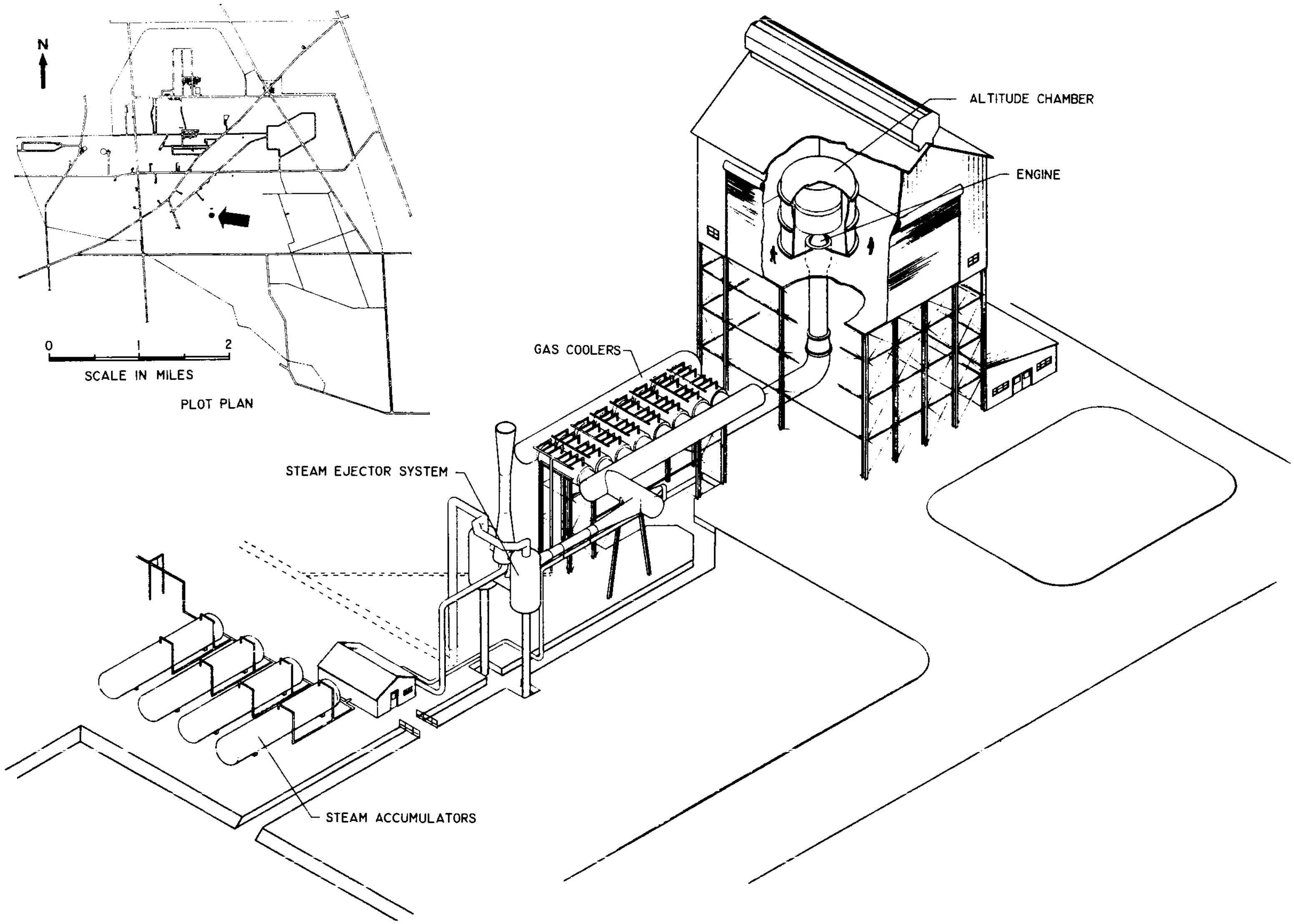
LEWIS RESEARCH CENTER
FISCAL YEAR 1963 ESTIMATES

LUNAR PROPULSION RESEARCH FACILITY



CF 8-C2

LEWIS RESEARCH CENTER

FISCAL YEAR 1963 ESTIMATES

LUNAR PROPULSION RESEARCH FACILITY

DESCRIPTION:

This project proposes the construction of test facilities for conducting altitude performance evaluations necessary to the development of the propulsion system for the lunar landing stage of the Apollo vehicle.

As indicated in the sketch on the following page, the facility will consist of a vertical firing test stand at the Plum Brook Station similar to but larger than the present altitude facility (B-1). The new facility will be located about 2,000 feet from the present stand and will be large enough to provide sufficient work area around a test chamber approximately 30 feet in diameter by 35 feet high. A test chamber of this size should be large enough to contain both the engine and fuel tanks of this stage. The facility will be designed for testing hydrogen-oxygen engines of appropriate chamber pressures and expansion ratios, up to 60,000 pounds thrust under gimballing and various part-thrust operating conditions.

A jacket around the engine and fuel tanks will be cooled with liquid nitrogen to obtain a low temperature environment. Low pressures in the test chamber will be obtained by using a diffuser on the rocket engine exhaust in addition to a multi-stage steam ejector system. The steam boilers associated with the present stand will supply the high pressure steam for the new facility. The steam will be piped to accumulators located at the new site. A new steam ejector system and spray coolers will also be installed. The circulating water system at the existing stand will be increased by adding additional pumps. The water supply and return lines will be extended to the new site.

JUSTIFICATION:

A manned lunar landing mission will require engines with the ability to start instantly upon receipt of the demand for thrust and with control characteristics and response rates which are compatible with landing trajectory requirements. Such engines will use high energy propellants and will be required to start under the very low temperature and pressure conditions existing in space. It will be necessary to study the ignition characteristics and the starting and stopping transients and to develop an ignition system which will give reliable starts under low pressures and after being exposed to very low temperatures for a long time. The guidance and control systems will also require the development of engines in which the thrust can be varied over a wide range to insure "soft" landings and control of the touch-down point.

The successful accomplishment of the manned lunar mission will ultimately depend upon how well the individual components have been integrated into a reliable propulsion system. It is therefore necessary that the many components, including fuel tankage, propellant delivery system, rocket engines, and controls, be designed so that they operate free from undesirable interactions and as an effective and reliable entirety. Only by testing these components functioning as portions of the complete system can their interactions be accurately determined and a reliable, trouble-free system of adequate performance be developed.

The facility proposed in this project will provide a sufficient simulation of the space conditions to permit the satisfactory development of the lunar landing propulsion system and for the qualification testing of the flight hardware. By the use of significant portions of the existing altitude facility, the construction of the new facility can be accomplished with important savings in cost and on a schedule which will be compatible with the Apollo program requirements.

COST ESTIMATE:

A.	LAND ACQUISITION..................................		---
B.	SITE DEVELOPMENT AND UTILITY INSTALLATIONS..........		$240,000
	Site development.....................	$170,000	
	Utility connections..................	70,000	
C.	FACILITY CONSTRUCTION AND MODIFICATIONS............		1,352,000
	Test stand structure; three floors.. (15,200 square feet at $80.00 per square foot)......................	1,216,000	
	Pump house addition at existing altitude rocket test stand... (3,200 square feet at $20.00 per square foot)......................	64,000	
	Control room addition at existing altitude rocket test stand.. (1,600 square feet at $45.00 per square foot)............................	72,000	
D.	EQUIPMENT, INSTRUMENTATION, AND SUPPORT SYSTEMS.....		4,078,000
	Exhaust system coolers...............	486,000	
	Exhaust system piping, heaters, and expansion joints...................	954,000	
	Water system.........................	572,000	
	Propellant system....................	505,000	
	Steam system accumulators............	700,000	
	Steam system piping, valves, and insulation.........................	375,000	
	Instrumentation and electrical equipment.........................	486,000	

E. DESIGN AND ENGINEERING SERVICES....................	$605,000
Total estimated cost....	$6,275,000

Page No.	Location and Project	Project Estimate	Location Total
CF 7	Langley Research Center:		$8,092,000
CF 7-A1	Location Summary		
CF 7-A2	Location plan		
CF 7-A3	Addition to heating plant	$858,000	
CF 7-B1	Additional equipment for magnetoplasmadynamics research...	1,450,000	
CF 7-C1	Additional power supply and improved arc chamber for 10-megawatt arc tunnel..............	760,000	
CF 7-D1	Environmental research facilities for spacecraft components and materials......................	997,000	
CF 7-E1	Particle accelerator for simulation of micrometeoroid impact.........	936,000	
CF 7-F1	Stabilization and control equipment laboratory......................	1,366,000	
CF 7-G1	Vehicle antenna test facility......	1,725,000	
CF 8	Lewis Research Center:		43,833,000
CF 8-A1	Location Summary		
CF 8-A2	Location plan		
CF 8-A3	Development engineering building...	4,650,000	
CF 8-B1	Hydrogen heat transfer facility....	2,400,000	
CF 8-C1	Lunar propulsion research facility.	6,275,000	
CF 8-D1	Modernization and reconditioning of Plum Brook service facilities.	1,508,000	
CF 8-E1	Nuclear rocket dynamics and control facility.................	3,500,000	
CF 8-F1	Space propulsion facility..........	25,500,000	
CF 9	Manned Spacecraft Center:		30,755,000
CF 9-A1	Location Summary		
CF 9-A2	Location plan		
CF 9-A3	Flight acceleration facility.......	10,630,000	
CF 9-B1	Thermochemical test facilities.....	6,000,000	
CF 9-C1	Lunar landing simulation facility..	6,500,000	
CF 9-D1	Site development and utility installations....................	7,625,000	
CF 10	Marshall Space Flight Center:		33,437,000
CF 10-A1	Location Summary		
CF 10-A2	Location plan		
CF 10-A3	Addition to computation division building........................	1,255,000	
CF 10-B1	Components test facility..........	4,000,000(I)	

National Aeronautics and Space Administration

BUDGET ESTIMATES

FISCAL YEAR 1963

CONSTRUCTION OF FACILITIES
PART 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1963 ESTIMATES

CONSTRUCTION OF FACILITIES

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PART 1

PART 2

JS2 ?

AA (Dr. Seamans)

September 10, 1962
RP(JLS/jh)

R (Dr. Bisplinghoff)

Lunar Propulsion Research Facility at Lewis Research Center

1. We have examined this facility proposal, have discussed it with the Lewis Research Center, and our conclusion is that such a facility would be very useful for research and technology programs and we recommend that it be built.

2. The facility was designed for investigating the altitude performance of hydrogen-oxygen propulsion systems. Additional advantages would be gained if the facility were designed to allow the use of toxic and highly reactive chemicals such as fluorine, oxygen-difluoride, diborane, and perhaps beryllium. Steam ejector pumping exhaust equipment and the water spray coolers are ideally suited for dealing with such toxic materials although additional treatment equipment will be required.

3. We feel that the requirement for altitude facilities for propulsion will increase. Some of the major problems that can be explored with such a facility include: (a) expansion processes in large area-ratio nozzles of advanced design, (b) heat transfer and cooling of large area-ratio nozzles, (c) starting, varying thrust, and stopping of chemical propulsion systems, (d) system dynamics as affected by thermal and pressure gradients, (e) testing of complete propulsion systems, and (f) testing of complete flight-weight propulsion stages of advanced design and low length-to-diameter ratios.

Raymond L. Bisplinghoff
Director, Advanced Research
and Technology

JLS:jh
BCM

NEWS RELEASE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LEWIS RESEARCH CENTER - 21000 BROOKPARK ROAD
CLEVELAND 35, OHIO - TELEPHONE: 252-7700 - TWX: CV 520

FOR RELEASE--September 24, 1962

PLUM BROOK RESEARCH STATION

During World War II the Army established Plum Brook Ordnance Works near Sandusky, Ohio, to manufacture TNT. After the war, the area was mothballed until the NACA in Cleveland began looking for a place to build a test reactor. Ground was broken for the reactor in 1956 under the administration of the NASA Lewis Research Center. Plum Brook grew to include rocket test facilities as the Army leased over additional land to NASA.

The Plum Brook area, currently valued at $28,114,000, will total over 6,000 acres when transfer of the property to NASA is complete. Plum Brook has been growing rapidly. In the last six months the staff has doubled from 200 to 400 and the station's director, Alan D. Johnson, estimates that it will reach 600 within the next year.

Plum Brook is equipped to handle full-scale, static tests of rocket components. The budget proposed for fiscal year 1963 includes almost 40 million dollars for construction and improvement at Plum Brook. A large portion of this will be used to build a Space Propulsion Facility. The "space tank" is designed to be 126 feet high with ground dimensions of 506 and 326 feet. Within the aluminum tank an environment comparable to that in outer space will be simulated to test lightweight chemical and nuclear rocket engines--their ignition, control and re-start capabilities will be of particular interest. The environment of the tank can be kept at liquid hydrogen temperatures (-423°F.) and 10^{-8} millimeters of mercury pressure for up to two weeks. (That's a pressure comparable to that at an altitude of 190 miles.) In addition, the tank can operate for 90 days at less rigorous space conditions for tests on long duration performance rocket engines and their components. This allows "cold soak" work---or, checking out the rocket component after long-term exposure to extreme environments. In the cold of space, it is possible for a bearing to "weld" into the touching metal. Plum Brook's space tank is a way of being sure that the final components of a spacecraft will not cold weld once they are in space.

Another new facility on schedule is the hot hydrogen heat transfer facility. This will heat hydrogen gas to temperatures around 4500°F. before passing it through a rocket test nozzle. This will allow on-the-ground testing of nozzle materials in an environment similar to that of a nuclear rocket

(more)

engine.

ROCKET SYSTEMS RESEARCH FACILITY

A Site--Pump Test Laboratory where liquid hydrogen (-423°F.) and liquid oxygen pumps can be inserted into a fluid transport system to test the pump's performance under the rigorous conditions of High flows and pressures with cryogenic liquids. Six thousand gallons of liquid hydrogen can be transferred at this facility in 30 seconds at a flow rate of 100 pounds a second. Liquid oxygen pumps can be tested at flow rates up to 225 pounds per second.

B-1 Site--Nuclear Rocket Engine Dynamics or Nerva Stand--will run 15 second checks on the starting transients of the Nerva (nuclear engine for rocket vehicle application) which will be used on long-range missions to supply thrust for extended periods of time; B-2 and B-3, part of the new construction, will be testing stands for the lunar landing or Apollo mission and the Phoebus, respectively.

C Site--Turbo Pump Laboratory has two test areas. The first is a research turbo pump to transfer liquid hydrogen. It is now operating at a capacity of 10 pounds per second but the system is capable of carrying much higher flows. The second, a liquid hydrogen boiling fluids pump, is designed to help solve the problem of pumping liquid hydrogen with a minimum suppression head. When cryogenically cold liquid hydrogen is stored in rocket fuel tanks, excess heat from the engines or even from the sun may raise the fuel temperature to its boiling point. This "boiling fluids pump" will help solve the minimum suppression head problem.

D Site-- Turbine Laboratory--contains two turbine installations. Each can test 15,000 HP turbines which run up to 60,000 RPM. Eddy current dynamo-meters are installed to absorb the power from these turbines.

E Site--Dynamic Research Laboratory--was originally constructed to test the Atlas missle under simulated take-off conditions. Two electro-magnetic shakers, one vertical and one horizontal, shake the test apparatus. This violent motion inside the 119-foot stand provides a good approximation of the stresses encountered on take-off.

(more)

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FISCAL YEAR 1963 ESTIMATES

APOLLO LUNAR LANDING PROPULSION FACILITY

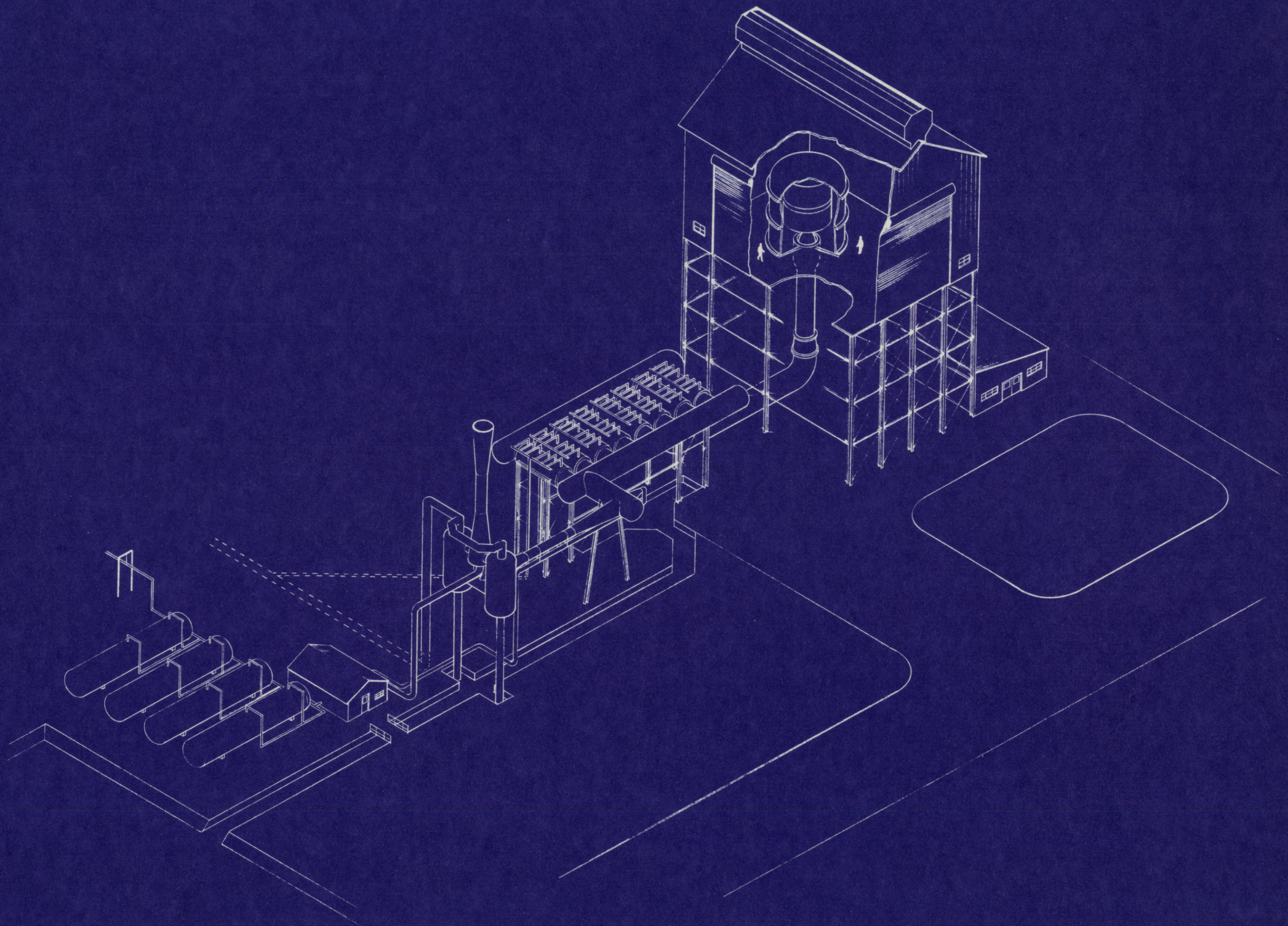

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EXHIBIT C of F-2
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LEWIS RESEARCH CENTER
FISCAL YEAR 1963 ESTIMATES

~~APOLLO~~ LUNAR ~~LANDING~~ PROPULSION RESEARCH FACILITY

new plot plan