projects estimated to cost less than $100,000, the nature and purpose of which are the same as for that work specifically delineated but which, because of their individual smaller sizes, are not listed by item. At this time, the items in this total package are considered to be of the higher priority. They have been carefully selected from lists totalling about $43 million. This FY 1979 listing thus represents a modest increment in relation to the existing total backlog of this type of work for which provisions must be made over the next several years.

As indicated above, the projects in this request are considered to be of the highest priority on the basis of relative urgency and expected return on the investment involved. It is recognized, however, that during the course of the year some rearrangement of priorities may be necessary. It is also realistic to assume that a change in some of the items to be accomplished within the allocated resources may be required. For the purpose of justifying this estimated facilities rehabilitation and modification requirement, a tentative listing of projects is set forth under "PROJECT COST ESTIMATE." This work will be accomplished on a priority basis. The total of $16,600,000 of discrete projects relates to the following broad categories of facilities:

a.	Utility Systems	$4,995,000
b.	Fire Detection/Protection Systems	1,265,000
c.	General Purpose Buildings	5,160,000
d.	Technical Buildings/Structures	4,665,000
e.	Pavements and Drainage	340,000
f.	Building Exteriors and Roofs	175,000

The additional lump sum estimate of $1,200,000 for smaller projects thus provides a total of $17,800,000 for this program.

NOTE: In many of the projects indicated herein the work involves the rehabilitation and modification of heating, ventilating and air conditioning systems. Reference to heating, ventilating and air conditioning has been abbreviated as HVAC.

PROJECT COST ESTIMATE:

A. Ames Research Center (ARC) 1,225,000

1. Modification of Boiler System in 20 Buildings 340,000

This project modifies 20 boiler systems in 20 buildings to provide a capability to burn fuel oil in addition to natural gas. These buildings are N-200, N-202S, N-203, N-206, N-207, N-210W, N-211S, N-213W, N-214, N-215, N-218S, N-218N, N-219, N-220, N-221N, N-221S, N-226, N-229A, N-236, and N-245. This modification will include the installation of a 1,000-gallon (3.78 kl) fuel oil tank placed under ground adjacent to the boiler room area of each building and the related piping to the applicable boiler. The associated burners will be modified or replaced to permit burning of natural gas, number 2 fuel oil, diesel oil, or JP-5 by manual selector. This conversion to fuel oil is required to maintain the continuity of necessary functions in these buildings during periods of natural gas curtailment. ARC is classed as an interruptible user of natural gas by its supplier. During the winter months, when gas heating is at a peak, severe shortages of natural gas fuel have been experienced and are expected to continue in the future with consequent interruption of supplies and the need to resort to other fuels.

2. Modification of Aviation Fuel System 180,000

This project provides for the modification of the aviation fuel system for storage of JP-4 fuel north of the Flight and Guidance Simulation Laboratory, Building *243*. This modification will include the installation of one 20,000-gallon (75.7 kl) fuel oil tank with all necessary piping, electrical, and pumping systems. The unloading system will be designed for truck and trailer receipt of JP-4 with a motor delivery pump, a delivery filter separator, valve and pipeline system, and a dispensing station. *ARC* maintains a fleet of some 25 aircraft for a variety of research programs. The aeronautical programs include flight test operations, navigation, guidance and control studies, lighting research, and noise reduction investigations. Airborne science programs involve specially equipped or modified aircraft for the collection of scientific data. These programs include infrared astronomy, earth resources studies, and meteorological and geophysical investigations. Fourteen aircraft use JP-4 fuel, and the remainder use JP-5 or aviation gasoline. The existing JP-4 fuel storage facilities are old, obsolete, and poorly located. They use unsafe and outdated handling techniques and equipment, and must be replaced.

3. Rehabilitation of Life Science Complex, Building N-236. 440,000

This project provides for general rehabilitation of the Life Science Complex, Building N-236, to improve these laboratory facilities. This work will include the enclosure of 13,000 square feet (1,208 square meters) of existing covered area with the addition of walls, insulation, and improved roofing. The lighting,

electrical, fire protection, and plumbing systems will also be improved. A new WAC system will be installed. This work will also include the installation of locker and rest room facilities. These rehabilitation and modifications are necessary to correct deficiencies and inadequacies and to upgrade the existing facilities to meet accepted standards for providing appropriate care for hibernating animals. The existing facilities lack the cleaning, washing, and environmental control facilities and the ability to manage live research activities on a quality basis free of microbiological and serological pathogens. This is in support of the Life Sciences Program. This project will provide a facility which will make possible the proper control and management of a wide variety of live specimens destined for use in experiments assigned to the Center. It will provide increased space necessary to accommodate the large number of backup specimens and wide variety of species needed for flight programs.

4. Modification of Building HVAC Systems 265,000

This project provides for the modification of the WAC systems serving 10 buildings. This work is necessary to attain a more efficient operation and reduction in energy consumption. These buildings are N-202A, N-211, N-229, N-235, N-237, N-241, N-243, N-244, N-245, and N-247. This work will include the modification of the WAC systems to allow the use of 100% outside air for space cooling when appropriate. Typical of this modification work is Building N-202A, which presently utilizes manual outside air and return air dampers. The project will provide an economizer air cycle, which requires the addition of a new return air fan, automatic dampers, controls, and new ductwork to be added *to* the existing air handling system. Some modifications to the existing ductwork and new penetration through the exterior metal wall will also be required. In addition, Buildings N-243 and N-245, for example, require air conditioning during working hours except for small computer areas within these buildings, which require continuous air conditioning. The proposed modification for these computer areas will provide separate air conditioning systems with a related reduction in the total energy consumption. These building HVAC modifications will result in a simple payback of just over four years.

B. Dryden Flight Research Center (DFRC) 1,290,000

1. Modification of Standby Power Systems *425,000*

This project provides for the modification of *two* electric power systems at the Central Standby Electric Power Facility, Building 4889, serving the flight control area data systems and the new FPS-16 Radar Facility, Building 4982. This project will provide for the rehabilitation and installation of two presently available 300-kW diesel engine generators in the existing Building 4889. This work will include the associated diesel fuel tank, switchboard, controls, instrumentation, and cables to Substation 1. A new 750-kVA transformer will be installed at Building 4889 and a second of the same capacity at Substation 1. The existing commercial electrical power transformer will be replaced with a new 1,000-kVA unit to be located adjacent to Manhole A.

This project also provides for the construction of a 400-square foot (37.2 square meter) addition to Building *4982* and the installation of two presently available 100-kW diesel engine generator sets. The work will also include the installation of the related switching, control, and starting equipment.

The existing standby electric power generation system at Building *4889* is inadequate to provide uninterruptible electrical power during flight missions. The installation of the two available standby generators and related equipment will provide a dependable power supply for the present and planned anticipated electrical loads. The installation of the two 100-kW generators is required at the FPS-16 Radar Facility, Building *4982,* to provide uninterruptible electric power service during flight missions at this remote site.

2. Modification of Substation 16, Building *4850* 310,000

This project provides for the modification of Substantion 16, Building *4850,* to properly provide distribution to the existing 12-kV primary system to various existing loads. The modification work will include the construction of an addition to the existing 12-kV Bus Steel Structure of Substation 16 to accommodate three new 600-A, 15-kV oil-filled circuit breakers with the related concrete footing and pads, chain link fence enclosure, floodlights, grounding, and controls. This work will also include new electrical service from Substation 16 to Substation 10, Building *4883; to* Substation *4,* Building *4888;* and to Substation 5, Building *4851.* The existing electrical service lines to these three substations will be modified to improve the overall electrical service. The existing Substation 16 was initially built in *1965* to supply the new High Temperature Loads Laboratory Facility, Building *4820.* The construction of other new facilities and the recent Hangar Building *4833* and adjacent Shop Building *4834* with a related growth of electrical load have resulted in an overload condition at Substation 16. This modification will allow the disconnection of individual facility substations without disconnection of other facility electrical services loads, and improve the protection of the electrical power systems at Substation 16.

3. Modification of Utility Control Systems. 270,000

This project provides for the facility modifications for a utility control system (UCS). This modification work will include the installation of a central station minicomputer and operator's console to be located in the Research and Development and Test Facility, Building *4800.* The utility systems that will be monitored and controlled include heating, ventilating, air conditioning, lighting, electrical power, and fire detection in *28* buildings. The existing centralized surveillance monitoring and fire alarm detection systems will be integrated with this UCS. The installation of sensing and control devices on the building utilities in coordination with this system for centralized monitoring and control will conserve energy resources, and reduce maintenance and operating manpower, thus contributing to better management of the Center's facilities within energy reduction goals and manpower guidelines. Resulting simple payback in less than three years.

4. Modification of Fire Protection Systems 285,000

This project provides for the facility modifications to improve fire safety at the Center. This modification work will include the installation of wet-pipe sprinkler systems in approximately *143,250* square feet *(13,308* square meters) in 11 buildings *(4800, 4801, 4804, 4810, 4820, 4824, 4827, 4830, 4870, 4886,* and *4889).* This work will include the sprinkler heads, related water piping, valves, and connections to the existing water systems. These facility modifications to improve the fire protection systems at DFRC are in accordance with the "balanced risk concept" to provide adequate fire protection with respect to life safety and protection of mission essential and high value equipment. A fire protection survey of DFRC indicated that these fire protection modifications are necessary and will provide for an improved level of fire safety to support flight operations.

C. Goddard Space Flight Center (GSFC) 1,765,000

1. Modifications to Mechanical Test Facility and Quality Assurance Laboratory, Building 22.. *475,000*

This project involves the modification of approximately 5,500 square feet (511 square meters) of space in Building *22* for Landsat-D Assessment activities. This modification work will include the installation of new partitions, and improvements to the electrical power and air conditioning systems for data processing equipment, technical support operations, and office space. The facility will provide space for the Landsat-D Assessment activities with the mission of demonstrating, by analysis and test, the utility of the earth observations provided by the Landsat-D System, particularly the Thematic Mapper. This effort will have the objective of providing information that will assist users in the application of the resulting data. The major areas of emphasis will involve the definition and validation of output data products, including calibration, position determination, registration of imagery, and optimization of data processing procedures. The modification of this existing space in Building *22* for Landsat-D assessment activities is the result of an extensive analysis of the overall GSFC housing situation. It has been determined that the most cost effective means of providing for the Landsat requirements would be to improve the utilization of existing space in several buildings, rather than the construction of a new facility. This space in Building *22* has been for modification for the assessment activities due to the similarity of work presently being performed in this building and its contiguous location with other applications activities.

2. Modifications to Project Operations Control Center/Operations Computer Area in Buildings 3, *14* and *23* *290,000*

This project provides for the modifications of existing project operations control center areas that are required to accommodate the establishment of the Project Operations Control Center Network facility and to allow for the replacement of existing computing systems with more modern, efficient equipment. In addition, equipment augmentation and reconfigurations with presently operational control centers will require certain

facility modifications. Approximately 2,800 square feet (260 square meters) will be modified in Central Flight Control/Range Operations Building 3; Spacecraft Operations Facility, Building 14; and Data Interpretation Laboratory, Building 23. This work will include the installation of new partitions and additional electrical power and environmental control systems. Modifications to the Mission Operations Computer Area in Building 3/14 are also required to support installation of computing equipment planned for the Space Shuttle. The present computing systems employ water cooling techniques which will be replaced by air-cooled equipment, necessitating augmentation and modification of the area environmental control systems. In addition, modifications to the secondary electrical power distribution equipment, including safety and signal ground arrangements, will be required. Equipment installation is scheduled to begin in mid-1979 to allow operation status to be achieved for the first Shuttle orbital flights. Modifications to a 300-square foot (27.9 square meter) area adjacent to the Telemetry On-Line Processing Operations facility in Building 23 are required to house the Tracking and Data Relay Satellite System (TDRSS), interface preprocessor. Modification of electrical power, air conditioning and partitioning systems is required to support this installation. The TDRSS interface preprocessor is necessary to allow reception and processing of data received from all orbiting spacecraft sending data via TDRSS.

3. Modifications to Spacecraft Operations Facility, Building 14..... *470,000*

This project involves the modification of approximately *6,000* square feet (557 square meters) in Building *14* for a Space Telescope Operations Control Center. This modification work will include the installation of approximately 3,600 square feet *(334* square meters) of raised floor for computer equipment and 2,400 square feet (223 square meters) for technical support and office space. This work also includes modifications to the partitions and improvements to the electrical power and air conditioning systems. The proposed modifications will provide space for software development, operational support, and data evaluation for the Space Telescope. This work must be accomplished at this time to support the instrument development, integration, and quality assurance of the Space Telescope project. The modification of existing space in Building 14 for the Space Telescope project activities is the result of an extensive analysis of the overall GSFC housing situation. It has been determined that the most cost effective means of providing for these operational control and developmental activities would be to utilize existing space that will be available when the Network Operation Control Center (NOCC) is completed, rather than the construction of new facilities for this requirement. Building 14 has been selected for the Space Telescope Operations Control Center due to the availability of communications and utility services and the related operations activities that are being conducted in this facility.

4. Modifications for Fire Protection and Safety..... 180,000

This project provides for the modification of facilities for fire protection and safety. Included in the project are the upgrading of exits for life safety in 10 onsite GSFC buildings, and the completion of sprinkler coverage in five onsite buildings. Exit upgrading and sprinkler coverage will be completed in

Buildings 8, 11, 12, 15, and 21, while sprinkler coverage will be completed in Buildings 2, 3, 6, 22, and 302. The upgrading of exits for life safety involves the provision of additional exits where required, the improvement of access routes to existing exits, and the modification to existing fire protection systems to ensure adequate sprinkler coverage.

5. Modifications for Energy Conservation in Five Buildings 350,000

This project provides for the modifications to the HVAC and other mechanical systems in five buildings to improve the utilization of energy. This modification work will involve improvements to the low pressure induction systems to eliminate reheating in the Space Sciences Laboratory, Building 6; Applied Sciences Laboratory, Building 11; and Tracking/Telemetry Laboratory, Building 12. This work will also include the installation of a boiler blowdown tank and heat exchanger to improve heat recovery in the Central Power Plant Building 24. An outside air intake with enthalpy control to reduce the cooling requirements will be installed in the Central Flight Control/Range Operations Building 3. An assessment of these improvements has been made to achieve improved energy conservation. These modifications are cost effective, with a simple payback of approximately 3 years.

D. Jet Propulsion Laboratory (JPL) 1,400,000

1. Modifications to the Central Cooling Tower System. 405,000

This project provides for the replacement of a number of small existing cooling towers that supply 10 buildings with a single cooling tower system. The work included in this package will provide a centrally located cooling tower with a capacity of 3,600 tons and all associated distribution piping. This effort consists of the maximum amount of work that could be accomplished in this time frame due to the scheduling of building shutdowns. The existing cooling tower systems serving these buildings are 25 years old and are badly deteriorated and must be replaced in any event. The replacement of the existing cooling towers with one central tower will significantly reduce the high operation, maintenance and energy costs which are now occurring as a result of the present cooling system.

2. Modifications in Various Buildings to Enhance Building Safety 205,000

This project provides for modifications to the elevators and shafts in Buildings 157, 168, 169, 183, 198, 230 and 238 for the protection of personnel in the event of an emergency. Work includes modification of portions of the existing elevator control circuitry to comply with the latest safety code requirements for special emergency service and rescue operations. A life support system will be provided with a control panel for use by the rescue forces. A communication system will be provided at each floor and inside each elevator car for use in case of emergency. Included will be structural modifications to the elevators, rails,

and drive systems. This work is necessary to protect the life and safety of personnel so that efficient egress and control of the building elevators can be accomplished in the event of an emergency.

3. Modifications to Fire Protection Systems in Various Buildings 370,000

This project provides for the upgrading of the fire protection systems in six buildings necessary to protect life and equipment. It includes the installation of fire alarm systems and sprinklers and critical portions of Buildings 58, 67, 82, 83, 99, and 197. This work is necessary to retard the spread of potential fire, provide personnel warning for timely evacuation and to protect high value research equipment/spacecraft components contained in these buildings. The project also includes the installation of wire glass in the steel frame of the high bay wall of Building 179 to prevent the spread of fire.

4. Modifications for Utility Control System 420,000

This project provides modifications to existing utility systems for remotely controlling measuring values, and determining the status of temperatures, pressures. humidities and electrical energy consumption in various mechanical rooms. The work includes the installation of multiplex equipment, building control panels and system control and approximately 140 monitoring points for some 30 buildings. This work is required to provide the necessary interface for remotely controlling each respective heating, ventilating and air conditioning system. Presently, roving patrols are utilized to monitor and repair the individual building systems on the Laboratory. The modified control system will provide immediate notification of equipment malfunctions, thereby minimizing unscheduled shutdowns and preventing potential damage to equipment requiring close environmental control. In addition, approximately 190 monitoring points in some 40 buildings will be provided for maintenance monitoring for the early detection of equipment malfunctioning. The integration of the maintenance systems with the automatic readout capability of the utility control system computer will result in better utilization of maintenance personnel and HVAC equipment. This project will have an estimated simple payback of less than 5 years.

E. Johnson Space Center (JSC) 1,365,000

1. Rehabilitation of the Natural Gas Distribution System 190,000

This project will provide for the rehabilitation of the JSC natural gas distribution system. The project consists of replacing 18,150 linear feet (5,532 m) of deteriorated underground lines and associated valves and regulators, and replacing or repairing the cathodic protection system as required in the natural gas distribution system. This gas distribution system has been in operation at the Center for approximately 15 years. The average life of such systems varies from 5 years for a pressure reducing valve, to 10-15 years for a magnesium anode bed, and up to 20 years for other items in the system. Consequently, the natural gas

system at JSC is approaching the end of a useful life based on normal expectancy, and failures are increasing. With a comprehensive, planned replacement program this distribution system can be maintained to ensure its reliability and operational efficiency.

2. Rehabilitation of Heating, Ventilating, and Air Conditioning Systems in Various Buildings 245,000

This project is a portion of a long-range program for rehabilitation of HVAC systems in various buildings at JSC. The rehabilitation work contained in this portion of the total WAC building program is in itself a facility project. It includes all of the facility work that can and needs to be done in this budget time frame. There are approximately 10 buildings included in this portion of the project. The work includes repair and/or replacement of air-handler casings and structures, compressors, condensers, valves, pumps, condensate units, and fan/scroll assemblies. Also included are coil cleaning, damper and duct repair, suspension replacement, instrumentation calibration, and insulation and painting of all components and ancillary equipment. The program is needed because age, high humidity, and salt/chemical content of the air in this region have deteriorated coils, fans, and casings of air handling units. Also, various components of the heating/cooling systems are approaching the end of a useful life expectancy. These systems are essential ingredients of the Center's energy conservation program and must be maintained in above-average condition for maximum operational flexibility and efficiency.

3. Rehabilitation of Heating/Cooling Generation and Distribution Systems, Building 24 Complex 145,000

This project provides for the rehabilitation of certain of the various components of JSC's primary utilities generation and distribution systems located in the Central Heating and Cooling Plant, Building 24, including utility tunnels. The rehabilitation work contained in this portion of the total rehabilitation of the Building 24 complex is in itself a facility project. It includes all the facility work that can and needs to be done in this budget time frame as limited by constraints generated by that portion of the complex which may be inoperable at any one time. The work includes the structural rehabilitation of all seven cells of the cooling tower; it covers catwalks, stairs, railings, basins, and all wood components of the cells. In addition, this project provides for rehabilitation of the support systems for the boilers in Building 24, which includes the boiler feed-water system, boiler condensate, return system, boiler chemical feed system, boiler blowdown system, and related piping and controls. The project also provides for rehabilitation of the steam, condensate and chilled water distribution systems located in the utility tunnel network. This work includes rehabilitation of approximately 15 valves in each system, and installation of loops to replace joints, traps, and insulation where possible. The purpose of this project is to continue to maintain the reliability, efficiency, and safety requirements of the installation's utilities generated at or distributed from the Central Heating and Cooling Plant.

4. Rehabilitation and Modifications in Various Buildings, NASA Industrial Plant, Downey, California..... 235,000

This project provides for system modifications to permit electrical demand control of existing building utility systems by establishing a predetermined time sequence shutoff of selected pumps, chillers, and HVAC systems. The existing data control unit will be modified along with local building hardware as required to reduce power demand and to achieve efficient and effective control of energy consumption. These electrical control modifications will be made in Manufacturing Building 001, Engineering Support Building 006, Painting and Drying Shop Building 287, Systems Development Laboratory Building 288, and Systems Installation and Check-out Building 290. This project also provides for the rehabilitation and modification work in the Electronic Laboratory Building 039, Cryogenics Building 286, and System Development Laboratory Building 288 at the Downey Plant.

In Building 039, work includes the replacement of an existing builtup roof with a new 15-year bonded roof. In Building 286, the work includes removal of a 15-ton air handling unit, condensing unit, and controls, and installation of a new 15-ton packaged system. Also included is the rehabilitation of an existing outside air supply fan and drive assembly. In Building 288, work consists of upgrading the existing grounding system. Demand control implementation will provide for: (1) selective load shedding in the event of power curtailments or control of electrical demand, (2) scheduled shutdown and restart on an automated basis, and (3) capability of short duration shutdown not practical with a normal program. The demand control will be effected by automatically shutting down and starting up air conditioning systems in selected buildings on a rotational basis, taking into consideration such factors as time, temperature, and electrical load.

The age and/or condition of these three buildings or systems are such that routine maintenance and repair are no longer practical. The roof of Building 039 was constructed in 1955 and has not been rehabilitated since then. The roofing material is badly cracked and has deteriorated beyond normal repair. In Building 286, the air conditioning system is 14 years old and in a poor state of repair. Since the building is classified as a hazardous test facility, a reliable HVAC system is mandatory. Many of the electrical systems housed in Building 288 require a grounding system with a resistance not greater than 0.5 ohm. Preliminary tests indicate that resistance exceeding this amount exists at several locations. A more reliable system is required for proper testing of electronic systems.

5. Rehabilitation of Flight Operations Facilities, Ellington AFB..... 375,000

This project represents the most urgent work in a total effort to provide for the rehabilitation of NASA's Flight Operation Facilities at Ellington Air Force Base. The work includes the general rehabilitation of seven buildings (135, 239, 265, 270, 271, 276, and 363), rehabilitation and/or replacement of HVAC systems in four buildings (135, 265, 270, and 276), and rehabilitation of concrete aprons. It includes all of the facility work that can and needs to be done in this budget time frame. General rehabilitation consists of

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motorization of large hangar rolling doors, replacement of an air compressor, repair of builtup roofing, installation of safety screens over fluorescent lights, removal and sealing of warehouse doors and windows, insulation and sheathing of stud walls, installation of aluminum siding, and painting of building exteriors. WAC system rehabilitation consists of the replacement of 23 air conditioning units (1.5 to 25 tons) and three boilers *(400,000* to *3,570,000* BTUs) as well as general system rehabilitation. The concrete apron rehabilitation includes the replacement of approximately *1,070* square yards *(895* square meters) of concrete. The aprons serve as aircraft mooring aprons hangar access ramps, and a wash rack. These facilities presently support the Earth Resources and Space Shuttle programs. These World War II mobilization-type facilities house the aircraft flight operations and aircraft maintenance activities. These are used for storage of costly, delicate equipment and instrumentation. NASA has performed only emergency-type maintenance over the past few years because of the uncertain future of the facilities, It is, however, now essential that this rehabilitation work be accomplished to maintain the integrity of the facilities in a safe and usable condition. The boilers and air conditioning units are obsolete and costly to maintain, breakdowns are frequent, and spare parts are difficult to obtain. Additional work of this nature will be required in the future especially as firm decisions are made with respect *to* the long term use and/or assignment of facilities by the Air Force and/or General Services Administration.

6. Rehabilitation of Roofs on Various Buildings..... *175,000*

This is a portion of a long-range program for rehabilitation of the roofs of buildings which were constructed during the early developmental stage of the Johnson Space Center. The rehabilitation work contained in this portion of the total roof rehabilitation program is in itself a facility project. It includes all the facility work that can and needs to be done in this budget time frame. This project provides for replacing approximately 59,800 square feet *(5,555* square meters) of builtup roofing and approximately 2,100 linear feet *(640* meters) of neoprene flashing on the Mission Simulation and Training Facility, Building 5; the Branch Cafeteria, Building 11, and the Central Heating and Cooling Plant, Building *24.* The work also includes replacing approximately 5,000 square feet *(465* square meters) of roof insulation board. In addition, the project provides for replacing neoprene flashing at the roof perimeter and along the exterior positioned roof trusses on the Flight Acceleration Facility, Building 29. The Buildings included in this project were constructed in *1964* and 1965. Over the years, the normal aging process, modifications which have affected the roofs, and the presence of numerous roof penetrations have combined to significantly reduce the integrity of the roofing systems. Weathering, blistering, and flashing failures have resulted in numerous leaks and moisture penetrations. Repairs are needed to preclude damage to building structures, interiors, and sensitive equipment. Additional funds will be required in subsequent years to complete remaining portions of this roof rehabilitation program.

F. Kennedy Space Center (KSC) 825,000

1. Rehabilitation of Heating, Ventilating, and Air Conditioning Systems in Various Buildings 175,000

This project will provide for the rehabilitation and replacement of air cooled, air conditioning condenser units in the following facilities: (1) Automotive Maintenance and Service Building MC-688, one 25-ton unit; (2) Fire Station M6-695, two 7 1/2-ton units; and (3) Supply, Shipping, and Receiving Building M7-505, 10 1 1/2 ton units. The basis of need is accrued maintenance. These facilities have been operational since 1964, and year-round operation of existing condensers with copper tube-aluminum fin coils in the high salt content air and constant moisture has resulted in a deterioration of finned surfaces and resultant drop in heat rejection capacity to the extent that this work must be done. Energy consumption has increased and compressor life and efficiency decreased.

2. Rehabilitation of Fire Protection System in Communication, Distribution, and Switching Center, Building M6-138 280,000

This project will provide an automatic fire protection and associated detection system in approximately 12,500 square feet (1,161 square meters) of the critical electronic areas, fire stopping around cable penetrations, six doors to isolate the protected area, and a standard wet-pipe automatic sprinkler system for the remaining areas of approximately 18,600 square feet (1,728 square meters). Building M6-138 has a real property value of $1,206,354; it contains approximately $6,000,000 worth of electronic equipment and communications relay frames. Communications, a utility control system, and fire alarm transmission lines within and between the industrial area and Launch Complex 39 pass through this facility. Some of these areas are involved in the distribution of data from the shuttle launch processing system and lift-off and flight data from the Merritt Island Launch Area Unified S-band station to JSC, GSFC, and KSC. This capability is critical to KSC's mission. The automatic protection system will provide optimum protection to the electronic equipment, and the sprinkler system will protect the adjacent areas from a fire before it can seriously expose the critical areas. This work must be accomplished prior to initiation of shuttle launch operations to permit ready access to the equipment rooms.

3. Modifications to Heating, Ventilating, and Air Conditioning Systems in Launch Control Center, Building K6-900 370,000

This project will provide energy reduction modifications to the HVAC systems presently serving the Launch Control Center, Building K6-900. The existing overhead set point reheat system will be converted to a variable air volume system, and the existing air conditioning system will be relocated and converted so as

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to provide a separate supply of preconditioned outside air to meet ventilation requirements for computer firing rooms. The necessary interlocks will be added to existing timers to ensure air conditionina unit and exhaust fan shutdown during unoccupied hours. It is estimated that the annual energy savings will result in a simple payback of less than 3 years making this a most pressing and attractive energy investment.

G. Langley Research Center (LaRC) 1,515,000

1. Rehabilitation of 2.3-kV Electrical Service, Back River Substation..... *460,000*

This project provides for the rehabilitation of the 2.3-kV electrical service equipment in the Back River Substation, Building *642,* to improve the operating conditions. This facility rehabilitation work includes replacing the nine existing old and obsolete open-type oil circuit breakers with new metal-enclosed switchgear structures, which will contain drawout air circuit breakers consisting of a main breaker, seven feeder breakers, and auxiliary support control devices. All of the existing old connecting electrical bus, switches, supporting steel, and foundations will be removed and replaced with a concrete foundation, including a new cable vault to support the switchgear. To accommodate the relocation, approximately 60 feet (18.3 meters) of 9-way duct will be installed to interconnect the new switchgear and the existing manhole no. 1; 30 feet (9.1 meters) of 6-way and 30 feet (9.1 meters) of 2-way duct will be installed to interconnect the new switchgear with transformer "U" and Bus "G". The existing associated steel support structure will be removed or modified. The Back River Substation 2.3-kV, "U"-bus provides electrical service to the East Area facilities, including the Transonic Dynamics Tunnel, Building *648;* the 8-Foot Transonic Pressure Tunnel, Building *640;* and the System Development and Test Laboratory East Shop, Building *647.* In the span of over 30 years considerable deterioration, caused by the surrounding salt atmosphere, has occurred; the circuit breakers are of obsolete design, and spare parts are no longer available. Replacement with new circuit breakers is required to ensure continuity of power and a safe environment for service personnel performing necessary inspection and maintenance.

2. Modifications to Hypersonic Propulsion Office, Building 1221..... 380,000

This project provides for the facility modifications to the existing Supersonic Jet Noise Apparatus in Building 1221 so that more realistic simulation of supersonic jet aircraft engine noise can be achieved. This modification work will include revisions to the existing valves and mufflers, installation of a new vertical electric air heater, a new stainless coannular flow adapter, an acoustically treated exhaust unit, and interconnecting piping. The electric air heater will be about 3 feet (0.9 meters) in diameter by 19 feet (5.8 meters) high. It will consist of multiple units of tubular element budles arranged in series to provide up to 1,000°F (538°C) quiet hot air at 2 pounds per second (0.9 kilogram/second). The work will include modifications to the system control and the installation of isolation valves. The work will also include modifications to the building roof to provide an access panel for heater maintenance, to the room

to provide supporting steel structure for the test apparatus, and to the building electrical supply to provide power to the air heater. This project is required to furnish a test apparatus for operating coannular nozzle jets at various velocity and temperature ratios for basic research of jet engine noise to obtain data for use in meeting certification rules. Two separate controllable air streams are necessary to compare a coannular nozzle air stream to an equivalent thrust single-core circular jet.

3. Rehabilitation of the Experimental Machine Shop, Building 1225..... 390,000

This project provides for the rehabilitation of approximately 38,000 square feet (3,530 square meters) of the Experimental Machine Shop, Building 1225. This work will include the improvements to approximately 30,000 square feet (3,787 square meters) of high-bay machine shop space and 8,000 square feet (743 square square meters) of office space. The exterior work will include the replacement of the wooden shop windows and the large hangar-type doors with a new wall for energy conservation. The interior work will include improving the toilet and locker facilities. The electrical power, air conditioning, heating and fire protection systems will be rehabilitated. This building was built in 1945, and this rehabilitation work will improve the existing inadequate conditions. The replacement of the old, rotted wooden windows and the large hangar doors will reduce air leakage and conserve energy. The rehabilitation of this building will improve the utilization of existing space within the facility and enable the machine shop to provide better support to the Center's research programs.

4. Modification of Heating, Ventilating and Air Conditioning Systems in Buildings 1148, 1212, 1212B and 1244..... 285,000

This project provides for facility modifications to the HVAC systems of the Structures Research Laboratory, Building 1148; Subsonic Tunnels Laboratory, Building 1212; 7x10- Foot (2.1 x 3.0 meter) High Speed Tunnel, Building 1212B; and Hangar, Building 1244. These modifications will include the elimination or reduction of reheat requirements, thereby minimizing makeup air requirements, providing economy cycles, and improving the operation of the controls in each facility. The existing HVAC systems in these buildings were installed at minimum initial cost and now operate in an inefficient energy mode. An assessment of the improvements to these systems has been made to realize improved energy conservation and to provide better working conditions. These modifications are cost effective and will save electrical energy and fuel oil, resulting in a simple payback of less than 4 years.

H. Lewis Research Center (LeRC) 1,770,000

1. Modification of Cooling Tower Water Distribution System..... 410,000

This project provides for a modification of the Cooling Tower #5 water distribution system for a more cost effective operation. This facility modification work will provide cooling water from the existing excess

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capaci y at Cooling Tower #5 to the Materials and Stresses Laboratory, Building 49, the High Energy Fuels Laboratory, Building 51, the Materials Processing Laboratory, Building 105, and allow for future service to Buildings 24, 34, 35, 50, 100 and the Neutron Facility. This new system will include the installation of about 2,000 feet (610 meters) of 14-inch (36 centimeter) diameter underground cooling water supply and return pipe, and about 1,100 feet (335 meters) of smaller pipe ranging from 12- to 1-inch (31 to 2.5 centimeters) diameter pipe in Buildings. Also included is the installation of a new 7,000-gallon (26.5 kiloliters) per minute, 350-horsepower (261 kilowatt) pump and associated electric service and controls. These buildings presently use city water for cooling research equipment, furnaces, presses, and air conditioners. This project will save an estimated 228,000,000 gallons (863,000 kiloliters) of potable city water with an associated savings of about $85,000 per year of water and sanitary sewer charges. This assessment of the improvements to the cooling water distribution system has been made in order to realize a savings of water resources and to provide better support for research test operations.

2. Modification to the Combustion Air System, Engine Research Complex..... 195,000

This project will provide for the facility modification to the ccmbustion air system of the Engine Research Complex (Buildings 5, 23, 37, and 38) for improved safety. This work will include the addition of 11 new direct-acting, pressure-relief installations into the existing combustion air distribution system. Each installation will include a penetration into the existing combustion air piping, a burst disc assembly, a pressure-relief valve, and up to 20 feet (6.1 meters) of discharge piping to a safe point of release to the atmosphere. This work will also include the electrical monitoring equipment to alert operations personnel when the relief system has been activated. A hazard analysis of the Engine Research Complex combustion air system has identified those areas of the distribution system where additional overpressure protection is required. Installation of this pressure relief equipment will prevent overpressure at pressure sources such as compressors and where systems rated at different pressures are cross-connected for improved personnel and equipment safety.

3. Rehabilitation and Modification for Utility Control System..... 455,000

This project provides for the rehabilitation and modification of the existing utility systems at LeRC to achieve a more cost effective energy installation. This utility control system work includes the installation of a central control center, communication system, building modification for computer environmental control, data acquisition control panels and sensors in 26 buildings. The control center will be located in Engineering Services Building, 21 and will consist of a master station, computer, and related peripheral equipment for real time control of the building utility systems. This facility work will optimize the operation of the building HVAC systems and control chiller plant equipment. This system will also provide system performance status data to effectively manage the Center's utility systems. These improvements are cost effective, will conserve energy, and will reduce manpower in the operation and maintenance of the utility systems. Estimated resultant simple payback of this project is less than 3 years.

4. Rehabilitation and Modification of Building Lighting 120,000

This project provides for the rehabilitation and modification of the lighting in Buildings 5, 23, 37, 53, 81, 87, and 90 to improve lighting conditions. This work will include the replacement of the existing old incandescent lighting fixtures with new high efficiency lighting fixtures. The new light fixtures are to be high pressure sodium or fluorescent arc lamps. The existing deteriorated wiring will be replaced with new plastic insulated wiring, eliminating a potential fire hazard. This project is a part of an overall plan to improve the Center's building lighting systems, and the work has been selected on the basis of urgency of accomplishment. This project is cost effective and it will conserve electrical energy, reduce maintenance labor, and improve the working conditions in these buildings, and result in a simple payback of just over 3 years.

5. Modification of Propulsion Systems Laboratory (PSL) Equipment, Building 64 125,000

This modification work provides for the installation of acoustic insulation barriers at five locations in PSL Equipment Building 64 to improve the working conditions. These barriers will include the installation of acoustical insulation on existing piping and control valves. This work will also include the installation of flexible sound screen curtains and unit absorber panels located around the noise sources to minimize reflection and reverberation. Equipment Building 64 contains equipment to supply and remove air in large quantities and heavy pressures in support of research operations. This building contains 14 centrifugal compressors and 20 centrifugal vaccum pump units, which total approximately 208,000 horsepower (155,106 kilowatts). The sound level presently approaches 125 dBA and presents a significant potential hazard for nonprotected personnel working in the area. These proposed noise reduction barriers are expected to reduce the overall noise level in the building. This modification work will improve the working environment, increase operations efficiency, and minimize the noise hazards to personnel.

6. Rehabilitation and Modification of Library Services Building 60 465,000

This project provides for the overall rehabilitation to the Library Services Building's mechanical system. The work includes replacing the old perimeter steam fan-coil system with a new 4-pipe fan-coil unit system that uses central chilled water and has individual room temperature control; installation of a new central air handling unit with controls that uses chilled water from the existing central system, thereby eliminating the need for the old evaporative condensers and refrigerant compressors which are over 25 years old; replacing the existing steam heating system with a hot water supply to the fan-coil units; replacing deteriorated steam condensate, hot and cold water, and HVAC piping; and providing duct modifications to the existing exhaust system. The electrical power system will be upgraded to meet the requirements for new mechanical systems. An early warning detection system that uses 34 smoke detectors will also be installed. The detectors will protect books and documents stored in the building. Necessary architectural/structural work to accomplish mechanical rehabilitation will also be provided.

Rehabilitation and modification to the mechanical system is [illegible] equipment. The equipment is over 25 years old and in constant need of repair. A new system will provide an environment compatible to office building requirements. It will provide a more efficient use of energy by using properly sized and properly located exhaust equipment, individual room controls for heating and cooling, and the use of hot water heating.

I. Marshall Space Flight Center (MSFC) 1,660,000

1. Rehabilitation of Laboratory Building 4487, "B" Wing East..... 450,000

This project provides for rehabilitation of approximately 42,000 square feet (3,902 square meters) in "B" Wing East of Laboratory Building 4487. The work includes refurbishing and/or replacing obsolete or overloaded air conditioning units, air handlers, and chillers; upgrading electrical distribution systems to provide adequate circuit breakers; correcting lighting levels; and providing individual room lighting controls. Floors, ceilings, partitions, doors, etc., will also be repaired or replaced. Building 4487 was originally constructed in the 1950's; normal deterioration over more than 20 years has increased energy consumption, maintenance costs, and downtime on these obsolete building systems.

"B" Wing East houses many optical laboratories that perform technology development, systems engineering, and flight hardware development in support of the Space Telescope, Spacelab payload experiments and other programs. Rehabilitating this building will preserve and enhance its capabilities, extend its useful life, and ensure building system reliability. It will reduce maintenance costs and energy consumption and provide better laboratory support for NASA programs. Delaying the project will result in continued high energy use and maintenance costs and increased rehabilitation costs.

2. Modifications of Utility Control System..... 475,000

This project provides for modification of the existing UCS system at MSFC to provide a means of remotely measuring values and determining status of temperatures, pressures, humidities, and electrical load consumptions in various mechanical equipment rooms and critical computer installations throughout MSFC. The major work will include a central processing minicomputer, sensors, and controllers. The control points will be used for starting and stopping entire air conditioning systems from a central remote site. The existing UCS will be expanded to include monitoring and control of functioning equipment in mechanical equipment rooms in 40 additional MSFC locations. Major buildings which will be serviced by the system are as follows: 4249, 4250, 4471, 4481, 4561, 4566, 4612, 4619, 4666, 4705, 4711, 4712, 4752, and 4755. The utilities savings resulting from installation of this system are estimated to result in a simple amortization of the investment in less than 2 years. Trend analysis will prevent costly shutdowns of computer and R&D test equipment by anticipating malfunctions of mechanical equipment. The existing UCS in operation at MSFC has proven reliable and beneficial in such ways as preventing shutdown and malfunctioning of air conditioning equipment, thereby preventing damage to critical computer and electronic test equipment requiring close environmental control.

3. Rehabilitation and Modification of Materials and Processes Laboratory, Building 4612.....

This project provides for the rehabilitation and modification of 90,000 square feet (8,361 sq m) of the Materials and Processes Laboratory, Building 4612. The work will include extensive modifications to overloaded air conditioning units, air handlers, and chillers to incorporate energy conservation features and reduce maintenance and materials costs. The electrical distribution system will be upgraded to provide adequate circuits and circuit breakers, and to correct lighting levels. Rehabilitation will also provide adequate insulation in both office and high bay areas, reduce potential fire hazards, and repair interior and exterior building surfaces. Building 4612 was originally constructed in the late 1950's, and continuous heavy use for over 20 years has resulted in a badly deteriorated building and building systems. This is one of the primary facilities at MSFC, providing unique materials and processes laboratory functions not existing elsewhere at the Center. They include such key elements as the Ceramics and Coating Development and Evaluation Laboratory, the Rubber and Plastics Technology Facility, the Metallurgical Testing Laboratory, the Failure Analysis Laboratory, the Rheological Properties Laboratory, and the Chemistry Diagnotics Laboratory. The personnel and equipment associated with these laboratories directly support the Space Shuttle, Space Telescope, and other programs. Rehabilitating this building will preserve its capabilities, extend its useful life, ensure building system reliability, and greatly reduce energy consumption and maintenance costs. Delay in accomplishing the work will adversely affect Center energy conversation goals and hamper support to important Center programs and other R&D activities. The estimated energy, labor, and materials savings from this project will result in a simple payback over a period of about 3 to 3 1/2 years.

4. Rehabilitation of Structures and Mechanics Laboratory Building 4619 East End..... 360,000

This project provides for the rehabilitation of approximately 84,000 square feet (7,800 square meters) of the east end of building 4619. The work includes extensive upgrading of overloaded air conditioning units, air handlers and chillers; upgrading of electrical distribution systems to provide adequate circuits and circuit breakers; correcting lighting levels; provision of adequate insulation in both office and high bay areas; and repair of interior and exterior surfaces. Building 4619 was originally constructed in the early 1960's; continued use over the last 15 years has resulted in an overall deteriorated condition of the building and systems. This is one of the primary facilities at MSFC. This portion of the building supports the structural testing of components such as the Space Shuttle, experiments qualifications, special hardware tests of Spacelab, and payload testing. Rehabilitating the building will preserve and enhance its capabilities, extend its useful life, and ensure building system reliability. It will also reduce maintenance costs and energy consumption and provide better testing areas to support NASA programs. Delaying this project will result in continued high energy use and maintenance costs, Given the problem of housing temporarily dislocated personnel and activities, this portion of work represents all that can be done in this time frame and completes the rehabilitation of building 4619 as presently known.

J. Michoud Assembly Facility (MAF) 710

1. Rehabilitation of Air Conditioning System, Engineering Support Building 350/351 150,000

This project provides for the rehabilitation of the air conditioning system located in Building 351, which also provides air conditioning services to the Engineering Support Building 350. The work includes the removal and replacement of the existing 600-ton chiller with a new one of equal size. Included in the work will be all necessary piping and electrical modifications to make the new chiller operational. This existing chiller was installed in the mid-1960's and has been the subject of numerous breakdowns in recent years. Parts for this chiller are becoming increasingly difficult to obtain. Although the chiller has been almost totally rebuilt, its reliability has not been appreciably increased. It is necessary to replace the existing chiller to provide reliable service and avoid high maintenance costs. The use of Building 350 has been increasing, and it is planned that essentially full utilization will be achieved by the end of 1978, thus making this project considerably more urgent.

2. Modifications to Fan Houses, Main Manufacturing Building 103..... 170,000

This project provides for rehabilitation and modification to the fan houses of the Main Manufacturing Building 103 at MAF. The work will include the installation of enthalpy controls; interconnections of fan houses with the existing utilities monitoring system; installation of variable volume controls; installation of timers to toilet exhaust fans; and repair and sealing of leaks, holes, etc.

During a recent energy conservation survey, it was determined that the proposed modifications and rehabilitations to the fan houses will prevent the exhaust of conditioned air from Building 103, restrict air losses, maintain space humidity and temperatures, reduce air washer flow, and cut fan power consumption. Since these fan houses consume approximately 24 percent of the energy at MAF, these modifications will save energy and result in a simple payback of approximately 3 years. Building 103 houses several activities and this project is now planned essentially as an energy reduction endeavor and not one unique to the Shuttle program. In this context the project is basically institutional in nature.

3. Modifications to High Bay Lighting in Main Manufacturing Building 103..... 390,000

This project provides for the modifications to the high bay lighting system in the Main Manufacturing Building 103. The work includes removing the 400-watt, 2771480-volt mercury vapor lights; deenergizing the existing 400-watt, 120-volt mercury vapor lights; and replacing these lights with approximately 873 high pressure sodium 400-watt, 277-volt lights. Also included is the installation of 7-day timers for automatic control of the lighting system. The installation of these new high pressure sodium lights and the timers will reduce energy requirements and result in a simple payback of just over 2 years. Air conditioning loads in this building will also be reduced. This is considered as an energy reduction endeavor and as a project that is basically institutional in nature.

K. National Space Technology Laboratories (NSTL)..... 1,100,000

1. Modifications to Building Heating, Ventilating and Air Conditioning Systems..... 450,000

This project provides for the modification of the HVAC systems in Buildings 1000, 1100, 1105, 1110, 1200, and 8100 to improve system efficiencies and thereby conserve energy. This work will include modifications of building HVAC zoning by relocating, repairing, or replacing existing thermostats to improve system efficiencies. Air distribution will be improved and heat losses reduced. As a result of the numerous interior changes within the buildings since the original construction 12 years ago, less than optimum performance is being obtained from the HVAC systems. In some areas, hot air ducts are positioned close to cold air ducts, resulting in a large waste of energy. Additionally, much manpower is wasted by maintenance personnel having to adjust and balance the systems manually. Under present operating conditions, an HVAC system frequently is unable to maintain uniform conditions throughout a particular zone. These modifications will upgrade the facilities and save energy. The present and projected heavy use of these facilities makes this project considerably more justified and pressing. The simple payback is estimated at slightly over 3 years.

2. Rehabilitation of High Temperature Hot Water (HTHW) Generating System in Central Heating Plant, Building 3204..... 375,000

This project provides for rehabilitation of the HTHW Generating System in Building 3204. The work will include rehabilitating the water tubes in all three HTHW generators, replacing the floor tubes and lower header assemblies in HTHW generators 1 and 2, installing economizers in the flue stacks of all three HTHW generators, and installing an additional HTHW system pump (544 gallons per minute - 2.1 kiloliters/minute). Earlier work on this building has exposed other sources of energy losses and inefficiencies. This project eliminates warped and deteriorated water tubes in the HTHW generators, which contribute to a loss in heat transfer efficiency. It also transfers waste heat from the flue gas to the inlet water supply, thereby reducing the heat input required to the generators. In addition, it will provide capability for operating the heating plant on one generator, reducing the need to keep two generators on line during periods of reduced demands. By rehabilitating this system as indicated, it will be possible to save significant amounts of energy, resulting in a more efficient system with a simple amortization of approximately 4 years.

3. Rehabilitation of Heating, Ventilating and Air Conditioning Systems to Improve Efficiency and Energy Conservation..... 150,000

This project will provide for the rehabilitation and modification of the HVAC outside air dampers. The work will include replacement of automatically operated damper controls with electrical controls, provisions for greater use of ambient air when temperature and humidity conditions are compatible with building requirements, and replacement of inoperative controls and parts. Because of the age of the NSTL facilities (10-12 years), many of the HVAC outside air dampers have become inoperative and are not functionally efficient. This

project will provide for the replacement of those parts or controls no longer operative, upgrade those that are still functioning, and generally bring the system up to acceptable and efficient standards. These modifications will be compatible with planned utility control system requirements. The rehabilitation of this system will save energy and provide a more reliable and efficient system. This work has been deferred for some time, and the point has now being reached where it must be undertaken. The simple payback is estimated at less than 2 years.

4. Modification of Utility Control System for Test Area..... 125,000

This project provides for the modification of the NSTL Utility Control System (UCS) to include the Space Shuttle Main Engine (SSME) Test Area. This UCS is for the purpose of controlling the mechanical systems of Buildings 4110, 4120, 4122, 4400, and 4995. This work will include the installation of central station computer equipment; facilities for transmission of data and control commands between the central station and remote terminals at building sites, and sensors and signal transmitters at selected locations for monitoring and controlling HVAC, and other utilities, Sensors will be connected by a communications network to an existing central monitoring and control station in the Central Heating Plant, Building 3204. This modification to the system is necessary to provide for automated monitoring and control of HVAC and other utility systems in support of the long term SSME testing program. This system will result in increased efficiency in both energy and manpower utilization. The installation of this system will reduce the electrical power requirements of the installation. In order for the installation to reduce energy demand and to further improve the operation of the mechanical systems of these facilities, these modifications are considered a primary requirement.

L. Wallops Flight Center (WFC) 1,235,000

1. Modification for High Speed Runway Turnoff..... 340,000

This project provides a paved transition surface between runway 4-22 and the parallel taxiway near the intersection of runways 4-22 and 17-35. This surface, which will consist of approximately 9,133 square yards (7,636 square meters) of reinforced concrete, will be used in conjunction with other exiting airfield paving at WFC to investigate airborne system requirements for guiding an aircraft through a high speed turnoff at speeds up to 80 knots to clear the runway rapidly under all operating conditions, including very low visibility. The project supports the Terminal Configured Vehicle Program, which is aimed at developing airborne systems for increasing runway landing acceptance rates at future high density airports. Increased runway landing acceptance rates offer possibilities of significant fuel savings, resulting from improvements in landing operations and reductions in schedule stretchouts. No alternative facilities with the capability of this proposed facility are available.

2. Rehabilitation and Modification of the Technical Support Shops and Office Building, F-10. 375,000

This project provides for rehabilitation and modification of Building F-10. This facility is an aircraft hangar modified for its current use as a machine shop, payload assembly shop, and office building. The work in the high bay machine shop area includes sealing the high windows located above the existing suspended ceiling, replacing water-damaged ceiling tiles, modifying existing large hangar doors at each end of the building and installing 12-foot by 14-foot (3.7 meter by 4.3 meter) rollup doors, painting the exterior of the large hangar doors, upgrading the shop ventilation system and constructing an air conditioned 3,000 -square foot (279 square meter) enclosure within the existing machine shop area to house the precision machining equipment being relocated from the Instrument Service Calibration and Chemistry Laboratories, Building F-160. The work in the south wing includes installing central HVAC equipment to replace existing window units, insulating outer walls (complete with interior wall finish), painting the interior of the wing, replacing light fixtures, reroofing, and retiling floors and ceilings. In addition, the work includes enclosing the four existing exterior stairways of the north and south wings to eliminate the hazardous conditions which are generated in inclement weather. This project is needed to upgrade this deteriorated and uninsulated facility and to provide appropriate space for precision machining operations.

3. Rehabilitation of the Range Control and Quality Verification Laboratory, Building N-159..... 340,000

This project provides for the interior and exterior rehabilitation of Building N-159. The work in the east and west wing shops and offices includes rehabilitating the HVAC equipment (complete with a variable volume fan), replacing existing windows with double-glazed windows, reroofing, rehabilitating restrooms, insulating outer walls (complete with interior wall finish), painting the interior, and sealing and painting the exterior. Additional work in the east wing includes replacing the ceiling tiles and the light fixtures. The work in the hangar high bay area includes painting the interior, sealing the high windows, installing new weatherstrips on the hangar doors, and painting the exterior of the hangar doors. The 15 year old HVAC system requires general rehabilitation; the roofs of the east and west wing leak; and the insulating values of the windows and outer walls are low. This work will upgrade this deteriorated and energy inefficient facility.

4. Rehabilitation of the Wallops Island Electrical Distribution System..... 180,000

This project provides for the rehabilitation of the Wallops Island electrical distribution system. The work includes replacing the existing overhead 2.4 kV service in the "X" area with underground service (installed in an existing duct bank) and pad-mounted transformers; removing the existing unused overhead line from the "X" area to pole HV-4; replacing deteriorated hardware on poles HV-4, HV-4a, and HV-4b; adding a neutral conductor between poles HV-4b and HV-4c; removing all abandoned electrical equipment in the "X" area;

and replacing three deteriorated 25 KVA transformers on the pole near the Special Projects Building V-65. The "X" area overhead distribution system, including the poles and hardware, is deteriorated, unsafe, and unreliable It is the only overhead distribution system in the launch area and its replacement with underground service is both desirable from the point of view of reliability as well as economy. This work is required to restore safe, reliable electrical distribution service to the Wallops Island facilities.

M. Various Locations... ..... *740,000*

1. Modification of Antenna Fire and Safety System, Goldstone, California (DSS-14) 150,000

This project will provide for fire and safety modifications to improve the water pressure and discharge rate at the 64-meter (210 foot) antenna (DSS-14) located at Goldstone. The work will include relocation of electrical/mechanical equipment and sprinkler heads and the provision of increased storage capacity for fire protection water. These modifications are required as a result of changes in space utilization and additional equipment now present at the facility. The modifications will ensure continuity and reliability of operations and minimize loss or damage to critical tracking and data equipment.

2. Modification for Utility Control Systems at Goldstone Complex

This project will provide a UCS for three facilities in the Goldstone complex. This system is composed of a real-time microprocessor subsystem, which will provide local monitoring and control of the commercial power engine generator plant; HVAC systems; fire protection system; and power and water distribution systems. This system will accept weather and tracking schedules to permit predictive responses. The control center will be located in the Operations Building at each site. The UCS will use electronic components for the automation of the station and will become an integral part of that system. Should there be a failure in the UCS, the equipment returns to manual mode or to its normal operating mode. The installation of the UCS system will reduce the consumption of energy at these remote sites.

Each facility will be managed as a separate project.

- Pioneer DSS-11 ..... *240,000*
- Venus DSS-13. 180,000
- Apollo STDN..... 170,000

MISCELLANEOUS PROJECTS LESS THAN $100,000 EACH..	1,200,000
TOTAL	17,800,000

FUTURE COF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

It is estimated that between $18 and $20 million per year will be required for the continuation of this facility rehabilitation and modification program.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

MINOR CONSTRUCTION

Summary of Project Amounts by Location:

CONSTRUCTION OF **FACILITIES**

FISCAL YEAR 1979 ESTIMATES

PROJECT TITLE: Minor Construction of New Facilities and Additions to Existing Facilities, Not in Excess of $250,000 Per Project	
LOCATION: Various Locations	
	FY 1979 CoF ESTIMATE: *$4,200,000*
FY 1977: $5,125,0009~	FY 1978: $5,950,000

COGNIZANT INSTALLATIONS/LOCATION OF PROJECTS: Various Locations

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller

SUMMARY PURPOSE AND SCOPE:

This project provides for minor facility construction at NASA field installations and at Government-owned industrial plants engaged in NASA activities. It includes minor facility projects involving the construction of new facilities or additions to existing facilities, each project of which is estimated not to exceed $250,000. Such minor construction is necessary in FY 1979 to improve the usefulness of NASA's physical plant by making it possible to accomplish needed adjustments in the utilization and augmentation of its capabilities.

The *$4,200,000* request for FY 1979 is composed of those projects that must be accomplished to meet critical programmatic and institutional requirements in direct support of mission goals and objectives.

PROJECT JUSTIFICATION:

The existing NASA physical plant is necessarily impacted by changing utilization and adaptations required by changing technology and mission needs, as well as by new facility requirements generated by research, development, test, and similar activities. Items included in this project reflect work which must be accomplished in FY 1979 to meet general requirements or technical facilities needs.

*NOTE: Subsequently adjusted as permitted by Appropriation Conference Report No. 94-1362, dated July 22, 1976, to $2,925,000.

This work is not solely or primarily required to support specific research or development programs. Included, however, are those items which are required in FY 1979 to meet the particular needs of one or more specific research or development programs, and which could be adequately identified at the time of submission of this budget estimate. Items of work proposed to be accomplished within this program for FY 1979 have been carefully selected from a list totaling about $7 million. This selection has been made on the basis of the relative urgency of each item and the expected return for its accomplishment in relation to the investment involved. It is recognized, however, that during the course of the year some rearrangement of priorities may be necessary and that changes may be required in some of the items to be accomplished within the resources allocated.

PROJECT DESCRIPTION:

Proposed minor construction items for FY 1979 are outlined under "PROJECT COST ESTIMATE"; they total *$4,200,000*. These represent requirements that must be met in this timeframe. These projects have a direct impact on mission goals and objectives. Their deferral or disapproval could critically affect program schedules associated with approved mission requirements as well as key facilities of an institutional nature that are vital to the operation of the installation.

Of the *$4,200,000* total listed, $3,590,000 represents specific discrete items of work, and $610,000 is indicated as a lump sum amount to provide for facility work of these types (new construction and additions) estimated to cost not in excess of $50,000 for each such project. This amount in turn is also based on a list of specific project tasks of a new construction or addition nature to be accomplished.

PROJECT COST ESTIMATE:

A. Ames Research Center (ARC) *485,000*

1. Construction of Flight Data Acquisition Facility *240,000*

This project provides for the construction of an elevated, single-story reinforced concrete building of about *2,800* square feet *(260* square meters). It will be used as an observation platform, control room, and data management center in support of research flights for short-haul and Vertical Takeoff and Landing (VTOL) aircraft. This new facility will be located off Zook Road and Sayre Avenues so as to have an unobstructed line of sight to the VTOL hover areas and Moffett Field runways for both visual contact and telementry reception. This project also includes raised computer flooring, ceiling, electrical and lighting systems, and observation windows. Heating, ventilating and air conditioning (HVAC) systems will be provided along with all necessary utilities to existing systems. Research flights for short-haul and VTOL aircraft will be performed at ARC. It is more cost effective to operate planned tests at ARC than at other locations for those flight tests which do not require aircraft tracking capability. This facility will provide space for 10 people, who will be involved in computer operations, system programming and data handling and processing to support research flight

operations An unobstructed view of the flight tests provides the flight test director with a view of the test area to monitor the research aircraft. This facility will assist with the real-time analysis of flight test results and permit necessary adjustments during test operations to achieve the maximum benefit from each flight test hour.

2. Construction of Addition to Central Computer Facility, Building N-233..... *245,000*

This project provides for the construction of a *4,000* square-foot (372 square meters), one-story masonry block addition to the existing Central Computer Facility, Building N-233. This new addition will include a computer room of 1,600 square feet *(149* square meters), a tape library of 1,600 square feet *(149* square meters), a supply room of *400* square feet (37 square meters), and rest rooms. This construction work will include the related electrical power, lighting, fire protection, and HVAC systems. A raised floor system will be provided for the computer room area. This new addition will provide space for new computer equipment to support additional requirements, and relieve crowded conditions in the existing facility. The computer room of the addition will house the Data Communications Facility, which is presently located in substandard space in the basement of Building N-233. The space to be made available in the basement will be better utilized for supporting mechanical and electrical systems. The tape library portion of the new facility will house magnetic computer tapes that are now stored in an unprotected area. The support room will house supplies used for dailv operations that are presently located in an almost inaccessible area in the basement. This new addition will improve the work conditions, efficiency, and safety for computer operations at ARC.

B. Dryden Flight Research Center (DFRC)..... *245,000* 245,

1. Construction of Equipment Storage Building..... 245,000

This project provides for the construction of a 12,000 square-foot (1,115 square meter) preengineered metal building near Hangar Building *4833* on Lakeshore Drive. The building will be built on a concrete slab and will be 80 feet *(24.4* meters) wide by *150* feet (45.7 meters) long with a 16-foot *(4.9* meters) eave height. This work will include two large sliding doors for equipment access, personnel doors, and metal windows. The building will be insulated and include lights and suitable electric power. This building is required to provide suitable protected storage space for ground-support equipment and other miscellaneous supplies. This equipment is frequently used in Hangar Building *4833* and must be protected from the outside severe sand and heat environment. The North Base area was considered for the storage of this equipment but because it is 3.5 miles (5.6 kilometer) away, it is not a cost effective solution to this requirement, There are no other reasonable alternative solutions.

This equipment storage building is vitally needed to protect high value equipment and to provide other logistic and supply support to activities in this expanded area.

C. Goddard Space Flight Center (GSFC) 555,000

1. Construction of a Direct Readout Facility 175,000

This project provides for the construction of support facilities for a 30-foot (9.1 meter) portable antenna system necessary for direct readout of Landsat data. The support facilities to be constructed include an antenna foundation, collimation tower, hardstands, electrical power systems, and signal cable ductbanks. The antenna system will provide validation data at X-band for foreign user image quality verification as well as direct readout capability for Landsat-D coverage of the continental United States in the event of a malfunction in the link between Landsat and the Tracking and Data Relay Satellite System (TDRSS). The direct readout system will interface with the Landsat-D data management system and the operations control center in the technical processing facility in real time. This project is required to be operational by January 1980 to support the Landsat-D program,

2. Construction of an Atmospheric Sounder Ground Station Facility 135,000

This project provides for the construction of a 1,000-square foot (93 square meter) one-story masonry building and cable tray to support the Visible and Infrared Spin Scan Radiometer Atmospheric Sounder (VAS) ground station. The building will contain necessary HVAC systems and electrical lighting. This facility will support the installation of a roof mounted 10-foot (3.0 meter) diameter antenna to accommodate the VAS ground station. This building is necessary to support receiving and recording, sounding, and multispectral data transmitted by GOES-D.

3. Construction of a Communication Ductbank to the Network Training and Test Facility, Building 25.... 245,000

This project provides for the construction of approximately 6,750 feet (2,057 meters) of 12-way communications ductbank from the Spacecraft Operations Facility, Building 14, to the Network Training and Test Facility (NTTF), Building 25. This work will include the installation of 12, 4-inch (10 centimeter) polyvinyl-chloride (PVC) conduits encased in concrete, precast manholes, and restoration of the pavements and lawns to their original condition. This communications ductbank is a vital part of a program that will provide reliable widebank data channels for the ground communications system during the Shuttle/Spacelab era. All data received from spacecraft will be transmitted over the widebank data channels in these ductbanks to the NASCOM Center and the Network Control Center in Building 14. The failure of a ground communications facility could result in the loss of a large amount of critical data from spacecraft programs, and possibly a spacecraft. This alternate routing of the ductbank must be provided to eliminate single point failure in this vital communications link.

D. Jet Propulsion Laboratory (JPL) 330,000

1. Construction of Antenna Range Test Tower..... 150,000

This project provides for the construction of a 240-square-foot (22.3 square meter) antenna control and equipment building, a 36-square-foot (3.3 square meter) concrete pad, a raised platform and a structural tower to support testing of spacecraft antennas up to 16 feet (4.9 square meter) in diameter. The existing antenna range test tower was installed as a temporary measure and is presently inadequate to handle the large spacecraft antennas required for accuracy and distant ranging necessary to support future flight missions. The building will be used for control and testing of the spacecraft antennas. This work is necessary to support the Shuttle free-flyer payload mission including the Jupiter Orbiter Probe mission.

2. Construction of Addition to the Combustion Research Facility, Building 129. 180,000

This project provides for the construction of a 2,400-square-foot (223 square meter) addition to the Combustion Research Facility, Building 129, in support of new and ongoing programs. Included in this addition will be 1,800 square feet (167.2 square meters) of laboratory space and 600 square feet (55.7 square meters) of office space. This addition will house the following NASA research projects: coal related research activities, exhaust product sampling, hydrogen energy probes, and planetary atmosphere combustion. The facility is needed for combustion work expanding out of past rocket combustion research. Because of the expansion of this type research, current work must now be housed in scattered, inadequate facilities while new work can only be accommodated by sharing of facilities on an interruptible basis. If this combustion laboratory addition is not provided, JPL's capability to effectively and efficiently support ongoing and future research tasks in this area will be seriously jeopardized.

E. Kennedy Space Center (KSC) 565,000

1. Construction of Addition to VAB Support Building K6-1146. 185,000

This project provides for the construction of a 1,700-square-foot (158 square meter) office addition to VAB Support Building K6-1146 to house KSC security patrol headquarters. The building office addition will include a bonded storage area for records and weapons. Minor modifications to the electrical and heating/cooling systems of existing Building K6-1146 will also be required to meet this need. The existing KSC security patrol headquarters is located in Security Fire Service Building K6-1045. This building (K6-1045) is old, in poor condition and is scheduled for demolition in 1979 because it is in the hazardous zone of the OPF (Orbiter Processing Facility). Building K6-1146, which has been used for logistics support for prior launch programs, is now unoccupied and is in a better location for this important activity.

2. Construction of an Information Activities Building 245,000

This project will provide for the construction of a 5,500 square-foot (511 square meter) prefabricated rigid-frame, metal-skinned, insulated building consisting of three main areas: (1) NASA and contractor work spaces, (2) press work areas, and (3) audio-video press distribution and control area. The facility will have minimum partitions; asphalt tile flooring; a fire detection system; a heating, ventilating and air conditioning (HVAC) system; suspended ceiling; fluorescent lighting, toilets; and electrical power receptacles for equipment. Utilities are available at this site. The Information Activities Building is required to support the "rollout" of the first operational Shuttle at KSC, and will replace the space previously leased in Cocoa Beach for somewhat comparable activities during previous manned launches, The interfaces with the news media such as are carried out at KSC would otherwise involve an estimated annual expenditure of *$75,000* to $100,000 for off-Center space rental, as well as other offsite operating expenses, such as additional audio/visual lines, equipment, transportation, and personnel to provide news and information to the broadcast networks. This solution is sound and prudent, and no reasonably effective existing facilities are available for these programs.

3. Construction of Addition to Central supply Building *M6-744* 135,000

This project will provide for the construction of a 10-foot **(3.1** meter) wide by 162-foot *(49.4* meter) long dock-type addition to the existing dock on the northeast side and a 20-foot (6.1 meter) wide by 204-foot (62.2 meter) long dock-type addition to the existing dock on the northwest side of Central Supply Building *M6-744.* This will include extending the dock roof coverage an additional 20 feet (6.1 meters) at both ends, relocating eight adjustable dock plates, and providing lights and roof drainage. A wider dock is required to stage hazardous materials delivery, packing, and crating and thus more adequately meet fire and safety requirements. Adequate dock areas must be available to facilitate the loading and unloading of vehicles with material handling equipment such as forklifts. The workload for handling items during the Shuttle era is projected to double that experienced during the peak of the Apollo program in *1969.* The extended roof over the docks will provide protection to government-owned equipment stored on dock areas or on vehicles during bad weather. Examples of shipments of hazardous materials on a monthly basis include: 50-75 pounds of radioactive materials; 80 pounds of hydrazine; a truck load of freon in drums; and approximately 25,000 pounds of photo fluids, paints, thinners, ammonia and bleach. Of this amount, approximately 20 percent will support programmatic requirements, such as Shuttle, and 80 percent will support institutional needs.

F. Langley Research Center (LaRC) 355,000

1. Construction of Graphics Building 120,000

This project provides for the construction of a one-story, 3,000-square-foot *(279* square meter) building on Bush Road. **The** building will include 1,800 square feet (167 square meters) of open space, with lighting adequate for drafting type work. The remainder of the building will include an office area, silk

screen process room, rest rooms, and storage and mechanical equipment areas. Construction of this building will consolidate the Graphics Branch at one location, will locate this function close to the Photo Laboratory (Building 1155), and will improve the very marginal working conditions now available for this organization. The Graphics Branch is presently housed in Financial Management and Procurement Building 1195, which is planned for demolition.

2. Construction of Addition to Transonic Cryogenic Tunnel, Building 1242 235,000

This project provides for the construction of a 5,650-square-foot (525 square meter) two-story masonry block addition to the Transonic Cryogenic Tunnel, Building *1242.* This new space will provide approximately 1,400 square feet (130 square meters) for pretest model and test section preparation and checkout, and a magnetic suspension laboratory of 1,500 square feet (139 square meters). This work will also include an area of 1,300 square feet (121 square meters) for an updated data acquisition and computer control system, and a high-bay area of ***350*** square feet (33 square meters) to enclose the existing tunnel drive motor and ancilliary equipment. An open office area, one rest room, and heating, air conditioning, lighting, and electric power systems will be provided. The walls and ceilings will be acoustically treated to reduce the noise levels. **The** Transonic Cryogenic Tunnel has unique capability; it presently supports the advanced technology airfoil research program at Langley. This tunnel has become a prime facility for designing, developing, and evaluating new air foils and blade sections to extend technology for all types of improved fixed and rotary wing aircraft. This project is required to provide space for new control equipment, data acquisition systems, and a model preparation area, and to improve the existing work conditions at this research facility.

G. Lewis Research Center (LeRC) 175,000

1. Construction of Storm Sewer, West Area. 175,000

This project provides for the construction of a storm sewer to improve drainage conditions in the West Area of the Center. This work will include the construction of approximately 1,240 linear feet (378 meters) of 4-foot (1.2 meters) diameter concrete pipe from the south side of Cryogenic Road to an existing pond off Guerin Road. This work will also include the construction of a concrete headwall with drop inlet; an outlet with a panel apron; five precast storm sewer manholes with open grate tops; all together with related excavation, backfilling, and grading. The construction of this storm sewer will eliminate more than half of the existing Guerin Creek ditch, thereby reducing the erosion which occurs and the maintenance which results from this condition. This new storm sewer is consistent with the long-range development plan for the area. It will not only improve the existing conditions but is essential to any research facilities planned for the west area of the Center.

H. National Space Technology Laboratories (NSTL) 425,000

1. Construction of Addition to Component Test Facility, Building 8100,..... 200,000

This project provides for the construction of a 1,920-square-foot addition (178.4 square meter) to the north side of Building 8100 and interior modifications to room 145 of that building. The addition will adjoin room 145, with which it will be made continuous. A Central Processing area and Electronic Repair and Calibration Laboratory area will be provided. To accommodate two other laboratory relocations, a nitrogen line in Building 8100 will be extended into an adjacent room, and a concrete equipment pad will be provided. This project is necessary to resolve several problems of the Technical Services Laboratory relating to Layout, work flow, and supervision between its Central Processing Group and several of its most active, special purpose laboratories, e.g., the Electronic Repair and Calibration Laboratory. This addition will provide the necessary spare to ensure a more efficient and effective overall operation of the laboratory.

2. Construction of Addition to the Data Applications Facility Building 1110.. 225,000

The project provides for the construction of a 4,800-square-foot addition (446 square meter) to the nata Applications Facility, Buildin 1110. The addition will be constructed of reinforced concrete panel exterior walls and vinyl covered plaster board interior walls to match the existing architectural motif. Additional rest rooms and associated heating and air conditioning and electrical utilities will also be provided. The addition is required to provide engineering and laboratory space for 30 personnel currently housed in twelve aging and deteriorated trailers which are scheduled for disposal. These personnel are engaged in permanent and continuing activities in support of the installation's approved mission. The trailers are over ten years old, scattered in various locations and are inefficient to maintain and operate. The permanent replacement would consolidate the related activities, reduce maintenance costs and provide for a more effective operation. If this project is not accomplished, purchase or lease of the equivalent number of trailers may become necessary.

I. Various Locations 455,000

1. Construction of Addition to Operations Building, Merritt Island, Florida.. 245,000

This project provides For the construction of a 3,000-square-foot (279 square meter) addition to the Operations Building at the Merritt Island Space Tracking and Data Network station. The addition will be concrete and masonry, constructed on a slab-on-grade, and match existing construction. Minimum air conditioning and heating will be provided. Existing utilities and the fire detection/protection system will be extended to the addition,

This space is required to install additional electronic systems to support tracking operations such as air-to-ground voice, VHF transceivers, support configuration consoles, TV systems, TDRSS "end-to-end" systems, and wide-band communications.

2. Construction of Maintenance Shop STDN Station, Canberra, Australia..... 150,000

This project will provide a 2,500-square-foot (232 square meter) maintenance building which will be constructed of concrete masonry on a slab on grade. Required utilities and the fire detection/protection system will be extended to the addition. This space is necessary to provide adequate shops to support this isolated facility. As a result of various additions to station facilities to meet operational requirements, facilitv space allocations have been displaced and relocated to the extent that it is becoming difficult, if not impractical, to function properly and efficiently. This project will correct the present situation and provide a building to centralize personnel and restore a functional and efficient capability to the station facilities.

This is a joint American/Australian project. The Australian Government will make a contribution of approximately $100,000 to this work, which amount is in addition to the above request.

3. Construction of Heavy Vehicle Service Area (DDS-62), Madrid Spain..... *60,000*

This project will provide a 1,250-square-foot (116 square meter) building constructed of indigenous field stone with a concrete floor and a service pit. Utilities, an access road and a parking area will be provided. In addition, this project provides for the acquisition and installation of appropriate heavy vehicle service equipment.

The heavy vehicles presently used at the Madrid station to maintain and do other work on the large antennas are serviced in the power plant mechanical shop in a makeshift service area. While it has been possible to maintain the heavy vehicles thus far, the makeshift facility has not met local safety regulations. In particular, work on the underside of the vehicle should be performed from a properly designed service pit or a hvdraulic lift and not with the heavy vehicle on jacks. This new facility will provide an austere but sale work area €or the mechanics. The closest commercial heavv vehicle service facility is in Madrid which is 30 miles *(48.2* kilometers) from DSS-62 station.

Miscellaneous Projects Less Than $50,000 Each 610,000

Total..... 4,200,000

~~Future Co~~F Estimate Funding Required to Complete This Project:

It is estimated that between *$4* and $6 million per year will be required for the continuation of this essential minor construction work at WASA field installations and Government-owned industrial plants engaged in NASA activities.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1979 ESTIMATES

SUMMARY

FACILITY PLANNING AND DESIGN

	Amount	Page No.
Regular Requirements:	6,450,000	
Master planning..	300,000	CF 10-2
Sustaining engineering support	1,300,000	CF 10-3
Preliminary engineering reports and related special engineering support	1,750,000	CF 10-4
Final design	3,100,000	CF 10-5
Other Requirements :	4,200 ,000	
Shuttle facility planning and design	1,300,000	CF 10-5
Spacelab/payloads facility planning and design.	300,000	CF 10-6
Large aeronautical facilities planning and design	1,650,000	CF 10-6
Energy reduction analysis and support	950,000	CF 10-8
Total.	10,650,000	

Regular requirements encompass the basic purposes outlined above. The "other requirements", while also in support of these purposes, cover those special needs which are related to large, complex projects or specific programs which are considered to represent high potential future construction requirements and for which early definition is essential. These large projects require significantly more planning and longer lead time than is normally involved. Much of this planning must be completed prior to inclusion of the project in a budget request. Most of these projects represent a continuing effort from previous years rather than new work.

1. REGULAR REQUIREMENTS 6,450,000

A. Master Planning.. ..... 300 000

This portion of the requirements provides for the updating and further development of existing master plans for the field installations, including facility studies and site investigations. Documentation will define facility parameters within which subsequent engineering efforts will be based for future development. This also provides for the documentation of existing plans where actions or deviations from previous plans have not been recorded for the various field installations.

Master plans at the various field installations are generally updated at cyclic 3-year intervals. Approximately one-third of the field installations are involved in any one fiscal year, keeping the level of effort relatively modest and constant. These plans provide for the orderly consideration of the allocation, proper arrangement, and efficient correlation of land areas and structures to serve the purpose of the various installations. Representative master planning activity candidates for FY 1979 are:

(1) Johnson Space Center

A scheduled major update consistent with the 3-year updating cycle to reflect new facilities; current and future land and facilities utilization; impacts of changing offsite factors, such a vehicular traffic; and the utilization interfaces with NASA activities at nearby Ellington Air Force. Base.

(2) Marshall Space Flight Center

An upgrading and updating of the topographic, utilities and roadway composite overlay map system, is necessary. These basic large scale maps, while not specifically incorporated in master plans, do comprise the vital inventory base necessary for all master planning documentation and studies. Most of these basic document maps have not been updated in 5 to 7 years and this upgrading is now essential to preclude the total master planning system from being outmoded.

(3) Wallops Flight Center

This is a scheduled 3-year update to reflect the existing facilities inventory and revised use. It will also include new facility and airfield pavement conditions, and land use interfaces with the Department of Interior and the City of Chincoteague.

(it) Lewis Research Center

This is a scheduled major 3-year update to incorporate new facilities, proposed development and probable land use changes which would be effected by planned adjacent Cleveland-Hopkins Airport expansion; and the potential incorporation of semihazardous test facilities within existing installation land boundaries.

B. Sustaining Engineering Support 1,300,000

Provisions for facility studies and specific engineering support continue to take on an added importance which has been evidenced in recent years, and must be given further high priority throughout FY 1979. These efforts are of utmost importance due to the more unpredictable cost situation which currently exists; cost trends in construction materials and fuels; the continuing importance of energy conservation and efficiency; and the operation and maintenance cost for the physical plant. This also includes provisions for maintaining a current engineering data base and updated construction specifications for utilization by the various field installations.

The following items are included in the FY 1979 requirements:

(1) Building Research and Advisory Board Support

This covers annual support to the Federal Construction Council (FCC) operations and provides for special studies that the Council will perform throughout FY 1979 to help advance the science and technology of Federal Government building and construction. The FCC is a committee of the Building Research Advisory Board, National Academy of Sciences, and its activities are supported by several Federal agencies including NASA.

(2) Utilities Services/Rates Analysis

This provides for the continued services of utility rate analysis support, to include counseling, surveillance, and agency-wide recommendations with regard to utility rates, contract negotiations and systems operations. This has become of increasing importance in light of the rapid increases in utility costs and utility supply problems.

(3) Design Specifications Update and Support

This provides for the continuation of engineering services for the updating and refining of the agency-vide construction specification systems which combine a catalog of preapproved standard construction specifications, and a program for selective retrieval and printout of bid specifications.

(4) Facility Operation and Maintenance Analysis

This provides for continued engineering support in implementing, at field installations, improvements relative to manpower utilization, work control systems, preventive maintenance, and facilities management and reporting. This also includes some facility operation and maintenance management surveys to be conducted on a priority basis at selected NASA field installations.

(5) Value Engineering, Cost Validations and Analysis

This will provide for the procurement of engineering services to improve, whenever possible, cost effectiveness of facility projects by subjecting project design criteria, specifications and working drawings for specific material components and systems to a detailed independent review by engineering specialists in the particular area of involvement. It will also provide services necessary to more accurately predict facility costs which will aid in resources planning for the various field installations.

(6) Facilities Utilization Analyses

Provides for the comprehensive analysis of agency-wide facilities utilization data covering: (1) office and other types of building space; and (2) utilization data on designated major technical facilities, such as wind tunnels. This analysis provides for the review of data in various formats and extractions, thereby permitting insights into, and development of, better methods of identifying underutilized facilities; improved techniques of quantifying their level of use; and of actions for improved utilization. This work also provides for any necessary special reviews of each installation's inventory data base in support of the facilities utilization program. These surveys are frequently necessary to validate the reported data especially in relation to a specific problem or need, and thus assist in the provision of a credible foundation for plans to further improve the utilization of facilities.

C. Preliminary Engineering Reports and Related Special Engineering Support 1,750,000

(1) Preliminary Engineering Reports (PER's) ..... (1,100,000)

Preparation of PER's, investigations, and project studies related to proposed facility projects to be included in the FY 1981 Construction of Facilities program are provided for by this estimate. These reports are required to permit the early and timely development of the best project required to meet the stated functional need and to provide the related basic data, cost estimates and schedules related to any such future budgetary proposals. This request will provide for PER work associated with proposed subsequent construction, except for Space Shuttle, payloads and large aeronautical requirements, involving an estimated cost of $20 to $30 million of construction for which updated PER's will be needed, and with new projects estimated to cost $50 to $55 million for which completed new PER's will be required.

(2) Related Special Engineering Support.... ..... *(650,000)*

Investigations and project studies related to proposed facility projects to be included in the subsequent Construction of Facilities programs are provided for by this estimate. Such studies have taken on an increased importance in recent years and involve documentation and validation of "as built" conditions, survey/study of present condition of such items as roofing and cooling towers, utility plant condition and operational modes, analysis and support of environmental impact assessments and statements and other like studies. These studies are required to allow for the timely development of projects to meet the stated functional needs and to provide basic data, cost estimates, and schedules for related future budgetary proposals.

D. Final Design 3,100,000

The amount requested will provide for the preparation of designs, plans, drawings and specifications necessary for the accomplishment of projects other than Space Shuttle, Spacelab, Payloads, and Large Aeronautical facility projects, primarily those which are planned for inclusion in the FY 1980 Construction of Facilities program, This request will provide for final design work associated with such proposed subsequent construction of this nature estimated to cost $50 to $55 million. It will also provide for residual requirements of this nature which have accumulated from prior years' final design activities.

2. OTHER REQUIREMENTS *4,200,000*

These other facilities planning and design requirements are generated by potential future projects, large in size and of a complex nature. Those in this particular request are primarily associated with future space programs which require a long planning cycle. Early and progressive design work is essential to ensure the ultimate best design, cost estimates and schedules. These projects then require added planning effort and associated design lead time well beyond that normally associated with preliminary engineering reports and general type facility projects. For this reason, these requirements must be provided for over and above the regular and the most recurrent facility planning and design needs covered above.

A. Shuttle Facility Planning and Design 1,300,000

(1) Shuttle Facilities Studies and Preliminary Design ..... *(350,000)*

This portion of the total Space Shuttle facility requirements is associated with the preparation of Preliminary Engineering Reports (PER's), the conduct of facilities investigations, and studies for facilities projects which, in most cases, will be included in the FY 1981 Construction of Facilities program. This preliminary work is associated with future construction for that year now estimated to cost approximately $20 to $25 million, and with anticipated requirements to study operational facility problems. Studies and PER's will thus be undertaken to examine the facilities needed to enhance the operational phase of the Space Shuttle

program. These facilities relate to launch and landing operations, solid rocket motor and external tank (ET) production at increased levels. These facilities will be required to sustain launch rates of up to 60 flights per year. Such facilities as a Solid Rocket Booster (SRB) Processing Facility, Solid Rocket Motor (SRM) storage, and modifications for increased SRM and ET production are candidates for inclusion in the FY 1981 budget. PER's in the amount of $200,000 are estimated to be required in order to support decisions relating to these facilities. In addition, studies estimated at $150,000 will be required in order to provide quick response, cost analysis and trade-off studies, environmental assessments, and cost validations of these proposed projects.

(2) Shuttle Facilities Final Design ..... (950,000)

This portion of the total facility planning and design required for Space Shuttle facilities is associated with the preparation of final design, drawings and specifications required for future construction of Space shuttle facilities, now estimated to cost approximately $10 to *$40* million and which may be included in a N 1980 Construction of Facilities request. The final design costs relating to the proposed FY 1980 projects will be somewhat reduced from that ordinarily expected since some of the project construction is similar to facilities already designed and under construction. This design effort is mainly related to the potential requirement for solid rocket motor production facilities at Wasatch, Utah, and to the operational phase of the Space Shuttle program at Kennedy Space Center, where increased flight ra es will have to be supported. Projects forecast for FY 1980 may include consideration of a third mobile launch platform (MLP-3), a crawler maintenance facility, and added modifications to both launch pads which may be necessary to minimize problems associated with external tank icing.

B. Spacelab/Payloads Facility Planning and Design *300,000*

This planning requirement is related to the study and preliminary engineering of facilities to support the Payloads program. These programs are essential to provide the capability for developing, integrating and checking out scientific application, technology, and upper stage payloads, as well as the capability to launch these payloads. Facility needs forecast for FY 1980 and 1981 include a Payload Processing and Servicing Facility. This projected facility is estimated to cost $3 to $5 million in FY 1981. The cost of studies related to these requirements and preliminary engineering effort required in FY 1979 is estimated at $150,000.

C. Large Aeronautical Facilities Planning and Design 1,650,000

(1) National Transonic Facility ..... *(850,000)*

This requirement is for studies, final design and technical engineering support related to the construction of the National Transonic Facility (NTF). The Aeronautics and Astronautics Coordinating Board recommended that a single ground aeronautical test facility be constructed at the Langley Research Center,

Hampton, Virginia, to satisfy both the research requirements of NASA and the aerodynamic research and development needs of the Department of Defense over a 0.2 to 1.2 Mach range, with Reynolds numbers capability up to about 120 million. It will be built for cryogenic operations which make such high Reynolds numbers attainable while keeping model loads and tunnel power requirements relatively low. Also, Reynolds numbers and aeroelastic effects will be separable in the data taken in the completed facility, a capability unattainable in any known existing wind tunnels.

Included in the Construction of Facilities FY 1977 and 1978 programs is a total of $48.5 million to begin and move ahead with the construction of this facility, the total cost of which is estimated to be about $85 million. In the FY 1979 Construction of Facilities budget, $24.5 million is requested as a third construction funding element for this major facility. It is planned that NASA will request the balance of some $8 to $12 million in a future year to complete this construction.

An amount of $6,800,000 has been provided in previous fiscal years for engineering studies, preliminary design, final design and other technical support. To date, much of the study and design work leading up to construction has been completed. This FY 1979 request, which is the final funding element for a total of $7,650,000 overall planning effort for the NTF, will provide for the completion of studies and final design, and the considerable engineering effort that will be required to solve construction-related problems.

Although actual construction of the NTF started in December 1976, additional studies, testing, and design are still required. These efforts which relate to construction and equipment which will be provided later in the construction program cycle were postponed so that other necessary revised and additional design could be accomplished in a timely manner. This deferred planning therefore must be accomplished expeditiously to preclude major impacts on the total facility acquisition schedule. Of particular significance are studies and engineering support needed to develop the process control system specifications and complete the design of environmental protection features. Other areas of concern which require additional effort include thermal insulation life, cooling coil design, hazards control, bearings and seals, emergency power, and fan blade development. Finally, as in all large, complex facility construction projects such as this, unforeseen problems probably will occur during implementation. Many of the solutions to these problems require considerable engineering effort and review on a short turnaround time basis. This funding request will also support a very modest level of this effort as a vitally needed activity.

(2) Modification of 40x80-Foot Subsonic Wind Tunnel ..... *(800,000)*

These resources are required for completion of the final design of the 40x80-Foot Subsonic Wind Tunnel Modification located at Amts Research Center, Moffett Field, California. Modifications to this wind tunnel will result in a national aerodynamic test facility with a capability for research as well as development testing of full scale rotorcraft and V/STOL aircraft. This category of civil and military aircraft, because of the increase in speed capabilities over the last ten years, can no longer be adequately evaluated in available test facilities. Additionally, the complexity of propulsion system/airframe structure/control

interaction requires the full scale testing of actual flight configurations. Studies have shown that the capability required to adequately test these aircraft can be achieved by retrofitting the 40x80 drive support structure with a new generation drive system (repowering) and by the addition of a new test leg. The Aeronautics and Astronautics Coordinating Board endorsed this concept in 1973. This major modification project is scheduled for completion in early to mid-1981.

As indicated in the Construction of Facilities FY 1977 and FY 1978 programs, a total of $19.5 million has been provided to initiate this modification to the 40x80-Foot Subsonic Wind Tunnel. An additional $31.6 million has been requested as the third construction funding element in FY 1979. NASA plans to include, in a future budget request, the remaining funds required to complete the construction of this $80 to $85 million facility.

Resources in the amount of $3,870,000 have been provided in previous fiscal years for engineering studies, preliminary designs, final designs, and other technical engineering support related to repowering the facility and adding a new test leg. This FY 1979 funding request is the final funding element of the total $4,670,000 required for the planning and design of this facility project.

A number of significant activities for which these funds are planned still need to be addressed. Value Engineering efforts for several of the high cost work packages promise to restrain the ultimate cost of the facility. Changes in the final design of the repowering and new test leg will not only result in a more functional design, but will generate more bidder competition in the marketplace. Finally, complex facility construction projects inevitably develop unforeseen problems which had not been anticipated. The resolution of these problems in a timely manner will require the application of concerted engineering effort to assure minimum schedule/cost impact. This vitally needed technical engineering support during construction will also be provided at a very modest level with this requested funding.

It was anticipated that Facility Planning and Design funds provided in FY 1978 would complete the work outlined above for these large aeronautical facilities. However, the additional effort required to refine the designs for both facilities as well as that associated with the increased cost of the NTF early in CY 1977 has caused these activities to be rescheduled and augmented. This has resulted in the necessary deferral to N 1979 of the residual design and study effort as well as the technical engineering support previously described. It is presently planned to complete all such effort with this N 1979 funding element. Any presently unknown future requirements will most probably be "construction oriented", and thus will be provided for as necessary with associated resources.

D. Energy Reduction Analysis and Support.. 950,000

This is the first year that FP&D requirements for energy reduction analysis and support are identified as "other requirements" in this estimate. This has been done in response to *two* factors: (1) the rapid growth of this requirement as reduction efforts have expanded; and (2) the revised focus accorded specific building

energy reduction by Executive Order No. 12003, July 20, 1977. This FP&D requirement thus covers special needs which are frequently related to complex facility studies, analyses, and other preliminary activities leading to the better identification of highly probable cost and energy effective facility projects. These preliminary activities are vital to the total effort of future energy reduction and must be undertaken on a priority basis if long-term energy reduction goals are to be attained.

NASA has progressively intensified its efforts to identify, study, and develop new energy reduction initiatives which could most probably result in sound and effective facility projects. In turn, it is anticipated that these result projects will reduce and/or limit future energy consumption through improved efficiency and, at the same time, minimize the impact of rapidly rising energy costs. Experience to date has demonstrated that these planning resources can produce appreciable energy reductions and can direct investment resources toward the most prudent and cost effective modifications to facilities on some priority basis. As compared to FY 1976 usage, for example, during FY 1977, approximately $4,000,000 in additional energy costs were avoided through the increased effectiveness of energy management and by modest prior investments. An anticipated additional 15 to 20% reduction in NASA's total energy consumption can probably still be achieved through additional planning, resulting in an estimated utility cost saving of a further $8 to $10 million per year in terms of average FY 1977 energy costs. These resources for needed anticipation planning are therefore essential since they are the key to the timely identity of the future facility investments. If this identification effort is not accomplished in a timely manner, added downstream utility and other costs will be reflected. These resources will be used for the following major areas of effort:

(1) To provide for engineering support, studies, and analyses involving changes in criteria and design methodologies, operation and maintenance procedures, improved research testing procedures, facility energy impacts due to new programs *as* well as cost and energy effective evaluations of investments. Other technical energy investigation and identification efforts, including fuel conversion and application of nondepleting resources associated with NASA's major technical facilities are also involved. Significant investments that reduce energy consumption in NASA's wind tunnels and other facilities are also involved. Significant investments that reduce energy consumption in NASA's wind tunnels and other technical facilities have already been identified. However, additional efforts are still required for studying those technical support facilities associated with NASA's major energy consumers, such as steam ejectors, test stands, launch and control facilities, and data handling and reduction facilities. In addition, the energy impact and reductions associated with the full scale operation of locations, such as KSC and MAF, must also be evaluated to insure that optimum energy utilization is achieved during future operations. This will essentially complete the study efforts directed primarily toward energy reduction in technical facilities. The cost associated with this item is estimated at $470,000 for FY 1979.

(2) To provide for the first phase of an anticipated multiphase program over the next two to three years to support and comply with the intent and directed purpose of Federal Executive Order No. 12003. This Executive Order places new focus and emphasis on saving energy in existing buildings. NASA has approximately

2,500 buildings with a total of over 30,000,000 gross square feet of floor area. Of these, there are 245 which contain over 30,000 gross square feet each. This analysis and study effort will provide the necessary "energy audits", engineering services, economic evaluations, and other technical support necessary to initiate the evaluation of a selected number of the most "energy intensive" major buildings and/or central utility plants. It is estimated that this will represent a total of about 3 to 5 million gross square feet of the NASA total or approximately 10 to 15%of the total area.

The emphasis of this effort will be directed at the determination of actual system configuration and thus operational modes and subsequent study of alternatives. The heating, ventilating, and air conditioning systems, lighting, thermal and electrical distribution systems, and any other operations, systems, or functions which require energy utilization/reduction analyses and evaluation will be involved.

Previous experience and results have indicated that very productive energy conservation initiatives associated with buildings can be identified and that these do result in significant energy savings with nformally less than three-year "simple payback". Specifically, these initiatives include control modifications, electrical power reductions, and system optimizations. The cost associated with the implementation of this effort is $480,000 for the FY 1979 time frame.

As indicated above, this is the first phase of a two to three year major effort to identify those significant and most promising energy consumption retrofits related to major buildings. The limited experience with buildings thus far has been very encouraging and indicates a high potential of success with very cost effective results.

TOTAL..... 10,650,000