

OPERATION OF "I" SITE FROM JULY 1, 1961 to JULY 1, 1962

"I" site is a liquid fluorine pump laboratory. In this test cell, data in the form of parameters is gathered to facilitate in the design of liquid fluorine pumps.

Within the past year, 50% of the time was spent checking the system with gas helium and liquid nitrogen. 17% of the time was spent calibrating the system with liquid nitrogen. This work was performed to prove the system safe for a liquid fluorine test.

Two liquid fluorine tests were conducted in early March 1962. The first test lasted forty-nine minutes and was considered successful. During the early moments of the second test, a fluorine leak occurred partially destroying the laboratory.

Since March, the remaining 33% of the time was used in rebuilding the laboratory for future fluorine tests.

of the pump suction and discharge lines.

d. "D" Site - Turbine Test Facility:

Operations have been limited to cold flow tests to investigate control problems and to a hot check of the gas generator. Results of these tests indicated that certain of the control valves and systems had to be modified and these changes are now being made.

e. "E" Site - Dynamics Laboratory:

Twenty-Nine research runs were completed between February and July of 1962 to support the MECA program, the SCOUT program and the Ranger payload systems as well as others.

f. "F" Site - Hydrogen Flow Facility:

This site was not operational during the Fiscal Year except for shake out testing that required several modifications to the existing equipment.

g. "G" Site - Pilot Plant:

Test operation of the Liquid Hydrogen Pump continued until the end of September 1961. After that time a new pump was installed and one run was made in June 1962. The turbine test facility at the same site had twelve runs between November 1961 and January 1962 using the NERVA three stage turbine. In addition one run was made in June of the Hy-Nut Turbine using Nitrogen gas.

h. Central Control:

This facility operates as a central control and data acquisition facility for most of the test stands. It has been in operation throughout the year as required to meet the various runs scheduled. In addition a considerable amount of time has been spent in de-bugging the data acquisition and read-out gear in order to eliminate deficiencies that showed up as part of various test operations as well as to improve the capabilities of the installed systems.

i. "I" Site - Liquid Fluorine Pump Laboratory:

During the past year this newly completed facility has been going through various check runs using gas helium and liquid nitrogen in order to "prove" the systems for use with liquid fluorine. Two liquid fluorine tests were conducted in March of 1962, one of which was considered successful. The second test resulted in partially destroying the test facility when a fluorine leak occurred in the equipment under test. The remainder of the fiscal year has been spent in rebuilding the facility for future fluorine tests.

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PLUM BROOK STATUS REPORT (continued)

ITEM NO	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
2	PUMP "I" Site	Fluorine Pump F5A (Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt & Whitney pump

STATUS: Because of the extensive damage which occurred as a result of fluorine pump failure, this facility has been completely rebuilt. During December and January, considerable running with liquid nitrogen has been completed. The liquid nitrogen runs have served to verify the facility as well as accumulating pump data. At this time, the facility is believed to be in first class condition except for the pump inlet pressure control system. It was found that the pneumatic control valves are too slow to maintain steady pump inlet conditions especially when approaching cavitation. The pneumatic units are being replaced with high response hydraulic units and a liquid nitrogen verification run is scheduled during the first week of February. After verification the system will be cleaned and dried in preparation for a fluorine run about February 15.

PLUM BROOK ROCKET SYSTEMS FACILITIES STATUS REPORT

CONTINUED

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
I	PUMP	<u>Fluorine Pump</u> F5A (Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt & Whitney Pump. STATUS: Note (A): In the month of February three liquid nitrogen runs were required to verify the pump inlet pressure control system in contrast to the one run predicted. The remainder of the month was devoted to preparing the system for a data run in liquid nitrogen. Liquid fluorine run is scheduled for the last week of March.

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PLUM BROOK STATION ROCKET SYSTEMS FACILITY STATUS REPORT			CONTINUED
SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
I	PUMP	Fluorine Pump F5A (Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt & Whitney Pump.
	STATUS:	Note (A) - A two week delay resulted from instrumentation problems involving temperature sensing devices. One liquid nitrogen data run was made in March. Not all of the required data points were obtained; therefore, another liquid nitrogen run was made and the tentative data was obtained. An additional problem occurred during the run pertaining to the turbine air supply. A large pressure drop occurred due to water, or other material in the air line, resulting in the shortening of run time. This problem will have to be solved before a liquid fluorine run is scheduled.	

PLUM BROOK ROCKET SYSTEMS DIVISION STATUS REPORT

CONTINUED

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
April 1963	I	PUMP	Fluorine Pump F5A (Pinkel) Liquid fluorine pump test involving 3 NASA configurations and 1 Pratt & Whitney pump. STATUS: Note (A)-Schedule was changed due to malfunctions in the air system and pump. The turbine air problem that occurred during the last part of February was due to a partially clogged air filter. Cleaning of this filter solved the turbine air problem. A liquid nitrogen run was made on April 8, 1963 to check the turbine air supply and turbine air control for pump speed. Speed control for the pump proved to be satisfactory. After the April 8 run the test rig was taken apart for cleaning and inspection. Plans were then made to run the pump with the new seals in liquid nitrogen for twenty minutes. This run would lap the seals prior to a liquid fluorine run. The liquid nitrogen run was made on April 29, 1963. A malfunction occurred within the pump probably due to a misalignment of an O ring which is difficult to install. The O ring probably caused the pump to stop and crack a secondary pump seal. This type of pump failure was the first of its kind. Replacement parts were available and the damaged parts were replaced. The following day, April 30, 1963, a liquid nitrogen run was made. The pump operated correctly and the seals were lapped during a twenty-one minute run. STATUS: Following the run a pressure check revealed numerous leaks in the pump gaskets. The pump is being disassembled and various surfaces will be remachined to insure good sealing of the gaskets. A liquid fluorine run is scheduled for a second week in May.

May 1963

PLUM BROOK ROCKET SYSTEMS DIVISION STATUS REPORT			CONTINUED
SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> F5A (Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump.
NOTE (A) : Operation schedule had to be changed because of pump seal failures.			
STATUS: On May 11 and 29, liquid fluorine data runs were attempted, no research data was obtained. In both runs the pump seal assembly's carbon nose cone failed, breaking into many small pieces. Both failures took place in less than eighteen minutes of pump operation.			
On May 11 the nose cone was installed at the site and on May 29, a new factory assembled seal was used. Although at this time no definite reason has been found for the failures, a new cleaning technique will be tried for the next run. Previously the seals were cleaned in trichloroethene.			
Another liquid fluorine run with this same pump configuration is scheduled for the week of June 3, 1963.			

June 1963

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> (Pinkel) OFO 553	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. <u>STATUS:</u> On June 5th and 15th, liquid fluorine data runs were attempted and no research data was obtained. In both runs, various components in the pump failed resulting in minor burnouts. For this series of runs, aluminum oxide was used as the primary liquid fluorine seal. Pure bond carbon was used in the other three positions. On June 5th while pressurizing the pump to 50 PSIG, fluorine leaked into the seal vent cavity, and burned the second seal assembly and the seal vent line. The damage was minor and there were enough spare parts to assemble the pump for another run. On June 15th, the pump was operating at 10,000 RPM with an inlet pressure of 70 PSIG when a silver plated "O" ring seal between the scroll and stationary shroud collapsed. Two of the mounting bolts in the pump were partially burned by this failure. It wasn't learned until after the pump was completely disassembled that the second seal assembly was burned. The damage was confined to the carbon seal assembly. The time this failure occurred is unknown. The day before the run, the system, pump and pump seal cavity was pickled with fluorine gas. No definite reasons have been found for these two failures. Since there wasn't an adequate supply of spare parts to run the NASA pump again, the test cell is now undergoing modifications for the Pratt and Whitney pump. First test run is scheduled for the second week of July.

July 1963

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> OF0553 (Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump.
<u>STATUS:</u> On July 12 and July 16, two liquid nitrogen data runs were made on the Pratt and Whitney pump. On both days, the inlet pressure oscillated, but after a half hour of testing, the oscillations were damped out. The system is being modified to eliminate these oscillations.			
<u>NOTE (A):</u> The above system modifications will be checked out using the NASA pump with liquid nitrogen. This checkout run will be made the first of August, before the Pratt and Whitney liquid fluorine run.			

August 1963

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> OF0553 (Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. <u>STATUS:</u> On August 15 and 21, two liquid nitrogen runs were conducted with the NASA liquid fluorine pump to check out the controls system. Prior to these runs, a 3-inch Annin valve was installed in the inlet line to the pump and the helium pressure reduced to the control valve. On August 15, two run points were taken with oscillations occurring at the inlet control pressure pickup. Sufficient data were obtained to establish that the total pressure probe provided with the research rig was far too small to give adequate frequency response. On August 21, a new total inlet pressure probe pickup with a reduced volume and larger pressure port was installed in the pump inlet line. Sixteen run points were taken using a flush-mounted transducer and a standard control pressure transducer on the new inlet pressure pickup. The control system exhibited stable conditions for all regions of pump parameters. Since all control systems appear to be operating correctly, liquid fluorine tests will be performed on the Pratt and Whitney pump starting in September. <u>NOTE (A)</u> : Schedule changes reflect research program requirements.

September 1963

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> OFO-553 (Pinkel)	Liquid Fluorine pump test involving three NASA configurations and one Pratt and Whitney Pump. <u>STATUS:</u> On September 13, a liquid fluorine run was made with the Pratt and Whitney monel pump, Model TL-206465. The Pratt and Whitney representative stated that the research data obtained was satisfactory and the main objective of the test was accomplished which was to obtain seal wear information in liquid fluorine. The pump seal configuration was of the three seal design using carbon as the seal material. The total run time on the pump was 14.1 minutes. This was shorter than the planned 1/2 hour run time. Difficulties in priming the pump were caused by excessive amounts of helium gas leaking into the system and vapor locking the pump. Five attempts were made before the pump became primed. The pump was then brought up to design speed, of 10,240 RPM, after 10 seconds a drop in the pump discharge pressure occurred and the Pratt and Whitney representative had the system shut down. An additional attempt was made to prime the pump which was unsuccessful. On September 16, the pump was removed from the system and shipped to Pratt and Whitney for disassembly and inspection. Inspection of "I" Site indicated that the facility was in operating condition for the next test. The monel pump with a modified seal configuration is scheduled for testing the second week in October 1963. An NASA pump program is needed to alternate with the Pratt and Whitney program in order to fully utilize the test facility.

October 1963

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	FLUORINE PUMP OF0553 (Pinkel)	Liquid Fluorine pump test involving three NASA configurations and one Pratt and Whitney Pump. <u>STATUS:</u> On October 10th, a liquid fluorine run was made using the Pratt and Whitney monel pump, Model TL-20645. A total of six data points were taken before an explosion occurred within the pump causing a shutdown. The pump was operating at design speed of 10,722 rpm with an inlet pressure of 43 PSIG when oscillation occurred in the pump discharge pressure the Pratt and Whitney representative had the system shutdown. With the pump rotating at a speed of approximately 2000 rpm, an explosion occurred within the pump separating the inducer housing from the impeller housing. The Pratt & Whitney and Lewis Research Center people stated later that the probably cause of the explosion was that the carbon liner seal changed chemical composition which in turn reacted spontaneously with the fluorine. Damage to the cell was confined to the torquemeter, electrical wiring, four pressure and temperature transducers and a distorted pump inlet line. The following items are being updated and repaired at the cell: 1. The inlet line is being modified to provide less turbulent flow to the pump inlet. 2. A control system is being installed to maintain a constant helium pressure to the pump seals. 3. New spool pieces are being made to accomodate better pressure and temperature measurements. The cell is scheduled for operation the last week of November.

November 1963

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> OF0-553 (Pinkel)	Liquid Fluorine pump test involving three NASA configurations and one Pratt and Whitney Pump. <u>STATUS:</u> In November, the damage which occurred during the liquid fluorine run of October 10th was repaired. The major items which were replaced were the inlet and outlet spool assemblies, inlet piping to the test loop, electrical wiring and instruments. The helium control to the liquid fluorine seal cavity was updated by replacing the mechanical control system with a hydraulic type. The test cell is in condition to permit conducting a liquid nitrogen checkout run during the first week of December 1963. <u>NOTE (A):</u> Due to a Pratt and Whitney schedule change, the November run was cancelled. Two nitrogen checkout runs will be made with an NASA pump in the month of December.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	<u>FLUORINE PUMP</u> OF0-553 (Pinkel)	Liquid Fluorine Pump test involving three NASA configurations and one Pratt and Whitney pump. <u>STATUS:</u> During December, four liquid nitrogen runs were conducted to check the newly installed instrumentation and control systems, using an NASA pump. The following is a list of items checked and results obtained: (1) During system checkout, the newly installed hydraulic control system to the fluorine pump seals was giving pressure surges when switching the controller to automatic. A manual control switch is being installed to prevent the pressure surges. (2) The new platinum probes were installed in the pumps inlet and outlet lines, and in the flow venturi. The temperature system operated satisfactorily with a sensitivity of 0.25° F. (3) The capabilities of the new torquemeter were checked and found to be unsatisfactory. The torquemeter previously used on the Pratt and Whitney pump was repaired and is being installed. Two additional checkout runs with liquid nitrogen are scheduled for January to determine the capabilities of the control system to obtain research data using the ramp generators for control of the pump parameters. New seal parts for the NASA pump should be available by mid-January to allow a liquid fluorine run of the NASA pump during the last of January. The Pratt and Whitney pump test schedule will depend on the results from the NASA tests. <u>NOTE (A) :</u> A three-week delay in the schedule was caused by non-availability of NASA pump hardware which is scheduled for delivery January 15, 1964.

January 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	FLUORINE PUMP OF0553 (Pinkel) STATUS: During January, two liquid nitrogen runs were conducted to: 1. Determine the capabilities of the ramp generators and programmer. 2. To compare the output of the torquemeter with the torque calculated from the turbine parameters. Outlined below are the results obtained. The ramp generators were used to control speed, pump inlet pressure and flow. The generators and programmer were adequate to control and generate the pump head curve desired by the research engineer. The torque calculated from the weight flow and temperature drop across the turbine agrees within 2% of the values indicated from the torquemeter. Since the readings from the torquemeter appear to be correct, this instrument will be used to indicate torque for all future runs. At the present time the site is in operational status. NOTE (A): Liquid fluorine runs for the NASA pump which were scheduled for January were delayed because of nonavailability of pump parts. Pratt & Whitney test will be scheduled pending results of the NASA test. The next predicted liquid fluorine run for the NASA pump is mid-February. A realistic test schedule cannot be predicted due to lack of information concerning availability of pump hardware and future test requirements.	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> OF0553 (Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. During the month of February, one liquid nitrogen and three liquid fluorine runs were conducted, using the NASA pump with aluminum oxide - K162B, Kennametal seal configurations. Four data points were taken during each of the fluorine runs. The liquid nitrogen run on February 5 was conducted to obtain seal wear data which was used to estimate the pump running time in fluorine. After 20 minutes of running time, the pump was disassembled. Seal #1 showed that all the aluminum oxide was removed (.013 inches). From this information, the maximum running time in fluorine was estimated at 5 to 10 minutes. On February 14, four data points were taken during a 4.2 minute run. The flow was ramped from 275 GPM to approximately 50 GPM at inlet pressures of 63, 36, 25 and 15 PSIG with a constant speed of 11,800 RPM. After disassembly of the pump, seal #1 had all the aluminum oxide removed (.013 inches); seal #2 had .007 inches of wear; and seal #3 had .002 inches of wear. On February 19, four data points were taken during a 6.5 minute run. The inlet pressure was ramped from 70 to 10 PSIG at approximate constant flows of 220 GPM, 180 GPM, 135 GPM and 80 GPM, with the speed held at 11,800 RPM. Seal inspection after the run showed that seals #1 and #2 had all the aluminum oxide removed and seal #3 had .002 inches of wear. Localized burning of fluorine in a contaminated tube fitting welded the inlet total pressure probe to the fitting. Necessary changes were made to the inlet spool piece and a new total probe was installed for the February 26 run. In order to completely define the pump performance, a 6.07 minute run was made on February 26. The flow was ramped from approximately 285 GPM to 50 GPM at inlet pressures of 63 and 36 PSIG and the inlet pressure was ramped from 70 to 30 PSIG at flows of 275 and 250 GPM. Speed was held constant at 11,800 RPM during both ramps. Pump disassembly for seal inspection was not completed in time for this report. If the pump running time had not been limited by the short life of the pump seals, the February 26 data could have been obtained during the February 14 and 19 runs. NOTE (A) : The test program for the NASA Mark II liquid fluorine pump has been completed. Since no hardware is available for the NASA Mark III configuration, testing of the Pratt and Whitney pump is scheduled for March. (A realistic test schedule cannot be predicted due to lack of information concerning availability of pump hardware and future test requirements.)

March 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	<u>FLUORINE PUMP</u> OF0553(I.I.Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. During the month of March, two liquid fluorine runs were conducted, using the Pratt & Whitney RL-10 pump. The pump seal configuration was aluminum oxide on K-162-B Kennametal nose pieces. Eleven data points were taken during the first run, ten during the second run, and each run was conducted for fifteen minutes. On March 11, the pump was ramped up to speed in four steps, along the design specific speed line. While maintaining the speed of 1,065 radians per second and inlet pressure of 2.46 kilograms per square meter, a flow excursion was performed from 700 liters per minute to 440 liters per minute. The pump was ramped down in four steps and twice ramped to a speed of 1,065 radians per second and held at a flow of 557 liters per minute for five minutes. The pump was removed from the stand and shipped to Pratt & Whitney for disassembly and seal inspection. The seal package was found to be in excellent condition. The pump was reassembled and shipped to Plum Brook for testing. On March 23, an attempt was made to ramp the pump to 1,065 radians per second in 10 seconds. At 945 radians per second, the pump primed and overpressurized the flow venturi transducer. The fluorine was back-transferred and the transducer was replaced. Three five-minute pump runs were performed. For each run, the pump was ramped to 1,065 radians per sec. in 20 seconds. The flow and inlet pressure were maintained at 577 liters per minute and 2.46 kilograms per square meter, except for the first ramp in which a flow excursion was performed from 700 liters per minute to 444 liters per minute. The pump was then removed from the stand and shipped to Pratt & Whitney. NOTE (A) : The Pratt & Whitney RL-10 pump program has been extended and the next scheduled run date is April 21. The NASA Mark III pump fabrication is scheduled to be completed by April 24. Its test schedule has not been established.

April 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> OF0553(I.I.Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. During April, one liquid fluorine run was conducted, using the Pratt and Whitney RL-10 pump. The pump and seal configuration was identical to the configuration tested in March. The pump was ramped up to design conditions six times and held for approximately five minutes. The total run time on the pump was thirty-two minutes during which the pump parameters were mapped using thirteen data points. The success of this test has proved that the Pratt and Whitney L-208533 liquid fluorine pump is now an operational flight weight pump for use on the Pratt and Whitney hydrogen fluorine rocket engine. The next Pratt and Whitney RL-10 pump run is scheduled for May 7. The NASA pump schedule has not been established.

May 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	<u>FLUORINE PUMP</u> OF0553 (I. I. Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. During May, one liquid fluorine run was conducted using the Pratt and Whitney RL-10 pump. The pump seal configuration was identical with those used on the past three tests. The pump was ramped to design speed and a flow excursion performed on the pump. The total run time on this pump was five minutes. The reason for the short run time was that this pump is scheduled to be part of the hardware for the hydrogen fluorine rocket engine to be tested during June by Pratt and Whitney. The next Pratt and Whitney RL-10 pump test is scheduled for June 8. The NASA pump is tentatively scheduled for the end of June.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	<u>FLUORINE PUMP</u> OF0553 (I.I.Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. On June 8, a liquid fluorine run was conducted using the Pratt and Whitney RL-10 pump. This run completed the testing program on the modified RL-10 pumps. The pump seal configuration was identical with those used on the past four tests; however, the impeller diameter was increased by .090 inches. The flow excursions were performed at inlet pressures of 35 PSIG and 15 PSIG with the pump speed held constant. The total run time was six minutes. Pratt and Whitney will use this pump for its hydrogen-fluorine rocket tests scheduled for July. NOTE (A): Schedule for the NASA MARK III pump includes four tests which will complete this program. The first test was scheduled for June 30, but had to be cancelled due to a failure of the pump seal bellows. The test has been rescheduled to July 13, 1964.
	June 1964		

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	<u>FLUORINE PUMP</u> PF1191 (I.I.Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump. During the month of July, two liquid fluorine runs were completed on the NASA Mark III pump. These two runs concluded the testing program for NASA liquid fluorine pumps. Due to the extended seal life, caused by good pump down characteristics behind the impeller, all of the required research data was obtained in two runs instead of the scheduled four runs. On July 13, the pump was ramped to design speed of 18,000 RPM. The design speed was held constant while head-flow data curves were generated at inlet pressures of 5.0, 8.5, 20, 30 and 40 PSIG. The total run time on the pump was 13 minutes. On July 21, head vs inlet pressure curves were generated at flows of 225, 215, 195, 175, 160, 140, 115 and 80 GPM. A head flow curve was also taken at 20 PSIG inlet pressure. The total run time on the pump was 23 minutes at a design speed of 18,000 RPM. The Mark III Fluorine pump program has been completed. Additional testing may be required if data obtained requires verification. As of now future Lewis research programs have not been determined. Pratt and Whitney Aircraft has obtained a new program from NASA Headquarters. The program consists of testing two fluorine pumps in the months of October and November. Objectives of test are to determine wear on new seal material.

July 1964

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SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> PF1191(I.I.Pinkel) During the month of August, "I" Site was maintained in "standby" condition waiting for the Pratt and Whitney pumps which are scheduled to be tested in October and November. All of the Lewis pump programs have been completed.	Liquid fluorine pump test involving three NASA configurations and one Pratt and Whitney pump.

August 1964

September 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	<u>FLUORINE PUMP</u> PF1191 (I.I. Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt & Whitney pump. During the month of September, "1" Site was maintained in "standby" condition awaiting testing of the Pratt & Whitney pumps scheduled for October and November.

October 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> PF1191(I.I.Pinkel)	Liquid fluorine pump test involving three NASA configurations and one Pratt & Whitney pump. On October 27, the Pratt and Whitney liquid fluorine pump was tested for thirty minutes. Twenty-one data points were obtained at speeds of 5,000, 7,000, 9,000 and 10,240 RPM. In addition, three flow excursions were performed at the design speed of 10,240 RPM with inlet pressures of 35, 25 and 15 PSIG. NOTE: After the tests, the pump was removed from the test stand, shipped to Pratt and Whitney, West Palm Beach, Florida, for disassembly and inspection. The pump will be reassembled and shipped to Plum Brook Station on November 18 for testing on November 23. At the present time, no additional tests are scheduled for "I" Site.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> PFI191 (I.I. Pinkel)	Liquid fluorine pump test manufactured by Pratt & Whitney The shipment of the Pratt & Whitney fluorine pump to Plum Brook was delayed because of difficulties encountered in matching the pump seals. The pump is scheduled to be delivered the week of November 30 and to be tested on December 7. There are no additional research programs or tests scheduled for "I" Site.

November 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
1	PUMP	<u>FLUORINE PUMP</u> PF1191(I.I.Pinkel)	Liquid Fluorine Pump test involving the Pratt and Whitney Pump. On December 7, the Pratt and Whitney fluorine pump was tested for thirty minutes. During this time a total of twenty-two data points were obtained at speeds of 5000, 7000, 9000 and 10 240 RPM. In addition, four flow excursions were performed at the design speed of 10 240 RPM with inlet pressures of 35, 25 and 15 PSIG. NOTE: This test completed the contractual obligation of NASA for testing Pratt and Whitney pumps at the "I" Site installation. At the present time there is an additional contract being negotiated for two pump tests in the second quarter of 1965. "I" Site will be maintained in stand-by condition for an indefinite period or until more information is available.

December 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> PF1191(I.I.Pinkel)	Liquid Fluorine Pump test involving the Pratt and Whitney Pump. The test cell has been maintained in standby condition during the month of January. Two pump tests are tentatively scheduled for testing in the second quarter of 1965.

January 1965

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> PF1191 (I.I. Pinkel)	Liquid fluorine pump test involving the Pratt & Whitney pump. The test cell has been maintained in "standby" condition during the month of February. Two pump tests are tentatively scheduled for testing in the second quarter of 1965.

February 1965

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> PF1191(I. I. Pinkel) The test cell will be maintained in standby condition indefinitely. At the present time, a research program has not been formulated for FY65 or FY66. No schedule for the "I" Facility will be reported in the future because of no program schedule.	Liquid fluorine pump test involving the Pratt & Whitney pump.

SITE	LOCATION	RESEARCH INSTALLATION	& DESCRIPTION
I	PUMP	<u>FLUORINE PUMP</u> PF1191 (I.I. Pinkel) On May 14, the Pratt and Whitney pump was tested for twenty-two minutes. During this time, a total of five data points was obtained at design speed and flow. In addition, five flow excursions were performed at the design speed of 10,240 rpm with inlet pressures of 35, 25, and 15 psig. NOTE: Two additional tests have been scheduled for "I" Site. These tests will be made for Pratt and Whitney, to investigate seal data and pump performance reliability.	Liquid fluorine pump test involving the Pratt & Whitney pump

May 1965

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June 1965

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
I	FLUORINE PUMP SITE	<u>FLUORINE PUMP</u> PF1191(I.I.Pinkel) Two liquid fluorine pump tests were performed on the Pratt & Whitney pump. On June 4, the Pratt & Whitney pump was tested for thirty minutes. During the test, four flow excursions were performed at design speed of 10 240 rpm with inlet pressures of 35, 25, and 15 psig. Also, sixteen data points were recorded. On June 25, the pump was ramped to the design speed of 10 240 rpm, in twenty seconds. After forty-three seconds at this speed, the system was aborted, caused by the Buglar wire shutdown device. Inspection of the test pump, after back-transfer of the liquid fluorine, indicated that the pump developed a leak at the inlet flange, which caused the liquid fluorine to burn the Buglar wire, causing the abort. NOTE: The attempted test on June 25 will be rescheduled for July 9. The completion of this test will complete the contractual obligation of NASA for testing Pratt & Whitney liquid fluorine pumps at "I" Site.	Liquid fluorine pump test involving the Pratt & Whitney pump.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
I	FLUORINE PUMP SITE	<u>FLUORINE PUMP</u> PF1191 (I.I.Pinkel)		Liquid fluorine Pratt and Whitney Pump tests.
		Two liquid fluorine Pratt and Whitney pump tests were attempted during the month of July.		
		On July 9, the pump was brought up to design speed in 20 seconds. After three seconds at this speed, the test was aborted caused by a leak at the inlet flange of the pump triggering the buglar wire shutdown system. The pump was removed from the stand and shipped to Pratt and Whitney for disassembly and inspection. The pump inlet flange was replaced with another flange and shipped to NASA for testing on July 30.		
		On July 30, the pump was brought up to 5 000 rpm speed in 10 seconds. This speed was maintained for 30 seconds allowing the pump to stabilize at LF ₂ temperature. The pump was then brought up to design speed 10 240 rpm in 10 seconds from 5 000 rpm. The test was again aborted after 33 seconds at design speed. The abort was caused again by a leak in the inlet flange of the pump.		
		An investigation is being conducted to determine the feasibility of installing a bellows between the pump assembly and inlet spool piece to relieve the strain on the pump inlet flange caused by contraction of the test loop and pump at LF ₂ temperature.		
		The next test is scheduled for the week of August 23.		

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
I	FLUORINE PUMP SITE	FLUORINE PUMP PFC553 (I. I. Pinkel)		Liquid fluorine Pratt and Whitney Pump tests. On August 24 the Pratt and Whitney pump was tested for thirty minutes. During this period, a total of twelve data points was obtained at design speed and flow. In addition, four flow excursions were performed at the design speed of 10 240 rpm with inlet pressures of 35, 25 and 15 psig. The completion of this test concluded all tests scheduled for "I" Site. No additional reports will be written until a research program is formulated for the test facility. August 1965

July 1966

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
I	PUMP	<u>FLOX AND FLUORINE PUMPS</u> OR1753 and OR0323 (I.A.Johnsen)	FLOX pump tests involving three Pratt and Whitney pumps. Liquid fluorine tests involving three Pratt and Whitney pumps. Mr. E. J. Manganiello gave verbal approval on June 23, to proceed with the testing of the RL-10 oxidizer pumps with FLOX and liquid fluorine. The FLOX program consists of a 30-minute run to evaluate pump performance and seal materials, and two 5-minute runs to check out the pump assemblies for engine tests. The propellant for these tests will be 82.5% FLOX, and the inlet pressure to the pump will be about 30-35 psia. These pump tests pertain to NASA Contract NAS3-7950, "FLOX-Methane Pump-Fed Engine Study." The fluorine program consists of a 30-minute run to evaluate pump performance and two 5-minute runs to check-out pump assemblies for engine tests. The inlet pressure will be a sub-atmospheric value. Exact value may be between 8 psia and atmospheric pressure. At this time, the exact value is being determined by NASA and Pratt & Whitney personnel. These pump tests pertain to NASA Contract NAS3-799, "Hydrogen-Fluorine Engine Evaluation." The test facility has been in standby condition for one year since the completion of the RL-10 oxidizer pump FLOX and liquid fluorine. test in liquid fluorine, which was sponsored by the Fluid System Components Division. Facility Service personnel have been assigned to the facility on July 5. They are proceeding to clean-up, reinstalling tools and equipment, and general checkout of the facility. Pertinent work which has been accomplished this month includes: maintenance of Howe weigh scale, installation of liquid fluorine dewar (500 lb. capacity) on Howe scale. Another pertinent item which has been initiated, and is 80% complete, is the relocation of the electronic components of the control system from the facility to the control console at "H" Building. This change will enable on-line change of gain settings of the control systems. Due to the necessity of operating the fluorine pump at sub-atmospheric pressure conditions, it is required that controls can be adjusted remotely. It is estimated that system will be relocated by August 9 and electronic checks completed before the end of August. The facility will be ready for FLOX testing during the month of September.

August 1966

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
I	PUMP	<u>FLOX AND FLUORINE PUMPS</u> OR1753 and OR0323 (I.A. Johnsen)	FLOX pump tests involving three Pratt & Whitney pumps. Liquid fluorine tests involving three Pratt & Whitney pumps. During the month of August, the test cell was reinstated from standby status to operational. All valves and transducers have been tested and cleaned. The controller move from the test cell to "H" Building has been completed and ready for an operational check. The addition of the FLOX sampling system is 75% complete; all materials are available. Installation should be completed by September 16. The first pump test is tentatively scheduled for the last week in September.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
I	PUMP	<u>FLOX AND FLUORINE PUMPS</u> OR1753 and OR0323 (I.A.Johnsen)	FLOX pump tests involving three Pratt & Whitney pumps. Liquid fluorine tests involving three Pratt & Whitney pumps. On September 30, the Pratt & Whitney RL-10 FLOX pump, S/N C71Y002, was tested for 34 minutes. During the 34-minute test period, four flow excursions and 10 data points were recorded. Each flow excursion was performed at a speed of 9995 r.p.m. with inlet pressures to the pump set at 35, 25, and 15 psig. At each inlet pressure condition, the flow was varied at a constant rate from 80 to 200 g.p.m. while pump speed was held constant. Each run was of 5-minute duration in which the speed was ramped from 0 r.p.m. to 9995 and back to 0. The pump was removed and returned to the Pratt & Whitney representative. The next FLOX pump test is scheduled for November 15.

October 1966

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
I	PUMP	<u>FLOX AND FLUORINE PUMPS</u> (I.A. Johnsen) OR1753 and OR0323 On October 27 the Pratt and Whitney RL-10 FLOX pump Serial No. C71Y002, build No. 8, was tested for 8 minutes. During this test, the pump was accelerated to 5 000 rpm. The flow was adjusted to 70-75 GPM with the inlet pressure to the pump maintained at 35 psig, then the pump was accelerated to 9995 RPM. A flow excursion was performed at 9995 RPM from 80 GPM to 200 GPM. Data was taken during the flow excursion. The pump was operated at 140 GPM and 9995 RPM with the outlet pressure held at 35 psig for 7 minutes. During this 7 minutes, an attempt was made to adjust the inlet fluid temperature to -300°F. Cavitation of the LN₂ pump occurred before the -300°F inlet temperature to the flow was reached. The pump was then decelerated in speed. After the pump was disassembled from the test stand, it was returned to Pratt & Whitney by the Pratt & Whitney research engineer. The third research test is scheduled for November 17.	FLOX pump tests involving three Pratt & Whitney pumps. Liquid fluorine tests involving three Pratt & Whitney pumps.

November 1966

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
I	PUMP	<u>FLOX AND FLUORINE PUMPS</u> (I.A. Johnsen) OR1753 and OR0323 On November 17, the test of the RL-10 FLOX pump, Serial No. C71Y001-23 was cancelled when a leak developed in the inlet flange of the pump. Repairs were made. On November 18, a test was conducted for five minutes. Speed was held constant at 9995 rpm with the inlet pressure at 35 psig. A pump performance map was obtained during one flow excursion. The pump was removed and returned to the Pratt & Whitney representative on November 18. This test completed the FLOX testing phase of Contract NAS3-7950. F₂ tests are scheduled to start in March.	FLOX pump tests involving three Pratt & Whitney pumps. Liquid fluorine tests involving three Pratt & Whitney pumps.

March 1967

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION																		
1	PUMP	<u>FLOX AND FLUORINE</u> OR0323 (I.A.Johnsen)		Five tests involving two Pratt and Whitney liquid fluorine pumps. On March 31, the first two pump tests in liquid nitrogen were completed. The purpose of the liquid nitrogen test was to demonstrate the facility capability to raise and maintain the temperature to the Pratt and Whitney pump at 155°R and develop operation procedures for the pump and facility. During approximately one hour the pump was operated as follows: <u>FLOX AND FLUORINE PUMPS</u> <table><tr><th><u>PUMP SPEED</u> RPM</th><th><u>INLET PRESSURE</u> PSIG</th><th><u>FLOW EXCURSIONS</u> GPM</th></tr><tr><td>9,000</td><td>35</td><td>70 - 180</td></tr><tr><td>11,490</td><td>35, 25, & 15</td><td>80 - 220</td></tr><tr><td>14,000</td><td>35</td><td>100 - 280</td></tr><tr><td>14,000</td><td>45 - 5.0</td><td>Constant at 185</td></tr><tr><td>11,490</td><td>45 - 5.0</td><td>Constant at 150</td></tr></table> Data was recorded continuously during the flow excursions and inlet pressure ramps. After the flow excursion data was obtained, the NPSP data was obtained at inlet temperature to the Pratt and Whitney pump of 155°R. This was done by reducing the flow to the heat exchanger from 350 GPM to 70 GPM. The exit pressure of the heat exchanger was adjusted to 15 psig. Two NPSP ramps were performed with inlet temperatures to the pump maintained at 155°R at speeds of 14,000 and 11,490 rpm. The next scheduled test will be on April 13. This will be a repeat of the test performed on March 31.	<u>PUMP SPEED</u> RPM	<u>INLET PRESSURE</u> PSIG	<u>FLOW EXCURSIONS</u> GPM	9,000	35	70 - 180	11,490	35, 25, & 15	80 - 220	14,000	35	100 - 280	14,000	45 - 5.0	Constant at 185	11,490	45 - 5.0	Constant at 150
<u>PUMP SPEED</u> RPM	<u>INLET PRESSURE</u> PSIG	<u>FLOW EXCURSIONS</u> GPM																				
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11,490	35, 25, & 15	80 - 220																				
14,000	35	100 - 280																				
14,000	45 - 5.0	Constant at 185																				
11,490	45 - 5.0	Constant at 150																				

April 1967

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
1	PUMP	<u>FLOX AND FLUORINE</u> YOR0323(I.A.Johnsen)		Five tests involving two Pratt and Whitney liquid fluorine pumps. On April 13, the last test using liquid nitrogen was completed. The pump was tested for one hour. This test was a repeat of the test conducted on March 31 for the purpose of refining test procedures for the liquid fluorine tests. The first test using liquid fluorine is scheduled for May 5. This test will be of 30-minute duration to demonstrate performance, durability and NPSH capability in the fluorine environment.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
1	PUMP	<u>FLOX AND FLUORINE</u> YOR0323(I.A.Johnsen)	Five tests involving two Pratt & Whitney liquid fluorine pumps. During the month of May, two fluorine tests were completed. On May 5, the Pratt & Whitney pump was operated for 37 minutes. During this period, the pump was operated at design speeds in which three (3) flow excursions were performed at inlet pressures of 35, 25, and 15 psig. Also, the inlet temperature was adjusted to 155°R. and three inlet pressure excursions were performed at flows of 147, 165, and 180 gpm. On May 26, the second Pratt & Whitney pump was tested for a period of 8.6 minutes. During this test, the pump was operated at design speeds, and one flow excursion and one inlet pressure excursion were performed at 35 psig and 147 gpm. After the test, the pump was removed from the test stand and returned to Pratt & Whitney Aircraft Company, West Palm Beach, Florida. The pump will be stored until needed for the rocket engine tests. The next scheduled fluorine test is June 16. This test will complete the present contract between Pratt & Whitney and NASA.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
1	PUMP	<u>FLOX AND FLUORINE</u> YOR0323(I.A.Johnsen)	Five tests involving two Pratt & Whitney liquid fluqrine pumps. On June 16, the Pratt & Whitney pump was operated for a period of 11 minutes. During this period, the pump speed was maintained at 11,490 r.p.m. while one flow and two inlet pressure excursions were performed. The flow excursion was performed at 35 psig inlet pressure and the inlet excursion was performed at 147 GPM. This test completed the contract with Pratt & Whitney. At the present time, no additional work or programs are scheduled for "1" Site.

June 1967