STATUS OF "F" SITE FROM JULY 1, 1961 TO JULY 1, 1962

The liquid hydrogen flow facility has been in various stages of construction and modification during this one year period of time. Problems have been encountered that have caused delays in making the system operational. Such items as flanges in high pressure systems with ponographic serrations or no serrations at all have been found. The hydraulic system had to be cleaned out and refilled with a new oil. All hydraulic components have been removed and are now being rebuilt.

As of July 1, 1962 all piping changes have been completed. The gas systems are being pressure checked and blown down to remove foreign matter from the lines.

The major block remaining in this facility is the amount of electrical changes that have to be made. The cell is grossly under powered electrically and major changes are necessary.

Checkouts with liquid nitrogen are intended to start by the end of September 1962.

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.

PLUM BROOK STATUS REPORT (continued)

ITEM NO	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
7	Hydraulics "F" Site	NIB (Humbel)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine

STATUS: All of the pertinent existing electrical, mechanical, cryogenic and gas pressure systems are being checked out. Some new equipment such as a variable temperature high pressure water system is required. The designs are substantially complete and some of the components such as the high pressure water tanks are already on order. Many of the modifications to the facility flow systems have been completed.

This project requires rather complex scheduling of temperature, pressure and flow of both the hydrogen and water systems. The existing contract with Compudyne Corporation was activated to provide the design for the required control system. The controls system design was reviewed in mid-January and appears to be sound and progressing satisfactorily. Compudyne is furnishing design specifications and procurement will generally be by NASA. Purchase requests are being prepared for most of the long lead time items. It is planned that the facility will be operational by May.

PLUM BROOK ROCKET SYSTEMS FACILITIES STATUS REPORT CONTINUED

2/28/1963

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER NIB (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.
	STATUS:	Facility buildup continues on schedule for the proposed research program. Electrical hookup and control panel modifications remain as major items to be completed before checkout can commence.	

PLUM BROOK STATION ROCKET SYSTEMS FACILITY STATUS REPORT CONTINUED

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER NIB (L.V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.
	STATUS:	All phases of the hydraulics laboratory operational check-out should begin during the week of April 4, 1963. The process piping work for the liquid hydrogen heat exchanger equipment is about 40% complete. Major areas of endeavor are: electrical hookup, control panel modification, and equipment procurement. Compudyne Corporation has completed all control design work and all purchase requests have been submitted for control equipment and systems.	

PLUM BROOK ROCKET SYSTEMS DIVISION STATUS REPORT CONTINUED

April 1963

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER NIB (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS:

Note (A) : A schedule slippage of two weeks was caused by unanticipated difficulties encountered in the facility check out.

Facility check out began during the week of April 8. The facility piping has been cold shocked with liquid nitrogen and pressure checked on four different occasions. Leaks at valves, fittings, and welds have occurred at each pressure check. The malfunctions are being repaired as they occur and the pressure check should be completed in one week.

The piping for the liquid hydrogen heat exchanger project is 95% complete. Electrical hook up of the valves should be complete in 2 weeks. Check out runs involving the heat exchanger should begin in mid-May.

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER NIB (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

NOTE (A) : The schedule has been changed due to difficulties that arose during facility checkouts.

STATUS: Six checkouts were made during the month of May. Five of the tests were made using liquid nitrogen as the working fluid. Gas pressurization systems, waste gas burnoff, and the liquid hydrogen controls functioned satisfactorily. Two valves in the cryogenic flow lines were found to be defective and were removed. The deionized water storage facilities have been checked operationally and are now performing satisfactorily.

Difficulties of the water heating system required considerable rework. Site personnel were also involved in installation and checking out of the heat exchanger mechanical equipment, including valving, controls and instrumentation. All of the process piping has been completed. 80% of the instrumentation and controls including control panels are finished. Liquid nitrogen and deionized water test runs are scheduled for the first two weeks in June.

June 1963

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER (L.V. Humble) ODO 625	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: Facility tankage, valves and lines were checked out during the first week of June. All systems performed satisfactorily and the facility is considered ready for hydrogen operation. Attention was then turned to the operation of the research hardware including the associated flow and pressure control systems. A series of twelve operational runs was made using warm nitrogen gas and water. Difficulties were experienced in the simultaneous ramping of water, nitrogen gas, and shell pressure. High pressure fluctuations resulted in the collapse and consequent failure of the water hoses and expansion bellows section. Problems were also experienced in maintaining proper control of pressure as programmed on the ramp controllers. One run was made using liquid nitrogen, warm gaseous nitrogen and water. These flow tests were made at below design rates and were not completely successful due to the inability to achieve precise pressure control. As of June 30, the controller problems are approximately 90% resolved. Another problem arose when the tube bundle, inside the heat exchanger, shifted, causing blockage of the pressure taps. The heat exchanger was returned to Cleveland for repairs.

Full emphasis is now being placed upon completing the nitrogen checkout runs as rapidly as possible. Hydrogen runs will be scheduled as soon as the present controller difficulties are fully resolved.

NOTE (A) : Due to operational problems in the nitrogen checkout runs, the schedule start date for hydrogen testing has been delayed.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER OD0625 (L. V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: During July, a total of 6 test operations were completed at "F" Site. The first 3 test operations were made using liquid N_2 for final checkout of the cryogenic and heat exchanger systems in anticipation of liquid hydrogen operation. Three run days were used with hydrogen in the system. On July 13, the cryogenic system was successfully checked out with liquid hydrogen and all systems performed well. Subsequent tests followed on July 15. One low pressure heat exchanger test was completed but several high pressure tests were not successful due to automatic programmer malfunction and failure of the heat exchanger water hose. The research heat exchanger was then modified to avoid shutdown due to hose failure. Process piping was retorqued and a ruptured stem bellows in a control valve was replaced. On July 23, a series of hydrogen runs was made that closely approached the requirements of the research program. Difficulty was experienced in manually controlling the hydrogen system within the time period dictated by water tank capacity. Some usable research data was obtained. No runs will be made until the second week of August to allow contractors to make electrical modifications and install a second H_2O tank.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS		
		LIQUID H_2 HEAT EXCHANGER 0D0625 (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: Two test operations were completed for this project on August 16 and August 29, 1963. Choked flow was found to exist through the gaseous hydrogen heat exchanger tubes at test flow and temperature conditions (August 16th run). The resulting high pressure differential caused the exchanger tube bundle to shift and consequently, the heat exchanger had to be returned to Lewis for repairs.

The August 29th operation was made to verify and improve test data obtained previously. Temperature instrumentation was expanded to obtain improved heat balances. Test runs were made at constant water flow rate and at varying hydrogen gas flow rates in order to secure a range of data necessary for mapping the system.

During the latter part of July, the 500 gallon deionized water tank was installed. Process piping between this vessel and the heat exchanger system was begun August 27. This additional water capacity is necessary for sustained runs, which are considered essential to the acquisition of improved heat transfer data.

Also, during inoperative periods, the cryogenic piping of "P" facility proper was repaired and high tensile strength bolts installed to prevent further flange seal leaks.

	CENTAUR INSULATION TEST 0V0698 (J.B.Esgar-CENTAUR Ins. Panel) (Pinkel & Manson)	Test program to develop a light weight external insulation system suitable for liquid hydrogen boost vehicles. An insulated heavyweight 9000 gallon Centaur tank will be filled with liquid hydrogen and the boil-off rates monitored.

STATUS: Orders have been placed for equipment with which to modify the present cryogenic facility in order to accommodate the Centaur tank for insulation studies.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS		
		LIQUID H_2 HEAT EXCHANGER OD0625 (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: One test operation was completed for this project on August 16, 1963. Choked flow was found to exist through the gaseous hydrogen heat exchanger tubes at test flow and temperature conditions. The resulting high pressure differential caused the exchanger tube bundle to shift and consequently, the heat exchanger had to be returned to Lewis for repairs.

A test run was also scheduled for August 29th to verify and improve test data obtained on previous tests. The test was aborted due to a minor hydrogen fire caused by a leak in the facility liquid hydrogen flow lines. The test will be rescheduled for September 14th.

During the latter part of July, the 500 gallon deionized water tank was installed. Process piping between this vessel and the heat exchanger system was begun August 27. This additional water capacity is necessary for sustained runs, which are considered essential to the acquisition of improved heat transfer data.

Also, during inoperative periods, the cryogenic piping of "F" facility proper was repaired and high tensile strength bolts installed to prevent further flange seal leaks.

		CENTAUR INSUALTION TEST OV0698(J.B.Esgar-CENTAUR Insulation Panel) (Pinkel & Manson)	Test program to develop a light weight external insulation system suitable for liquid hydrogen boost vehicles. An insulated heavyweight 9000 gallon CENTAUR tank will be filled with liquid hydrogen and the boil-off rates monitored.

STATUS: Orders have been placed for equipment with which to modify the present cryogenic facility in order to accommodate the CENTAUR tank for insulation studies.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS		
		LIQUID H_2 HEAT EXCHANGER OD0625 (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: The hydrogen leak, that caused a cell fire during the August 29th run, was located and repaired during the first two weeks of September. Seven test runs were completed on 3 days of operation during the last 2 weeks of September. All runs were made to determine the heat transfer characteristics of the water to hydrogen heat exchanger. During all tests, the water flow and temperature has been kept constant while varying the hydrogen flow rates and temperatures. The third day of tests was terminated when a water hose burst due to high pressure created by choked flow through the heat exchanger. The new 500 gallon water tank will be in operation by the middle of October.

CENTAUR INSULATION TEST OV0698 (J.B.Esgar-CENTAUR Ins. Panel) (Pinkel & Manson)	Test program to develop a lightweight external insulation system suitable for liquid hydrogen boost vehicles. An insulated heavyweight 9000 gallon CENTAUR tank will be filled with liquid hydrogen and the boiloff rates monitored.

STATUS: The concrete work has been completed for the CENTAUR tank which is scheduled to arrive at Plum Brook on October 21st or 22nd. Other equipment is being installed as soon as it arrives at Plum Brook. Electrical wiring, lighting, TV camera installation and 'H' Bldg control modification are progressing satisfactorily. Piping work is scheduled to start during the first week of October.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER 0D0625 (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: No research data runs were made during October. Difficulties have been encountered in the fabrication of a new heat exchanger. Runs will be scheduled when the heat exchanger arrives from Lewis. On October 21st two operational test runs were made to check out the operation of the newly installed 500 gallon water tank. Also a checkout was made on a new system for automatically controlling water flow to the heat exchanger.

	CENTAUR INSULATION TEST 0V0698 (J.B.Esgar-CENTAUR Ins.Panel) (Pinkel & Manson)	Test program to develop a lightweight external insulation system suitable for liquid hydrogen boost vehicles. An insulated heavyweight 9000 gallon CENTAUR tank will be filled with liquid hydrogen and the boiloff rates monitored.

STATUS: The Centaur tank arrived at Plum Brook on October 18, 1963. Work on the tank and equipment support frame has been completed. The Centaur tank was installed inside the frame on the 31st of October. Work on electrical wiring, lighting, instrumentation, controls, and piping is continuing. Checkout runs are scheduled for the latter part of November.

NOTE Ⓐ: Schedule change reflects a re-evaluation of the man hours required to complete the test installation.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER 0D0625 (L.V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: On November 5 and 6, eight runs were completed using a new stainless steel-aluminum heat exchanger. Hydrogen and water flows and pressures were varied. Further runs were stopped by the development of a leak in a valve in the liquid hydrogen transfer line.

Several of the above runs were checked by heat balances, and were within 1 to 4 percent relative error, which was the expected accuracy.

Turbine flowmeters will be installed in the liquid hydrogen and gaseous hydrogen lines before the next heat exchanger tests.

NOTE (A) : All work on the heat exchanger has been stopped until the 'F' Site CENTAUR tank insulation test has been completed.

NOTE (B) : Installation of the Compudyne control package is scheduled for May 1964.

	CENTAUR INSULATION TEST 0G0851 (J.B. Esgar-CENTAUR Ins. Panel) (Pinkel & Manson)	Test program to develop a light-weight external insulation system suitable for liquid hydrogen boost vehicles. An insulated heavyweight 9000 gallon CENTAUR tank will be filled with liquid hydrogen and the boiloff rates monitored.

STATUS: During November, insulation of the CENTAUR was completed and about 90% of the associated piping was installed. Approximately 75% of the necessary electrical work was completed. An estimated 50% of the controls and instrumentation work was finished during November, including the programming of 'F' Site control systems needed for these tests.

The entire system should be ready for checkout and test operations during the last two weeks of December.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER ODO-625 (Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: Operation of this heat exchanger was suspended during December in order that maximum effort could be placed on the Centaur tank insulation program. Mutual consent for this action was obtained from all research personnel involved in these programs.

The heat exchanger apparatus is now being readied for test operation during January 8, 9, 10, 1964.

CENTAUR INSULATION TEST OGO-851 (J.B.Esgar) (CENTAUR Ins.Panel) (Pinkel & Manson)	Test program to develop a light-weight external insulation system suitable for liquid hydrogen boost vehicles. An insulated heavy-weight 9000 gallon CENTAUR tank will be filled with liquid hydrogen and the boiloff rates monitored.

STATUS: An LH_2 test run was made in this facility on the full scale Centaur insulated tank during this reporting period. The test commenced on December 19, 1963 and was terminated December 22, 1963. A test of 29 hours, 14 minutes duration was completed successfully using 9,280 gallons of LH_2. Further testing will be accomplished during January 1964.

OBJECTIVES OF THE TEST PROGRAM WERE:

(1) The determination of PTV Tank insulation thermal conductivities from measuring of LH_2 boiloff rate.

(2) Pressure rise rate (6 to 12 PSIG) within the insulated PTV tank, with the vent valves closed, at the 40 ft^3 and 80 ft^3 ullage points.

(3) And, to observe mechanical or physical performance of this insulation during and following the test operation (warm-up period).

Modifications are now being made in instrumentation and mechanical systems to correct minor deficiencies in preparation for the next test operations.

NOTE Ⓐ : Test program was extended.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID H_2 HEAT EXCHANGER 0D0625 (Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

STATUS: On January 10, four warm gaseous hydrogen test runs were made to check out a new test shell differential pressure controller. This controller was a replacement for one damaged due to water freezing during the first Centaur insulation test.

One cold hydrogen run was attempted on January 11, but liquid hydrogen leaks developed in the cryogenic piping at two points. One leak occurred in a valve body flange and the other in a pipe flange seal. As a result of these liquid hydrogen leaks, only a small amount of pressure drop data was obtained. The leaks were corrected and the facility could have run the week of January 20, but required services could not be supplied since they were scheduled for other facilities.

On January 30, a total of four test runs was completed in which temperature and flow rate of hydrogen were varied in accordance with a predetermined test program. Eleven data points were obtained during the data acquisition period. No significant operational difficulties were encountered during the operation.

CENTAUR INSULATION TEST 0G0851 (J.B.Esgar) (Centaur Ins. Panel) (Pinkel & Manson)	Test program to develop a light-weight external insulation system suitable for liquid hydrogen boost vehicles. An insulated heavy-weight 9000 gallon Centaur tank will be filled with liquid hydrogen and the boiloff rates monitored.

STATUS: The second Centaur PTV insulation Test was completed on January 22 through January 24. Test objectives were successfully completed. Eight pressure rise tests were performed at four ullage points. Boiloff rate was substantially greater than that anticipated; therefore, the actual boiloff test was terminated after 10.5 hours. This increased boiloff rate was caused by failure of the vacuum bulkhead between the liquid hydrogen and liquid oxygen tank. 9150 gallons of liquid hydrogen were used, of which 8300 gallons were actually boiled off during the test.

Two or three PTV insulation panels apparently failed in addition to five panels which failed during the first test. At this time, no further test runs are anticipated.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT-EXCHANGER	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

On February 7, 8, 17 and 18, a total of 56 successful heat transfer test runs were conducted. The week of February 10-16 was spent in maintenance work such as re-torquing cryogenic piping flanges, weatherproofing valving, replacement of instrumentation, and control checkout of the water flow system.

On February 27 and 28, a new series of tests were started to map water to hydrogen heat transfer in a new hydrogen flow and temperature regime. A total of 20 heat transfer test runs were made.

NOTE (A): A majority of steady state heat transfer data has been obtained for this project and all of it should be obtained by April 1, 1964. The site will then discontinue operations until an automatic control system has been installed. Transient heat transfer tests will be conducted after checkout of that system.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER 0D0625 (L. V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.
			On March 2 and 3, thirty-nine heat exchanger test runs were completed and the research engineers decided to defer any further test operations until some of the test data obtained in previous runs could be reduced and analyzed.
			On March 20, the research engineer requested that a new series of heat exchanger runs be made. The water flow through the heat exchanger will be reversed and will be in the same direction as the hydrogen flow, rather than counter-flow, as during past test operations. Modifications for this series of runs have been initiated. Test runs are scheduled for the second week of April.
			NOTE Ⓐ : Lewis engineers have requested a two-week extension of the test program.
		CENTAUR 0V0687 (D. S. Gabriel)	Insulation test for Centaur vehicle.
			On March 17, the Centaur liquid hydrogen tank was deflated from 6 PSIG to atmospheric pressure. This was a test to determine the effect of the insulation on the structural rigidity of the tank. No adverse effects were observed as the tank was deflated. Further testing is not anticipated and the Centaur tankage will be removed from "F" Site.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER OD0625 (L. V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

On April 9 and 10, sixteen heat exchanger tests were completed, using parallel water-hydrogen flow. A nineteen-tube stainless steel heat exchanger was used for these tests.

On April 23 and 24, thirty-one test runs were made, after the installation of a new aluminum heat exchanger. These tests conclude parallel-flow steady-state heat transfer tests, and test apparatus will now be modified for transient test operation.

The CompuDyne automatic control equipment package was received on April 23. This equipment will be installed during May and June. Other work necessary for transient tests includes conversion of control valve from pneumatic to hydraulic operation and process piping modification.

Checkout runs are scheduled to begin in mid-June.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER OD0625 (L. V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

The water to hydrogen heat exchanger test equipment is now being modified for completely automatic temperature, pressure and flow control operation. Both transient and steady-state tests may be performed by the new configuration.

During May, a new automatic control unit was installed at "H" Building after minor shipping damages were repaired. About 60% of the wiring for the control unit has been completed.

30% of the auxiliary instrumentation and control panel modifications have been completed.

The pneumatic control valves on the heat exchanger apparatus were modified for hydraulic operation and approximately 30% of the electrical work has been completed. The portable hydraulic pump unit piping installation is completed, and about three days of electrical work remains.

The waste gas burnoff line is being extended 100 feet and all the foundation and structural support work has been completed.

The liquid hydrogen dewar foundations have been repaired.

Checkout of the test equipment is anticipated to begin about June 15, while full scale transient heat exchanger test operations are scheduled for July.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER OD0625 (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

During the month of June, "F" Site was down for test equipment modification prior to proceeding with transient heat exchanger tests.

Work completed at this site during June consisted of the following:

(1) The waste gas burnoff line was extended 100 feet.

(2) Foundations were poured for a stationary GN_2 and GH_e tube banks.

(3) Automatic control system package was wired and partially checked out.

(4) Portable hydraulic system completed including wiring.

(5) "F" Site auxiliary instrumentation panel completely modified and standardized.

(6) "F" Site control panels modified to accept new valving and equipment control switches and symbols.

(7) Additional level and temperature measuring instrumentation installed on water supply tanks and heat exchanger apparatus.

(8) Six hydraulic control valves and twenty-eight remote operated valves were rewired to the new automatic control equipment.

(9) Checkout of ROVs is now proceeding (60% complete)

(10) Checkout and programming of the test hydraulic control valves is about 40% complete.

(11) Modified operational procedures and check sheets were written.

(12) Preliminary engineering work was completed prior to issuance of bids for installing new cryogenic valves in the "F" Facility piping. The installation work will be completed during October.

Transient tests should begin about July 15.

NOTE (A): Schedule changes are required because of manpower requirements for system checkouts.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER PB0625 (L.V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

During July, the following work was completed at "F" Site, prior to transient heat exchanger tests which were begun July 27:

(1) The Compudyne automatic control equipment was checked out electronically.

(2) Water flow, temperature, and pressure control systems were programmed, then checked out satisfactorily.

(3) Checkout of remote operated valves on the heat exchanger test equipment was completed.

(4) The heat exchanger hydraulic control valves were programmed on the analog computer, then checked out.

(5) A contract was awarded for the foundations for two 6500 gallon deionized water storage tanks.

(6) Bids were issued for replacement of four remote-operated, two control, and four hand-operated cryogenic valves in the "F" Facility piping. This contract calls for minor modification of the vacuum-jacketed piping.

(7) On July 23, complete checkout of the water and hydrogen flow, temperature, and pressure control system was completed, using liquid hydrogen. These tests were considered successful although all operating ranges were not as wide as were anticipated.

On July 27 and 28, research data runs were made. A total of twelve transient runs was completed.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER PD0625 (L.V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

A total of 21 transient hydrogen to water heat exchanger tests were completed during four operation days in August. a 19-tube, 3/16", stainless steel heat exchanger was used for the counter flow tests.

Present planning calls for completing the test program for this heat exchanger by September 4, after which an aluminum heat exchanger of the same configuration will be installed. About 20 parallel flow transient heat exchanger tests should complete the test program. These tests should be finished by mid-October 1964. Other items given attention during August were as follows:

(1) All 3-inch cryogenic valves (10) have been received for installation during October and November.

(2) New burst discs were installed in the dynamic vacuum systems.

(3) Metal expansion bellows and flanges were ordered for the dynamic vacuum systems to replace the Tygon tubing. It is anticipated that the dynamic vacuum pumping time can be significantly reduced.

(4) Bids have been issued for laying of a 40 x 110 foot concrete gaseous supply trailer pad. This work should be completed in September and October.

Future planning calls for installation of an expanded version of the present heat exchangers during November. Test operations using this exchanger should begin in December 1964.

The test schedule has been changed to reflect the information stated above. (Completion of the stainless steel heat exchanger by September 4, aluminum heat exchanger by mid-October and transient expansion test by May.)

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER PD0625(L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

During September, fifty-two heat exchanger runs were completed on six run days. Twenty-nine of these were steady-state tests in which pressure drop data was obtained to substantiate previous data collected at various hydrogen and water flow rates. Twenty-three transient heat exhanger tests were made using a new aluminum heat exchanger with hydrogen and water in parallel flow. The test program on this equipment should be completed by October 12, 1964.

During October, site modification will be made to accept an expanded version of the present heat exchanger equipment. Hydrogen flow rates will be increased six times while water flow rate will be increased four times over the present values.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER PD0625 (L.V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

On October 12, three heat exchanger runs were completed. During these tests, transient heat transfer data was obtained for the 19-tube aluminum heat exchanger under parallel hydrogen-water flow conditions. An analog device was used to correct for the change in liquid hydrogen mass flow. These changes are caused by the changing temperatures at the liquid hydrogen flowmeter entrance. Very good mass flow control was obtained from these runs.

NOTE: During November and December, modifications will be completed to accept an expanded version of the present heat exchanger equipment. These modifications include installation of two 6,500 gallon deionized water tanks, new heat exchanger, piping, valves, instrumentation, controls, and ten new valves in the main liquid hydrogen flow lines. Site checkout and research runs are scheduled for January 1965.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS		
		LIQUID HYDROGEN HEAT EXCHANGER PD0625(L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.
			Two 6,500 gallon deionized water tanks with associated piping and valves were installed during November. An Invitation for Bids for the electrical work required to operate the expanded heat exchanger was sent out. The installation of the ten new liquid hydrogen valves in the main flow lines was 30% completed. This valve installation will be delayed about two weeks because one of the new liquid hydrogen valves had a porous body and will have to be replaced. All other contracts are on schedule. The present heat exchanger equipment will not be dismantled until all the data tapes have been analyzed to determine if any data points should be repeated. NOTE: Site checkout and research runs are scheduled to start in February.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER PD0625 (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.

The contract to install ten new valves in the cryogenic flow facility is 75% complete. Difficulties were encountered during the high pressure tests. Leakage was detected around the valve stems and one valve yoke failed. Redesigned yokes will be supplied by the valve manufacturer. Successful cold shock tests have been completed for seven of the ten valves.

The design and specifications for the electrical and piping work to expand the heat exchanger system have been completed. A purchase request was sent to procurement on December 24. The new heater exchange system will increase the hydrogen flow rates from 8 #/second to 32 #/second and the water flow rates from 0.43 #/second to 3.0 #/second.

A contract for the installation of two new 127 conductor control cables was awarded December 29.

NOTE: Heat exchanger tests are scheduled to resume by the end of March or first of April.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS		
		LIQUID HYDROGEN HEAT EXCHANGER PD0625 (L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water-moderated nuclear rocket engine.
			Site modification continued during the month of January. Installation of the new cryogenic valve in the cryogenic flow system is now being deferred until all new Pacific valves are modified by NASA. New yokes have to be installed on all remote operated valves, therefore all remote valve stems and operators have to be removed from the system, disassembled, both mechanically and electrically, and then reassembled with the new yokes. Two of the three new pan and tilt TV Cameras have been installed. These cameras will provide better control over the visual monitoring during high pressure test runs. The drawings have been completed and the equipment has been ordered for the new 5000 psig gaseous hydrogen trailer stations. The installation is scheduled to start February 15.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS	LIQUID HYDROGEN HEAT EXCHANGER PD0625(L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

During February, new yokes were installed on the new 3" cryogenic valves, the valves were repiped hydraulically, and rewired. Pressure checks revealed a leak in the downstream flange of the liquid hydrogen dewar dip tube shutoff valve. A scratch was found on the flange gasket surface. This flange will be removed and remachined.

A self-regulating automatic pressure control system will be installed to control the liquid hydrogen dewar pressure pneumatically when the electronic controls have been de-energized. This will allow a cryogenic fluid to be safely left in the dewar and it will avoid recooling the vessel for a succeeding day's operation, resulting in a substantial monetary savings.

The present heat exchanger test equipment is now being removed so that the installation contractor can begin his piping and equipment modification work in April. This contract has been delayed because of fiscal matters, causing an extension of the scheduled test operation date from May to June.

A contract has been let to rewire the TV camera systems so they will conform to Class I, Group B, Div. 1 standards. This work is scheduled to be completed in April.

SITE	LABORATORY	INSTALLATIONS (FOF)	DESCRIPTION
F	HYDRAULICS		
		LIQUID HYDROGEN HEAT EXCHANGER PD0625 (L.V. Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in a water moderated nuclear rocket engine.

During March, various facility components were installed and modifications were made.

(1) One of the new yokes on a 3-inch Pacific valve was warped and caused the stem to score at the gland seal. A replacement yoke and four new gland flanges are being supplied by Pacific.

(2) Substantial time and effort was expended during March in an attempt to seal the outlet flange on the dewar shutoff valve. All attempts to date have failed. Before the valve is removed and the flanges replaced, another attempt will be made to seal the flange.

(3) The contract to rewire the TV camera systems was started March 22.

(4) A standby automatic pressure control system was installed on the liquid hydrogen dewar. During the initial checkout with liquid nitrogen, it was discovered that the differential pressure controller was inoperative and it is presently being repaired.

(5) A forced air convective cooling system was obtained and will be installed in order to lower the temperature of the deionized water after it has been circulated through the heat exchanger.

In order to quickly verify the adequacy of the data obtained during a test run, a Plum Brook computer program is being written for reduction of a limited sample of the test data.

SITE	LOCATION	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
F	HYDRAULICS LAB	LIQUID HYDROGEN HEAT EXCHANGER PD0625(L.V.Humble)	Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in water moderated nuclear rocket engine. In-house work on expanded heat exchanger modifications are proceeding on schedule, although a considerable amount of extra time had to be spent to seal the dewar flange. The outlet flange on the dewar shutoff valve was finally sealed and work is now proceeding on final checkout of the vacuum system around the valve assembly. The contract for electrical and mechanical work was let on April 13. This contract has a 45 day completion date, but Union difficulties have already caused a delay in the start of the contract. Completion of the TV camera system rewiring contract has been delayed by the late delivery of special fittings.

SITE	LOCATION	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625 (L.V. Humble)

Experimental tests of a segment of a water to liquid hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine

Contracts for the electrical and mechanical modification of the heat exchanger test system are proceeding. About 75% of the electrical work is complete, while 80% of the mechanical modification is finished.

The high-pressure gaseous hydrogen manifold has been modified to accept two 5000 psig trailers. Electrical wiring is about 80% complete for this system.

An air-cooled heat exchanger has been installed to provide cooled water for the heat exchanger tests. Previously, liquid nitrogen was used for cooling.

Replacement parts were received from Pacific Valve Co. to repair the defective cryogenic valves. These parts include new valve yokes, gland flanges, and one valve body. The valve operators are also being reworked.

A new mockup test heat exchanger has been received and is being installed for checkout test runs. Test equipment instrumentation is also being installed. Checkout runs are scheduled for mid-July.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625 (L.V. Humble)

Experimental tests of a segment of a water-to-liquid-hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.

The build-up and checkout of the heat exchanger program systems continued this month.

The heat exchanger gaseous pressure control and flow control systems were checked out. Only the hot water storage tank pressurization system remains to be checked. Problems were encountered in welding the heater nozzles to the hot water storage tanks. The tanks are constructed of 347 stainless steel, while the nozzles were 304 stainless steel. 347 stainless steel flanges were obtained from Thor surplus equipment, and 347 stainless steel piping has been secured to replace the 304 stainless steel material. This work is presently six weeks behind schedule and is delaying the water-flow and pressure checkouts.

Further checkout of the cryogenic systems has been delayed until the Pacific cryogenic valves are repaired and re-installed. Pacific Valve Company is making belated efforts to rectify a bad situation in supporting repair of the valves. Additional redesigned operators and other parts should be received from Pacific by the first week of July so modification work can proceed.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	
		LIQUID HYDROGEN HEAT EXCHANGER PD0625(L.V.Humble) — Experimental tests of a segment of a water-to-liquid-hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.
		Build-up of the heat exchanger test equipment will be completed August 6 when the contracted electrical work will be finished. The presence of contractor personnel in the area has restricted system checkout to evenings and Saturdays due to hazardous operating conditions. This has slowed down checkout considerably.
		The process piping work for the water transfer and storage has been completed. This contract was completed two months after the original contract completion date. Full flow (water) test checkouts should be complete by August 1
		All parts have been received for repair and modification of the Pacific Cryogenic Valve as of Friday, July 23. These valves should be installed and tested by August 2, to allow checkout of the cryogenic flow systems by August 7. All systems should be completed and ready for full scale testing by the middle of August.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625
(L.V.Humble)

Experimental tests of a segment of a water-to-liquid-hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.

During August, all contract work at "F" Site was completed, although difficulties were still experienced in obtaining the proper operation of the new Pacific valves. The trouble appears to be poor valve design and workmanship in manufacture.

Checkout tests continue and satisfactory tests have been made on the heat exchanger water flow, temperature, and pressure control system, as well as hydrogen flow and pressure control for ambient temperature gas. The cryogenic flow systems have been cold shocked and pressure tested. This work, including final retorquing of the piping fittings was complete on August 31.

A full scale liquid hydrogen-water test will be conducted September 3 using a mock-up heat exchanger.
Tests with the test heat exchanger should begin the week of October 3.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625
(L. V. Humble)

Experimental tests of a segment of a water-to-liquid-hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.

On September 2, the cryogenic system was checked out with liquid hydrogen. The new Pacific valves performed satisfactorily with exception of hydraulic oil leaks which developed around the valve operators. This deficiency was rectified by a reduction in hydraulic oil operating pressure.

Three full-scale water and liquid hydrogen runs were completed on September 10 using a mock-up heat exchanger. Hydrogen temperature, flow and pressure controls performed satisfactorily; consequently, no further cold hydrogen runs are contemplated until the test heat exchanger installation is completed.

Since water temperature control has not been completely satisfactory, several test runs were made on September 16 and 22 to solve control problems. Transport lag is thought to be the control problem. Therefore, piping modifications are being made to reduce the temperature sensing lag between the control point and the heat exchanger inlet. This will assure proper ramping of temperature at the exchanger inlet.

Tank 7f, a 1250 gallon high pressure deionized hot water storage tank, has been installed and piping is about 50% complete. This additional water supply will reduce the cost per data point by allowing several transient test runs to be completed for each test run operation.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625
(L. V. Humble)

Experimental tests of a segment of a water-to-liquid-hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.

The installation of the high pressure deionized water tank (7F), its process piping, insulation and electrical wiring was completed on October 13. In order to obtain the proper water temperature control the connecting piping was shortened between the water flow meter and the heat exchanger. The flow meter was moved from its upstream location to downstream of the heat exchanger.

On October 14, four water flow tests were completed using the mockup heat exchanger. The water temperature control systems were checked and proved to be satisfactory.

Installation and instrumentation of the test heat exchanger was completed on October 26.

On October 28, three full-scale hydrogen-water heat exchanger tests were successfully completed.

Further testing is scheduled after the "H" Building data acquisition modifications are completed. This work is scheduled to be completed November 15.

(6) Structural modifications to the tower for the lateral pull-offs will begin the first week in November.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625(L.V. Humble)

Experimental tests of a segment of a water-to-liquid hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.

The new research heat exchanger was delivered on November 22 and is now being instrumented and installed.

One-quarter of the planned program (twenty steady-state and six transient tests) is scheduled to be completed during three December test days.

A Plum Brook computer program is being assembled so that a "quick look" can be made of the test data before it is sent to Cleveland. Data tapes will be duplicated; then, by using the Plum Brook tape-handler-equipped IBM 1620 computer, the data will be sampled and tested for validity. Heat material balance calculations will be used to check the data. The most difficult portion of this programming has been completed. Presently, the test data can be retrieved, sampled, and printed out in base ten numbers.

SITE	SITE NAME RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB LIQUID HYDROGEN HEAT EXCHANGER PD0625 (L.V. Humble) Experimental tests of a segment of a water-to-liquid-hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine. Five test runs were successfully completed on December 8. Post-operation computer printout of digitized data is now available for data validity check. Although the complete program is not yet finished, data is available as millivolt readings. This will be of value to the operations personnel as well as the research engineer. The next test run is scheduled for January 4, 1966.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625(L.V.Humble)

Experimental tests of a segment of a water-to-liquid-hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.

Twenty-three hydrogen-to-water heat exchanger steady-state test runs were completed during operations on January 4, 12, 21, and 31; leaving approximately three steady-state and six transient test runs to complete the present program. Preliminary steps are being taken to shut down and secure "F" Site equipment at termination of this program.

The Plum Brook computer program used for operations analysis of data is proceeding satisfactorily. Water parameters now available in printout form include all heat exchanger inlet and outlet temperatures, flow rates (corrected for temperature), and heat loss. Hydrogen heat exchanger inlet pressure and outlet temperatures are also available, while flow rate and inlet temperature printout should be available by February 15. The computer program has been of valuable assistance to the operations and research engineers in establishing the validity of data obtained, and has helped determine the course of future test runs.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

LIQUID HYDROGEN HEAT EXCHANGER
PD0625 (L.V. Humble)

Experimental tests of a segment of a water-to-liquid hydrogen heat exchanger proposed for use in water-moderated nuclear rocket engine.

A total of thirteen hydrogen to water heat exchanger test runs were completed on three operation days during February: February 11, February 17, and February 24. These tests included four steady-state and nine transient runs. Examination of test control run data for these operations indicates satisfactory data were obtained, the average heat balance error being less than 1.0%.

NOTE: The above tests complete the present research program. The test site will be left in standby, should confirmation tests be required. This research program was completed two months ahead of the planned test schedule.

Use of the Plum Brook computer program has enabled operations analysis of test data within twenty-four hours after test operations are completed. Further test operation planning can be initiated much sooner than previously with more assurance that preceding operation met research data requirements. Work is continuing on this program to increase its versatility and scope.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	
		LIQUID HYDROGEN HEAT EXCHANGER PD0625(L.V.Humble) — Experimental tests of a segment of a water-to-liquid hydrogen heat exchanger proposed for use in water moderated nuclear rocket engine.
		The test program for PD0625 was completed during February; however, test apparatus is being maintained in readiness for any data fill-in tests which may be desired.
		Two innovations used at "F" Site were submitted to the Technology Utilization Office during March. These were an electronic circuit for mass flow control of cryogenic hydrogen (40 to 90°R) and a valve position indicator.
		Since the test program has been completed, no further status reports will be made.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	

CENTAUR 5-C TANK — Centaur tank cold shock test.

YOV2273(E.R.Jonash)
(CPO - A.J.Stofan;
RSD - J.E.Sholes)

The Centaur 5-C tank cold shock test is tentatively scheduled for late December. The following major items were accomplished in November:

(1) Started checkout of air, gaseous nitrogen, gaseous helium and vacuum system.

(2) Mounted 5-C tank.

(3) Repaired and installed insulation panels on 5-C tank.

(4) New ROV's and control valves were assembled, cleaned, and checked out.

The following major items are in progress:

(1) Install, fill and vent valves, piping, and instrumentation on 5-C tank.

(2) Clean LH_2 tank.

(3) Cold shock cryogenic system with LN_2.

(4) Control panel modifications at "H" Building.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	
		CENTAUR 5-C TANK YOV2273 (CPO - A.J.Stofan; RSD - J.E.Sholes) Centaur tank cold shock test.
		The Centaur 5-C tank cold shock test is scheduled for mid-January. The test was rescheduled because of time lost due to inclement weather during December. The following major items were accomplished in December: (1) Cleaned Centaur hydrogen and oxygen tanks. (2) Installed fill lines to Centaur LOX and LH_2 tanks. (3) Installed vent systems for Centaur LOX and LH_2 tanks. (4) Completed control panel modifications at "H" Building. The liquid nitrogen cold shock of all cryogenic systems is scheduled for early January.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
F	HYDRAULICS LAB	
		CENTAUR 5-C TANK YOV2273 (CPO - A.J.Stofan; RSD - J.E.Sholes) Centaur tank cold shock test. On January 5, the Centaur 5-C tank was cold shocked with liquid nitrogen. The LOX tank was filled two-thirds full with 2,000 gallons of LN_2 and the hydrogen tank was filled one-third full with 3,000 gallons of LN_2. No major probems were encountered. On January 10, the tank was cold shocked with liquid hydrogen. The LOX tank was again filled with approximately 2,000 gallons of LN_2 and then the hydrogen tank was filled. After the intermediate bulkhead had cryopumped to 60 microns, both tanks were pressurized to their design pressures. The intermediate bulkhead did not cryopump as low as had been expected. No leaks could be detected on the post-run examination of the tank. Approximately 5,000 manhours were expended in preparing "F" Site and the tank for the cold shock. The vehicle has been moved from "F" Site to Building 5131 (Air Compressor Building). The tank was leak checked and the intermediate bulkhead given a mass spectrometer test. Both tests were completed successfully. A complete X-ray examination of the vehicle will be conducted by GDA personnel in February.

NARRATIVES ON ADJOINING PAGE

PROJECT	SITE	TASK
STATUS		SCHEDULE

CHANGES: (schedule changes since last report)

LOX FLOW TESTS	F	YOV61
LOX FLOW TEST RUN SCHEDULE		Dec 1973
ITEMS COMPLETED		
Located run tanks, X-rayed and inspected.		
Work orders written to clean and insulate tank.		
Reactivated "K" Site		
Telephones installed.		
Checked out valve control panels.		
Preliminary instrumentation flow sheet completed.		
Checked out instrument room and cabling.		
Ordered platinum sensors and bridges from Cleveland Instrument Pool.		
Installed controller and manual valve stations at H.		
Control wiring completed to trailer pad.		
ITEMS IN PROGRESS		
Cleaning control valves and other components		50% complete.
Calibrating pressure transducers.		
Checking out digital subsystems at H Bldg.		
Fabricating LOX tank probe.		

CHANGES: None

SITE	SITE NAME	RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB	

LOX FLOW TESTS
(Y0V6114)

PSD - R. C. HENDRICKS
RSD - W. E. KLEIN

SUMMARY

"F" Site is being reactivated to run a series of oxygen flow tests. Oxygen will be passed through a choked nozzle to see if the principle of corresponding states may be applicable to fluid flow problems in general.

DISCUSSION

OPERATIONS

PROGRAM DESCRIPTION

This is the first report covering a series of oxygen flow tests to be run at "F" Site. The flow rates will range from 1/4 to 3 pounds per second at pressures up to 1400 psi. The temperatures will range from saturated liquid at atmospheric pressure up to the critical temperature. The flows will include sub-cooled liquid, saturated liquid, saturated gas, and warm gas.

Previous studies of the characteristics of fluid flow through choked nozzles have shown that the principle of corresponding states may be applicable to fluid flow problems in general. Numerous tests have been run at LeRC in Cleveland, Ohio, using nitrogen and some tests using methane. These results have been extrapolated to predict the behavior of oxygen. The purpose of the tests at "F" Site is to substantiate the theory that such data can be extrapolated to predict the behavior of other fluids.

CURRENT STATUS

The run tank was located in the tank storage area in Cleveland. The tank has been X-rayed and inspected. Work orders for LOX cleaning and insulating the tank have been written. These two items are the pacing items for the project. The LOX cleaning will probably be done in-house and the method to be used is now under discussion. A purchase request for the tank insulation is in Procurement. The normal procurement cycle would get the job complete about the end of the year. This will get us into cold weather problems and maybe manpower problems with other programs. Therefore, we will attempt to shorten this time.

(Continued on Page 11)

SITE	SITE NAME RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB

LOX FLOW TESTS (Continued)

The control valves and other flow system components have been located and are being LOX cleaned. No problems are anticipated in this area.

The test stand has been reactivated, telephone installed, etc. The gaseous nitrogen system was pressurized and no problems were encountered. The valve control panels have been energized and most of the site valves have been cycle checked. No major problems were encountered. Because the flow system is relatively small and simple, virtually no system installation work will be attempted until the tank is in place.

INSTRUMENTATION

A preliminary flow sheet is complete.

The required pressure transducers are now being calibrated.

The site instrument room and cabling check outs are complete.

The digital subsystem at H-Building is now being checked and requalified.

The LOX tank probe is being built by the thermocouple shop.

The platinum sensors and bridges are on order from the instrument pool in Cleveland.

CONTROLS

All controllers and manual valve stations have been installed at H-Building. The wiring is also completed out as far as the trailer pad for all control functions. Work orders have been written for build up of all control valves and this work is approximately 50% completed.

SITE	SITE NAME	RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB	

LOX FLOW TESTS
(YOV6114)

PSD - R. C. HENDRICKS
RSD - W. E. KLEIN

DISCUSSION

OPERATIONS

Very little manpower was expended on F-Site this month. We were waiting on the delivery of gaskets and cleaning materials for the run tank.

The tank support stand was completed and the tank is now located in the stand. The gaskets and cleaning materials were delivered late in the month. Work on mellographing and cleaning the run tank will start the first week in December. The tank will them be moved to F-Site and the flow system fabricated.

The bids for supplying and applying the tank insulation were opened November 20, 1973. The job will be awarded to Standard Asbestos Manufacturing Company of Cleveland, Ohio as soon as the system is ready.

INSTRUMENTATION

The required pressure transducers have been calibrated.

A logic modification to the digital subsystem at H-Bldg. is being made at the present time. Upon completion of the modification the subsystem will then be requalified.

The thermocouple shop is awaiting delivery of platinum sensors from Cleveland for the LOX tank probe buildup.

CONTROLS

The control wiring from H-Bldg. to F-Site has been checked out and final connections will be made to the valves as soon as they are installed.

The necessary control valves are approximately 80% complete in the valve shop.

NARRATIVES ON ADJOINING PAGE

PROJECT	SITE	TASK N

STATUS	SCHEDULE

CHANGES: (schedule changes since last report)

LOX FLOW TESTS — YOV611

LOX FLOW TEST RUN SCHEDULE	Feb 1974.
ITEMS COMPLETED	
Support stand completed.	
Tank installed in stand.	
Received tank gaskets and cleaning materials.	
Opened bids for tank insulation.	
Calibrated pressure transducers.	
Checked out control wiring for "H" to "F" Site.	
ITEMS IN PROGRESS	
Modifying H-Bldg. digital subsystem logic.	
Servicing control valves at valve shop	80% completed.

CHANGES: Run schedule changed.

NARRATIVES ON ADJOINING PAGE

PROJECT	SITE	T/
STATUS		SCHEDULE

CHANGES: (schedule changes since last report)

LOX FLOW TESTS	F	Y
LOX FLOW TEST RUN SCHEDULE		Feb 1974.
ITEMS COMPLETED Received gaskets and cleaning materials. 2250 psig hydrostatic pressure test of tank. Fabricated anti-vortex baffle assembly. Fabricated and pressure tested mixing chamber. Awarded contract for tank insulation. Fabricated and calibrated flow measuring system.		

CHANGES: None.

SITE	SITE NAME	RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB	

LOX FLOW TESTS
(YOV6114)

PSD - R. C. HENDRICKS;
RSD - W. E. KLEIN

DISCUSSION

OPERATIONS

No significant manpower was expended on F-Site during December.

Gaskets and cleaning materials for the run tank were received. Hydrostatic pressure testing of the tank to 2250 psig was completed satisfactorily. Completion of final steps in the tank cleaning process is expected early in January.

An anti-vortex baffle assembly for the run tank was fabricated. A redesigned mixing chamber for the LOX flow measuring system was also fabricated and pressure tested.

The tank insulation job was awarded to Standard Asbestos Manufacturing Company of Cleveland on December 26, 1973.

INSTRUMENTATION AND CONTROLS

Very little manpower was spent on instrumentation and controls preparations for this test because of higher priorities for manpower on other tasks during December.

Probe assemblies for the flow measuring system have been fabricated and calibrated. Delivery from Cleveland is expected the first week in January.

NARRATIVES ON ADJOINING PAGE

PROJECT	SITE	TASK NO.

STATUS	SCHEDULE

CHANGES: (schedule changes since last report)

LOX FLOW TESTS F YOV6114

LOX FLOW TEST RUN SCHEDULE	March 1974.
ITEMS COMPLETED	
Cleaned LOX Tank	Jan 25, 1974
Installed anti-vortex baffle	
Installed tank lid	
Installed tank	
Fabricated and checked vent system	
Cleaned variety of equipment items	
Test section nozzle extension rewelded	
Received temperature sensors and liquid level system	
ITEMS IN PROGRESS	
Valves being assembled.	
Working on tank liquid level probe.	

CHANGES: Schedule Change.

SITE	SITE NAME RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB

LOX FLOW TESTS
(YOV6114)

PSD - R. C. HENDRICKS;
RSD - W. E. KLEIN

DISCUSSION

OPERATIONS

There was no site manpower expended during January. However, there was some work accomplished in the Combined Shops area.

LOX cleaning of the tank was completed on January 25, 1974. The anti-vortex baffle was then installed and the tank lid bolted in place. The bolts were torqued to obtain approximately .032 inch stretch in each bolt. The tank has been moved into position at F-Site.

The LOX tank vent system was fabricated, hydrostatically checked, cold shocked, and X-Rayed. It is now ready to be installed on the tank.

The Valve Shop still has some work to do to complete the assembly of the valves needed for the test. The Clean Room has a variety of items which are ready to be cleaned.

A bad weld was found on the nozzle extension of the test section. The extension was cut off and rewelded. The test section will again be X-rayed and hydrostatically checked.

INSTRUMENTATION AND CONTROLS

Very little manpower was expended during January. The platinum resistance temperature sensors for the flow measuring system and the tank liquid level system have now been delivered to Plum Brook. Work is now proceeding on the tank liquid level probe.

NARRATIVES ON ADJOINING PAGE

PROJECT	SITE	TASK NO.
STATUS		SCHEDULE

CHANGES: (schedule changes since last report)

LOX FLOW TESTS	F	YOV6114
LOX FLOW TEST RUN SCHEDULE		Apr-May 1974.
ITEMS COMPLETED Equipment cleaned and moved to test stand. Preliminary planning for routing of lines & equipment location accomplished. Tank liquid level probe assembled and cleaned. ITEMS IN PROGRESS Valve shop working on valves for test.		

CHANGES

2-74

SITE	SITE NAME RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB

LOX FLOW TESTS (YOV6114)

PSD - R. C. HENDRICKS;
RSD - W. E. KLEIN

DISCUSSION

OPERATIONS

There was very little manpower expended during February. Most of the equipment needed for the test has been cleaned and moved to the test stand. Some preliminary planning for routing of lines, equipment location, etc., has been accomplished. The valve shop still has three valves needed for the test.

INSTRUMENTATION AND CONTROLS

No site manpower was expended in February. The tank liquid level probe was assembled and cleaned. It will be mounted in the tank after the insulation contract is complete.

SITE	SITE NAME RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB

LOX FLOW TESTS
(YOV6114)

PSD - R. C. HENDRICKS;
RSD - W. E. KLEIN

SCHEDULE - MAY 1974

SCHEDULE CHANGE - THE SCHEDULE WAS MODIFIED DUE TO DELAYS CAUSED PRIMARILY TO INCLEMENT WEATHER AND TO A SLIGHT DEGREE - LACK OF MANPOWER.

DISCUSSION

OPERATIONS

Manpower was assigned essentially full time to assemble and install the system during March.

Items Completed

(1) Tank venting and relief system assembled and installed.

(2) Test rig, flow system and tank fill system installation.

(3) GHe purge and GOX pressurization and buffer system installation.

(4) GN_2 pressure system for test rig and trailer valve operators.

(5) Accumulator and hydraulic pressure system for test rig flow control valve operator.

(6) Tank liquid level probe assembly and flow system pressure transducers installation.

Items in Progress

(1) Wiring for instrumentation sensors and control valves.

(2) System leak check and cold shock process.

(3) Installation of tank and system insulation is scheduled to start in mid-April.

(4) Test runs are expected to begin near the first of May.

SITE	SITE NAME RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB

LOX FLOW TESTS
(YOV6114)

PSD - R. C. HENDRICKS;
RSD - W. E. KLEIN

SCHEDULE - MAY 1974

DISCUSSION

OPERATIONS

Manpower assigned essentially full time to assemble, install, and check out systems during April run schedule depends on interface with manpower and data instrument requirements at other sites.

ITEMS COMPLETED

(1) Wiring for instrumentation sensors and control valves.

(2) System cold shock and leak checks.

(3) Tank and system insulation job.

ITEMS IN PROGRESS

Valve adjustments and operational check-outs.

SITE	SITE NAME RESEARCH INSTALLATION & (TASK NO.) - PROJECT ENGINEERS
F	HYDRAULICS LAB

LOX FLOW TESTS
(YOV6114)

PSD - R. C. HENDRICKS;
RSD - W. E. KLEIN

SCHEDULE - COMPLETE JUNE 1974

DISCUSSION

Operational checkout of flow controls and instrumentation was completed at 500 and 1000 psig (GN2).

The following flow data runs were completed using test rig assembly #1.

DATE	NOZZLE ASSEMBLY	FLUID(S)	NOM. FLOW TEMP. (°K)	INLET FLOW PRESS. RANGE (PSIG)
5-20-74	#1	GN2	amb	300-900
		LN2/GN2	94	200-1000
			130	
5-21-74	#1	LN2/GN2	111	200-1000
			130	250-1000
5-23-74	#1	GOX	amb	300-1000
5-24-74	#1	GOX	amb	300-1000
		LOX/GOX	93	50-1000
			115	75-1050
			133	300-1050
			136	300-1050
			124	150-1050
5-28-74	#1	LOX/GOX	147	500-1050
			155	500-1000
			160	250-1050
5-29-74	#1	LOX/GOX	117	850-1400
			96	15-1350
			116	850-1400
			136	280-1400
5-30-74	#1	LOX/GOX	125	100-1400
			160	100-1350
			148	200-1400
			160	900-1400
			116	48-650
			131	155-650
5-31-74	#1	LN2/GN2	80	16-1000
			131	100-1050

Test runs should be completed during the first week of June.