STATUS REPORT OF "J" SITE FROM JULY 1, 1961 = JULY 1, 1962

J-1

The gaseous hydrogen-liquid oxygen rocket test engine has been in operation for the entire 1 year period. At the same time construction has been proceeding to support the second phase of work to be done in the J-1 test rig.

J-2

For the period July 1, 1961 to December 31, 1961, the cell was operational. The H_2-F_2 rocket system test program was completed on December 31, 1961. From December 31, 1961 to May 7, 1962 the cell was inactive. Construction began on May 8, 1962 on a new H_2-O_2 rocket system. Construction is continuing and should be complete by August 1, 1962.

J-3

This facility has been under construction for the past 12 months. The space tank facility will be in partial operation by July 16, 1962.

J-4

The facility was inactive for the first six months of the period. The next three months were spent in construction and reactivation for a series of tests of liquid hydrogen tank insulations. From March 2, 1962 to July 1, 1962 the tests were run and the program completed. The liquid hydrogen tank is now being reinsulated by Goodyear Aircraft at their plant. When the insulation installation is complete another series of tests will be run in the facility.

J-5

The fluorine material compatibility facility was operated from July 1, 1961 to March 2, 1962. Since this period of time the cell has been inactive. New tests are now being discussed between Lewis and Plum Brook engineers.

j. "J" Site - Rocket Test Area:

The operation of the various test stands making up the "J" site are listed below:

"J-1", The gaseous hydrogen - liquid oxygen rocket test engine has been in operation throughout the year. Work has now progressed to include the second phase of the test program.

"J-2", The rocket systems test stand ran from July 1, 1961 to December 31, 1961 with an H_2-F_2 rocket system test program and from December 31, 1961 to May 7, 1962 the cell was inactive. The remainder of the year has been spent in preparing for the new H_2-O_2 rocket system.

"J-3" has not been in operation during the past twelve months but construction has taken place to prepare for tests for the Space Tank Facility.

"J-4" has been in operation from March 2, 1962 to July 1, 1962 doing tests of liquid hydrogen tank insulation materials. This program will continue with another series of tests to be done in the coming year.

"J-5", The fluorine material compatibility facility, was in operation from the beginning of the Fiscal Year until March 2, 1962. It has been inactive during the remainder of the Fiscal Year, as new test programs are prepared.

4. It is hoped that the above material will satisfy your requirements for information on the Plum Brook operations during Fiscal Year 1962. Should additional information be required please contact the writer.

Alan D. Johnson
Director, Plum Brook Station

ADJ:ejf

Copies to:
G Hennings
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PB Sta files

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.

8	Rocket Systems "J" Site	Hydrogen-Oxygen Rocket Engine 28K (Olsen)	A hydrogen-oxygen rocket engine is operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber

STATUS: The rig has been in,more or less,continuous operation for the past year. The solid copper engines are fired for periods of approximately one to two seconds and heat transfer coefficients are calculated from temperature profiles measured in copper slugs. The solid engine program will continue for another four to six months. The solid engine program will probably continue until a suitable liquid hydrogen cooled engine is constructed. Such an engine has been designed and is under construction at Lewis Research Center for the past six months.

For the past six weeks, the cell's high capacity gaseous hydrogen system has been utilized for burnoff tests. The burnoff tests are being conducted to provide support data for designing the hot hydrogen facility. The tests have covered flow rates to 15 pounds per second.

"J-2" Site	Liquid Hydrogen-Liquid Oxygen Throttling Tests	Throttling and combustion instability tests of a liquid-oxygen - liquid hydrogen pressure fed rocket system

STATUS: The test rig was completely rebuilt during the early part of 1962, and has been in more or less continuous operation since. Propellant flows and chamber pressure are under closed loop automatic control and each firing covers a range of test conditions. This program has been well supported by Lewis Research Center with both hardware and people.

On the last run, the regeneratively cool combustion chamber split longitudinally two seconds after a successful ignition. The safety system detected the failure and the engine was automatically shut down with no damage to the cell. This chamber,of channel construction,had eleven minutes of accumulated running time before failure.

The failed combustion chamber is being replaced from spare hardware on hand and no lapse in schedule will occur

"J-3"	Vacuum Environment Facility 51201	This facility consists of a "zero leakage" high vacuum tank designed for testing fibreglas and resin liquid hydrogen tanks in low pressure environment. Diffusion of hydrogen through the walls of these plastic tanks was to be determined by sealing off the vacuum space and measuring the pressure rise in the known volume.

STATUS: The vacuum test rig was built up and installed during the first half of 1962. The facility's capability was demonstrated and validated using a metal tank. The experimental plastic tanks of approximately 20 gallon capacity were screened in Cleveland at cryogenic conditions. Most of them failed. The best tank was installed at Plum Brook but failed during the filling operation. No data was obtained and the facility has subsequently been idle for the past several months.

Recently, a request has been received from Cleveland to extensively modify the vacuum tank in "J-3". The immediate objective is to make the facility capable of accepting a larger metal tank insulated with Linde insulation. Heat transfer data would be obtained when the tank was filled with liquid hydrogen and the insulation exposed to high vacuum conditions. A longer term objective is to equip the tank with a large capacity diffusion pump and a heat source. A solar environment is to be simulated.

"J-4"	51201 (Pinkel)	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. It was originally built to accommodate the old NACA high energy test vehicle.

STATUS: Metal tanks of a few hundred gallon capacity have been insulated by contractors and installed in the "J-4" facility for boiloff tests. Several configurations have been evaluated over the past couple of years. The boiloff tests were generally conducted in a period of one to two weeks and then the facility was down for several months awaiting a new configuration. The principle support effort is that required to checkout the systems and the instrumentation after the long idle periods.

"J-5"	Fluorine Hydraulics Laboratory	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with a couple of cubic feet of fluorine with pressures up to 1500 psi

STATUS: No program exists and the facility has been idle for the past year.

GENERAL The five rigs in "J" area are very congested. With more than two rigs active, progress of any one project is generally impeded. Because of the propellant handling, and extensive high pressure leak testing, the two rocket rigs exclude people from the other test rigs for long periods of time, and considerable work inefficiencies result. Presently, the two rocket rigs run on alternate weeks which is a very satisfactory arrangement. Since both the "J-3" and "J-4" rigs use only small quantities of hydrogen, Plum Brook offers no unique capability, therefore any new programs in the "J-3" and "J-4" area should be carefully considered and probably can only be justified on the basis of expediency.

ITEM NO	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
9	High Energy Rocket Engine Research Facility	A2G A2F A6B (Gabriel)	NERVA engine propellant feed system tests. The investigation will include turbo pump "boot strapping" tests, fluid instabilities in the engine flow passages and equipment performance evaluations. Construction of the facility is in final stages and some equipment checkout has begun. All work at Plum Brook is either on or ahead of the PERT schedule and no problems are apparent at this time. It appears that the pacing items are still the delivery of the Rocketdyne turbo pump and engine nozzle. However, these statements could easily be cause for regret. Many of the major systems, which includeinstrumentation equipment, the electrical controls and wiring, etc, are still in the hands of the contractors. Therefore, no knowledge of the subtle built-in problems exists. Checkout and operation of the steam system is well underway. Many of the cold weather freezing problems have been encountered and are at least partially solved. Both boilers have been to full operating pressure and the accumulators have been charged. The entire steam system, including the accumulators, shut-off valves, pressure regulating station, and second stage ejector, has been operated. All operations were performed

PLUM BROOK ROCKET SYSTEMS FACILITIES STATUS REPORT CONTINUED

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	ROCKET SYSTEMS "J-1"	Hydrogen-Oxygen Rocket Engine 28K (N.D.Sanders)	A hydrogen-oxygen rocket engine is operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.
	STATUS:	Two run days produced seven gaseous hydrogen burnoff data points. Based on this and pervious data the research engineers requested larger hydrogen weight flows and larger burner configurations. Modification of the facility is nearing completion to provide this capability. Numerous liquid nitrogen tests were made on two run days to check out the propellant controller for future rocket engine runs.	
	ROCKET SYSTEMS "J-2"	Liquid Hydrogen-Liquid Oxygen Throttling Tests (I.A.Johnsen)	Throttling and combustion instability tests of a liquid oxygen-liquid hydrogen pressure fed rocket system.
	STATUS:	A total of nine data runs were made on one run day. Testing was terminated due to engine failure. New hardware has been installed and the program will continue with no major delay in schedule.	
	ROCKET SYSTEMS "J-3"	Vacuum Environment Facility 51201 (I.A.Johnsen)	This facility consists of a "zero leakage" high vacuum tank designed for testing fibreglas and resin liquid hydrogen tanks in low pressure environment. Diffusion of hydrogen through the walls of these plastic tanks was to be determined by sealing off the vacuum space and measuring the pressure rise in the known volume.
	STATUS:	Rebuilding cell to facilitate A. D. Little tank. By May the cryogenic valving and changeover to standardized LH_2 trailers should be completed. Test runs will start in June.	
	ROCKET SYSTEMS "J-4"	Linde Tank 51201 (Pinkel)	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. It was originally built to accomodate the old NACA high energy test vehicle.

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
	"J-4" (cont)		
	STATUS: At present, J-4 Test Cell is being put into running condition for expected boil-off tests on Linde applied super insulated test tank. Expected arrival date of test tank with insulation is March 4, 1963. It is anticipated that ground handling test runs will commence during the third or fourth weeks of March. This delay being caused by the different configuration of Linde Tank when compared to types of tanks for which the test cell was designed.		
	ROCKET SYSTEMS "J-5"	Fluorine Hydraulics Laboratory	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with a couple of cubic feet of fluorine with pressures up to 1500 psi.
	STATUS: No program exists and the facility has been idle for the past year.		

3/28/1963

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 Hydrogen-Oxygen 28K Rocket Engine (N.D.Sanders)	A hydrogen-oxygen rocket engine is operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.
	STATUS:	Facility modifications to provide larger gaseous hydrogen weight flows has been completed. Two run days produced four research data points. This completed the 6 inch diameter stack study. A 20" diameter stack is being installed and more research data runs are scheduled. Preparation continues for the liquid hydrogen engine program. This operation is limited to two to three runs per day because the large gaseous hydrogen requirement depletes available trailers.	
		J-2 Liquid Hydrogen - Liquid Oxygen Throttling Tests (I.A. Johnsen)	Throttling and combustion instability tests of a liquid oxygen-liquid hydrogen pressure fed rocket system.

(Continued on next page)

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	(CONTINUED)		

STATUS: J-2 Two run days produced a total of 13 research data runs. Minor engine failures were noted after the second series of runs. Engine repairs are being made, and the program will continue on schedule.

M-1 Hydrogen-Oxygen Gas Generator (I.A. Johnsen)	Investigation of the gas generator for the Aerojet M-1 rocket engine program.

STATUS: Plans are progressing for the gas generator tests as manpower time permits.

J-3 Vacuum Environment Facility 5120 (I.A. Johnsen) A. D. Little Tank	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

STATUS: Physical building of the cell is awaiting final decisions by A. D. Little Company relative to specific requirements of process systems and instrumentation. The design of equipment is progressing but has not been finalized. Project managements schedule appears optimistic based on past facility build-up experience. A request has been made to test J-4 Linde tank in J-3 Facility. These tests will be run if they do not interfere with the A. D. Little tank tests. As of this report date no written requirements have been received from the research engineers relative to the Linde tank tests.

STATUS: J-4 Tank Test Facility Linde Tank	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. It was originally built to accomodate the old NACA high energy test vehicle.

Note (A)- The Linde insulated liquid hydrogen tank tests have been delayed. The tank arrived at Plum Brook with damaged insulation and was returned to Linde for repair. A delay of 3 to 4 weeks is expected. When the tank is returned

(Note (A) continued on next page)

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	(CONTINUED)	Note Ⓐ continued	
		J-4 the research engineers wish to install it in J-3. Operation-wise this installation will depend on the amount of facility modification that has been completed in preparation for the A. D. Little tests. Preparations are still being made to mount the Linde tank in J-4.	
		Note Ⓑ- If Project Management so desires, cold-shock test will be run on the A. D. Little tank in J-4.	
		Note Ⓒ- Combined propellant tanks, such as the "high energy test vehicle" tanks, will no longer be tested in J-4. Anticipated programs call for single, insulated, liquid hydrogen tanks. The facility will be modified accordingly.	
		J-5 Fluorine Hydraulics Laboratory	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with a couple of cubic feet of fluorine with pressures up to 1500 psi.
	STATUS:	No program exists and the facility has been idle for the past year.	

April 1963

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 Hydrogen-Oxygen 28K Rocket Engine (N.D. Sanders)	A hydrogen-oxygen rocket engine is operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber
	STATUS:	The gaseous hydrogen burn off tests were completed during the month of April. Three run days produced a total of eight research data points. This 4 month series of tests was made to obtain data necessary for the design of a portion of the hot hydrogen Facility. Equipment used for the burn off tests is being removed and the cell build up is directed toward resumption of rocket engine firings. The next testing phase will utilize the solid copper heat sink engines. A hydrogen-air torch will be used instead of fluorine for engine ignition. This new ignition system is needed to check out the optical pyrometer for measuring combustion side wall temperatures of the rocket. A rocket engine test firing is planned during the week of May 20th.	
		J-2 Liquid Hydrogen Liquid Oxygen Throttling Tests (I.A. Johnsen)	Throttling and combustion instability tests of a liquid oxygen-liquid hydrogen pressure fed rocket system.

J-2 STATUS continued on next page 11-9

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	(CONTINUED)		

STATUS: J-2 On April 10th one research data run was made of 25 seconds duration. During the 25 second period, both the engine and injector suffered burn out failures. Leaks in the engine had been repaired prior to this run with silver solder. This was the first firing after the engine had been repaired. It is believed that engine failure occurred first which resulted in the injector burn out. This was the last regenerative engine of its size available for test firing. A new engine of shorter length is being fabricated and is expected at Plum Brook for installation during the week of May 13th. Cell modifications now in progress include larger hydrogen and oxygen flow lines and valves, instrument changes, and engine exhaust system changes to accept the new engine. Test firings are planned for the last week of May.

M-1 Hydrogen-Oxygen Gas Generator (I.A.Johnsen)	Investigation of the gas generator for the Aerojet M-1 rocket engine program.

STATUS: The ordering of vendor supplied hardware is 90% complete. Drawings for plumbing of flow lines and for locations of equipment and dewars are 50% complete. Tentative date for system check out should be late July.

J-3 Vacuum Environment Facility 5120 (I.A.Johnsen) A. D. Little Tank	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

STATUS: Note (A) : On March 28th it was decided to rebuild the J-3 facility to handle only the Linde tank test. Tank alterations for A. D. Little tank will be done after Linde tests are completed.

The first $2\frac{1}{2}$ weeks of April were spent in rebuilding the facility to accept the Linde insulated liquid hydrogen tank. The object of the test is to determine the effectiveness of the insulation under vacuum conditions.

J-3 STATUS Continued on next page 11-10

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J		(J-3 STATUS CONTINUED)	
	STATUS:		One test run was made on April 22nd and 23rd. Approximately 35% of the run was completed when the test was aborted due to accidental shut down of a vacuum pump. All data obtained before the shut down was usable. The second test run commenced on April 27th and will continue through May 12th. Research data is being recorded at one hour intervals on an "around the clock" basis. The purchase requests for major equipment items for the A. D. Little tank tests should be completed shortly. The demands of the Linde test during the month of April has limited the Plum Brook operation engineers time on the A. D. Little project.
	STATUS: J-4	Tank Test Facility Linde Tank	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. It was originally built to accommodate the old NACA high energy test vehicle. Note (A) : Schedule was delayed because the Linde tank is presently being tested in J-3 facility, after these tests are completed it will be tested in J-4. Cold shock tests will not be conducted on the A. D. Little tank. The J-4 facility will be modified to accept the Linde insulated tank now under test in J-3. Testing in J-4 should begin in late May. Purpose of the test is to determine the effectiveness of the insulation under atmospheric conditions

PLUM BROOK ROCKET SYSTEMS DIVISION STATUS REPORT CONTINUED

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 Hydrogen-Oxygen 28K Rocket Engine (N. D. Sanders)	A hydrogen-oxygen rocket engine is operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.
	STATUS:	The solid copper heat sink engine has been reinstalled in the test cell. An identification heat check has been made on the revised thermocouple instrumentation. All pressure transducers have been recalibrated, cleaned, and reinstalled in the system. Facility controls have been moved to the new control panel and have checked out satisfactorily. The monitoring instrumentation changeover to the new control panel is nearing completion. The electrical hookup of the liquid hydrogen system, for hydrogen cooled engine test, has been completed. Items left for completion are final checkout of instrumentation and electrical systems and checkout of the engine igniter torch. Runs are scheduled for the first week of June.	
		J-2 Liquid Hydrogen Liquid Oxygen Throttling Tests (I. A. Johnsen)	Throttling and combustion instability tests of a liquid oxygen-liquid hydrogen pressure fed rocket system.
	STATUS:	NOTE (A): The number of run days requested by research engineers has been increased from six to eight. NOTE (B): Anticipated start of research runs has been changed to compensate for delivery of component hardware. The O_2 and H_2 flow system cell modifications have been completed. Provisions were made to install flush mounted pick-ups for investigation of feed line oscillations in the larger diameter flow lines. All components for the engine exhaust system modification are fabricated. Minor cell modifications will be completed when the new test engine is delivered to Plum Brook. Depending on the arrival of the test hardware, research runs are tentatively scheduled for the week of June 9, 1963. Approximately four run days will be required to complete the present program which will include two engine changes.	

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	(CONTINUED)		
		M-1 Hydrogen-Oxygen Gas Generator (I. A. Johnsen)	Investigation of the gas generator for the Aerojet M-1 rocket engine program.
	STATUS:	All major components required for the installation of gas generator system have been ordered. Installation will start prior to the completion of the current program in the test cell. The 175 cubic foot liquid hydrogen tank will be positioned during mid-June. Specifications for the removal of the present tanks, modification of the test cell and installation of the exhaust system are now being written for contract purposes.	
		J-3 Vacuum Environment Facility 5120 (I. A. Johnsen) A. D. Little Tank	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.
	STATUS:	NOTE (A): The schedule has been changed by two weeks which reflects the present anticipated deliveries of materials.	
		Two tests were completed on the Linde super-insulated liquid hydrogen tank. The first test was conducted with the space chamber evacuated to a pressure of five microns. Data was recorded at one hour intervals for eight days. The second test was made to evaluate the affects of compression of the super-insulation on the liquid hydrogen boil-off rate. To accomplish this the vacuum chamber pressure was raised in increments of twenty-five millimeters from five microns to two hundred millimeters of mercury. Data was recorded at thirty minute intervals for five days. The test data is now being analized by research engineers.	
		On May 14, 1963 the Linde tank was removed from the space tank and rebuilding of the test cell started for the A. D. Little tests. The space tank has been raised and modified and the new floor grating has been installed.	

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	(CONTINUED)		
		J-4 Tank Test Facility Linde Tank (I. I. Pinkel)	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. It was originally built to accomodate the old NACA high energy test vehicle.
	STATUS:	Modification of the test cell to accept the Linde super-insulated liquid hydrogen tank has been completed. During tests in J-3 test cell, a small leak developed in the insulation. Location of the leak has been determined and the research engineers will attempt to seal it. Instrumentation installation and checkout is progressing and tests are scheduled for the first half of the month of June. The objectives of the test are; (1) Measure liquid hydrogen boil-off rates under atmospheric conditions, and (2) Verify results obtained during initial tests in J-3 when the space chamber was at atmospheric pressure.	
		J-5 Fluorine Hydraulics Laboratory (I. A. Johnsen)	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with 7 cubic feet of fluorine at pressures to 400 psi.
	STATUS:	Note (A) : No definite run schedule has been established at the present time. The cell is being reactivated for material compatibility tests using liquid oxygen with varying quantities of liquid fluorine added. The tests are to study the effects of liquid fluorine and liquid oxygen mixtures on present day liquid oxygen propellant and engine system components. The J-5 test cell has been inspected for general operating conditions and pressure checked. Minor repairs have been made. Drawings are being updated and revisions made where necessary. Liquid oxygen flow checkouts will be made during the month of June.	

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K Rocket Eng. (N. D. Sanders) OCO 425	A hydrogen-oxygen rocket engine operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.

STATUS: Following complete installation and checkout of all necessary hardware and equipment, a hot firing of a copper engine was attempted on June 6, 1963. The purpose was to measure the combustion side wall temperature with a remote reading optical pyrometer and compare this with recorded thermocouple data. Gaseous fluorine previously used as an ignitor gave erroneous pyrometer results because of flame discoloration. A hydrogen-air torch was being tried this time as an ignition source and several "ignition attempts" were scheduled. Two aborted starts led to discovery of controller troubles. These were corrected and a third run was successfully accomplished. A fourth run attempt showed additional controller problems and further runs were cancelled. Investigation by the Plum Brook controls group is presently underway to determine the exact cause of the controller malfunctionings. Runs will be scheduled the first two weeks of July dependent on proper functioning of the controller.

	J-2 LIQUID HYDROGEN-LIQUID OXYGEN Throttling Tests (I. A. Johnsen) OR 9045	Throttling and combustion instability tests of a liquid oxygen-liquid hydrogen pressure fed rocket system.

NOTE (A): Engine and injector failures during operational test firings have increased the time required to complete the test program.

STATUS: The present tests will be completed with one more test day which should be the week of July 7, 1963. The test run of June 21 resulted in a burned out injector and a crack in an engine channel. The hardware has been returned to Lewis for repair and/or replacement.

Flush mounted pressure pickups using a helium purge were incorporated in the flow system for the last run and the data is being analyzed.

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	(continued)		
		M-1 HYDROGEN-OXYGEN GAS GENERATOR (I. A. Johnsen)	Investigation of the gas generator for the Aerojet M-1 rocket engine program.

NOTE (B): Equipment deliveries and installation work time estimates have been increased and this is reflected in a change of operation schedule from August 15 to the end of September.

STATUS: Work has been completed on the pad for the hydrogen tank and the tank is to be placed in position and leveled on June 27. The drawings and specifications for contract purposes have been completed and the Purchase Request is being processed. Operations should begin the latter part of September.

	J-3 Vacuum Environment Facility 5120 (I.A. Johnsen) A. D. Little Tank ORO 399	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

NOTE (A): The schedule has been changed by two weeks which reflects delays in arrival of new equipment to support the program. Some instrumentation equipment is not scheduled to arrive until mid-July.

STATUS: The test cell is currently being rebuilt to accept the Arthur D. Little Company environmental tankage test program. Work completed this month includes: (1) extension to the existing vacuum chamber, (2) panels for equipment mounting (3) second floor installation, (4) monorail on the existing roof frame to place the insulated tanks in the vacuum chamber. Work is progressing on the placement of equipment, valves, pumps, piping, and the electrical wiring of the test cell and the control panels. It is anticipated that a two shift per day, six day a week operation will be necessary to complete the facility by August 1, 1963. With the present workload in the "J" area, this type of support does not appear possible without closing down other cells in the "J" area.

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
J	(continued)	J-4 TANK TEST FACILITY LINDE TANK (I. I. Pinkel) 51210	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. It was originally built to accomodate the old NACA high energy test vehicle.

STATUS: Two research test runs were accomplished on the Linde super-insulated liquid hydrogen tank. Both tests were made at atmospheric conditions around the tank and less than 15 micron vacuum on the insulation. The first test lasted approximately forty hours. This test was unsuccessful due to leakage of the boil-off gas through a burst disc assembly. Repairs were made and the second test was run a week later. The second test was successful and lasted forty-eight hours. That data obtained from the second test is being analyzed by the research engineers. Further tests will be scheduled for the last two weeks of July.

		J-5 FLUORINE-HYDRAULICS LABORATORY (I. A. Johnsen)	The facility consists ofa high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with seven cubic feet of fluorine at pressures to 400 psi.

STATUS: The schematic flow diagram of the facility has been redrawn and revisions are being made as definite research requirements are specified. Actual design and buildup of the new components in the system are in the preliminary stages. The existing system has been functionally checked and the replacement of existing instrumentation has begun. A review is in process of the former system. This will determine the best method of operation of the cell for the present test requirements.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K Rocket Eng. OC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.

STATUS: A total of thirteen runs on 3 days were made this month. Successful engine ignition was obtained with both a GH_2-Air torch and a GH_2-GO_2 torch. The objective of these tests was to compare combustion wall temperatures as measured by thermocouples with those seen by an optical pyrometer. No direct correlation has been achieved to date. Further tests of this nature have been cancelled until some major change is made either to the pyrometer temperature measuring circuitry or to the problem of flame discoloration.

The next tests in the cell will include calibration of a new injector with LN_2 and flow controller checkouts. Hot firings will then be resumed to endurance test a copper injector.

		J-2 LIQUID HYDROGEN-LIQUID OXYGEN Throttling Tests (I.A. Johnsen) OR9045	Throttling and combustion instability tests of a liquid oxygen-liquid hydrogen pressure fed rocket system.

STATUS: On July 9, it was decided by Cleveland engineers that the J-2 cell would not be run so that more effort could be placed on the J-3 buildup. On July 17, this decision was reversed since existing equipment in J-2 was needed for the completion of both J-3 and J-5 test cells. Manpower was reassigned to the cell to prepare for a run. On July 26, four runs were completed successfully before the tests were terminated by engine failure. The cell is being dismantled for the M-1 program and will be reassembled when parts and manpower become available.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	(Continued)		
		M-1 HYDROGEN-OXYGEN GAS GENERATOR (I. A. Johnsen) OR0152	Investigation of the gas generator for the Aerojet M-1 rocket engine program.

STATUS: Items ordered for this program are in the process of being delivered. Drawings for moving the control consoles from the trailers to B-1 control addition are being prepared.

	J-3 VACUUM ENVIRONMENT FACILITY (I. A. Johnsen) A. D. Little Tank OV0698	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

STATUS: On July 9, it was decided by Cleveland personnel that the test cell would be used for CENTAUR arc tank insulation tests before the ADL insulated tank was tested. The test cell construction is complete for the CENTAUR tests and checkout of the facility will be made in the time period before the CENTAUR arc tank arrives. Construction related to the ADL tests will continue as manpower is available from the CENTAUR test program.

NOTE (A) : Schedule changes reflect current research program requirements.

	J-4 TANK TEST FACILITY LINDE TANK (I. I. Pinkel) OV0698	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. It was originally built to accomodate the old NACA high energy test vehicle.

STATUS: On July 9, it was decided by Cleveland personnel that the test cell would be used for CENTAUR arc tank insulation studies. Plans were immediately formulated and actual modification started a week later. Since the CENTAUR arc tank will be installed in the J-4 cell before J-3, some manpower has been diverted from J-3 to assist in the J-4 modifications. It is anticipated that all modifications will be complete before the arrival of the CENTAUR arc tank.

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SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J		J-4 TANK TEST FACILITY LINDE TANK (Continued)	NOTE (A) : Schedule changes reflect current research program requirements.
		J-5 FLUORINE-HYDRAULICS LABORATORY (I. A. Johnsen) (OR0137)	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with seven cubic feet of fluorine at pressures to 400 psi.

NOTE (A) : Based on present manpower available, this project is scheduled for its first test run the week of September 2.

STATUS: Items completed in July were the LN_2 baths for the test section and the weigh tank, parking area for the LOX and LF_2 trailers, the holders for the test samples and parts for the natural gas disposal system. Completed specifications and drawings on the burnoff tower and piping were put out for bid after a safety meeting on July 24. Valving in the test section is being installed as it becomes available from the shop. Items left to be completed are mounting of the weigh tank system, installation of the gas burnoff system, and installation of a heat exchanger for gaseous O_2F_2 testing. Laboratory scale tests using very small quantities of FLOX will be run near the test cell before the completion of J-5.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K Rocket Eng. OC0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.

STATUS: A total of five successful firings out of six attempts were made on two run days this month. The objective of the first two runs was to evaluate a copper injector face plate on the basis of endurance under hot firing conditions. The results from these tests indicate this injector to have definite promise of successful use for the extended runs with the future liquid hydrogen cooled engine.

The remaining runs were to checkout the O/F control circuitry of the fire valve controller. The engine was put on condition with fixed valve position, but immediately began to drift off condition upon being put on O/F control. The Plum Brook controls group is investigating this problem and future runs are anticipated to develop the necessary control stability.

Several "cold flow" runs with LN_2 were also made on a new injector to calibrate pressure drop versus weight flow. These tests also indicated further work was necessary in the Pc control portion of the fire valve controller.

		J-2 M-1 HYDROGEN-OXYGEN GAS GENERATOR OR0152(I.A.Johnsen)	Investigation of the gas generator for the Aerojet M-1 rocket engine program.

STATUS: Equipment for the program is in the process of being delivered. The contract for the test cell modification has not yet been released for bidding. Work has not begun on the dismantling of the test cell due to lack of manpower to start the work. Drawings related to the relocation of control functions from the trailers to the B-1 addition are in various stages of completion.

(Continued on Page 11 - 11)

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J		J-2 M-1 HYDROGEN-OXYGEN GAS GENERATOR (Continued)	

NOTE Ⓐ : Schedule has been changed to reflect deliveries of materials and anticipated cell buildup time.

J-3 VACUUM ENVIRONMENT FACILITY (I.A.Johnsen) (I.I. Pinkel) 0V0698	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

STATUS: Two test runs were made during the month of August. Test program for #1 CENTAUR tank in J-3 was partially completed on August 21. A hydrogen leak from the CENTAUR tank to the vacuum chamber necessitated a premature shutdown of the test. Continuation of the test at this point would be highly dangerous since the test calls for introduction of 30 KW power into the vacuum chamber with the possibility of arcing during the vacuum chamber evacuation. Subsequent checks of the system revealed no leakage at ambient temperature. The research personnel therefore decided to repeat the test at a later date using LN_2 as the cryogenic fluid. On August 26, the #1 CENTAUR tank was tested in J-3 facility using LN_2 as the cryogenic fluid. Tank boiloff was stabilized, then test sequence was followed. The sequence consisted of evacuating the vacuum chamber for 150 seconds to a pressure of 7 mm Hg ABS., then energizing the heating section for 60 seconds. The tank insulation surface attained a temperature of 640° F. Subsequent investigation of the tank and insulation revealed that the insulation was badly burnt, and it was determined that the heater lamps had been installed improperly which accounted for the burnt condition of the tank insulation.

NOTE Ⓐ : CENTAUR arc tank insulation program has been extended until October 1.

J-4 TANK TEST FACILITY LINDE TANK (I. I. Pinkel) 0V0698	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems.

STATUS: Three tests were made during this report period. On August 13, a programmed test on #1 CENTAUR tank was run. The tank was filled with LH_2 and boiloff data was recorded. The liquid level sensors did not function correctly. Inspection of the tank after test shutdown revealed that an

(Continued on Page 11-12)

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J		J-2 M-1 HYDROGEN-OXYGEN GAS GENERATOR (Continued)	

NOTE Ⓐ : Schedule has been changed to reflect deliveries of materials and anticipated cell buildup time.

J-3 VACUUM ENVIRONMENT FACILITY (I.A.Johnsen) (I. I.Pinkel) OV0698

This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

STATUS: Two test runs were made during the month of August. Test program for #1 Centaur tank in J-3 was partially completed on August 21. A hydrogen leak from the Centaur tank to the vacuum chamber necessitated a premature shutdown of the test. Continuation of the test at this point would be highly dangerous since the test calls for introduction of 30 KW power into the vacuum chamber with the possibility of arcing during the vacuum chamber evacuation. Subsequent checks of the system revealed no leakage at ambient temperature. The research personnel therefore decided to repeat the test at a later date using LN_2 as the cryogenic fluid. On August 26, the #1 Centaur tank was tested in J-3 facility using LN_2 as the cryogenic fluid. Tank boiloff was stabilized, then test sequence was followed. The sequence consisted of evacuating the vacuum chamber for 150 seconds to a pressure of 7 mm Hg ABS., then energizing the heating section for 60 seconds. The tank insulation surface attained a temperature of 640° F. Subsequent investigation of the tank and insulation revealed that the insulation was badly burned.

NOTE Ⓐ : Centaur arc tank insulation program has been extended until October 1.

J-4 TANK TEST FACILITY LINDE TANK (I.I. Pinkel) OV0698

The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems.

STATUS: Three tests were made during this report period. On August 13, a programmed test on #1 Centaur tank was run. The tank was filled with LH_2 and boiloff data was recorded. The liquid level sensors did not function correctly. Inspection of the tank after test shutdown revealed that an

(Continued on Page 11-12)

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J		J-4 TANK TEST FACILITY LINDE TANK (Continued)	

insulation panel had separated from the tank skin during the test. Research personnel decided to continue the test program in J-3 utilizing #1 Centaur tank. A programmed test on #2 Centaur tank was run in J-4 on August 24. The tank was filled with LH_2 and boiloff data was recorded. Attempts by the United Controls liquid level sensor representative to adjust sensors were to no avail and the sensors did not function. Inspection of the tank after boiloff was completed revealed that approximately 2/3 of the insulation had separated from the tank skin during the program. The #2 tank was again tested on August 28 to verify boiloff results obtained in the test of August 24th.

NOTE Ⓐ : Centaur arc tank insulation program has been extended until October 1st.

J-5 FLUORINE-HYDRAULICS LABORATORY (I. A. Johnsen) (OR0137)	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with seven cubic feet of fluorine at pressures to 400 psi. The facility is presently being reworked to test FLOX and gaseous O_2F_2 as well as LF_2.

STATUS: Lack of manpower has delayed work in the cell considerably. Some welding and other fabrication work was sent to Lewis to expedite the cell buildup. Since J-3 and J-4 test cells are now operational, welders and electricians will be diverted to J-5 cell during the early part of September to complete that aspect of the modification. Problem areas exist in scheduling the necessary instrumentation technicians and mechanics into the test cell and still keeping data producing facilities in J area running.

NOTE Ⓐ : Schedule has been changed to reflect delays in the cell buildup due to interference from the operating rigs (J-1, J-3, J-4).

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K Rocket Eng. OC0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.

STATUS: A total of 19 runs on 4 days were made this month. The objective of these runs was to check out the Pc and O/F controlling circuitry of the fire valve controller. Accurate control of these parameters is of prime importance in the heat transfer work to be done at J-1. To date, system stability with fast accurate response has been obtained only at the 300 psia chamber pressure. A satisfactory arrangement between system pressures and controller response characteristics has yet to be determined for 600 psia chamber pressures. Future tests are planned to meet this objective. A modification to the J-1 test cell structure is scheduled to begin early in October. Cell operations will be curtailed approximately 3 weeks during the cell modification construction period.

		J-2 M-1 HYDROGEN-OXYGEN GAS GENERATOR OR0152(I.A.Johnsen)	Investigation of the gas generator for the Aerojet M-1 rocket engine program.

STATUS: All hardware, except for some valves and the hydraulic pump system, has been received for the M-1 gas generator program. Delivery is expected on the valves by October 30th.The pump contract is now ready to be awarded. The bids for the cell modification have been received and are being reviewed. All equipment which is unnecessary for the new program has been removed from the test cell. Tentative instrumentation lists have been compiled and distributed to the groups concerned. The necessary funding for the move of control functions from J control trailers to B-1 control addition has been approved by Plum Brook Station and was sent on 9-23-63 to the Lewis Budget Office. The plans for the move are well underway and should progress rapidly when money is made available.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	(Continued)		
		J-3 VACUUM ENVIRONMENT FACILITY	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

STATUS: Three test runs were made during the month of September. The intial vacuum/heating cycle test of #2 CENTAUR tank was made on September 3. The test was unsuccessful due to incorrect thermocouple installation. As a result, no temperature data was recorded and test was rescheduled to September 5. The test program for #2 CENTAUR tank was successfully completed September 5, using LN_2 as the cryogenic liquid. Leakage of hydrogen gases from #2 CENTAUR tank necessitated usage of LN_2 during the vacuum/heating cycle. All objectives of the test were achieved; tank insulation and wrap were broken in areas where GN_2 was trapped between insulation and the tank skin. The test program for #3 CENTAUR tank was successfully completed, September 12, using LH_2 as the cryogenic liquid. Inspection of the tank after shut down revealed that several areas of insulation and wrap were separated from the tank. Several thermocouples on the heated portion of the tank short-circuited, during the test; however, the remaining thermocouples fully satisfied research data requirements.

NOTE Ⓐ : CENTAUR arc tank insulation program has been extended until October 15th.

J-4 TANK TEST FACILITY LINDE TANK (I.I. Pinkel) OV0698		The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems.

STATUS: Two tests were made during this report period. On Sept. 9, a programmed test on #3 CENTAUR tank was run using LH_2 as the cryogenic liquid. Boiloff data was satisfactorily recorded for research purposes. The "United Controls" point level sensors functioned correctly on this test. Inspection of the tank after shutdown revealed a small area where trapped air had broken the insulation to tank bond. Goodyear personnel repaired the failure and #3 CENTAUR tank was then mounted in J-3 facility. On September 28, the initial test on #4 CENTAUR tank was run, using LH_2 as the cryogenic liquid. Boiloff data was satisfactorily recorded for research purposes. The #4 CENTAUR tank, wound with Mylar and fiberglas, provided the same results as previous tests. The insulation to tank bond failed on #4 CENTAUR tank.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	(Continued)		
		J-5 FLUORINE-HYDRAULICS LABORATORY (I. A. Johnsen) OR0137	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with seven cubic feet of fluorine at pressures to 400 psi. The facility is presently being reworked to test FLOX and gaseous O_2F_2 as well as LF_2.

STATUS: During the month, work on mechanical and electrical items progressed sufficiently so that pre-run test cell checkouts could be started. Items completed are: test section tubing, test section bath tubing, weigh tank tubing, weigh tank bath tubing, FLOX fill system, vent and waste disposal system, control tank wiring, test closet wiring, fill system wiring, weigh tank wiring, and electrical checkout of the overall system. The burnoff stand and the installation of burners, valves, orifices and tubing for the FLOX burnoff system were completed and an observation periscope installed in the control tank. Sample tests were run on the heat exchanger with a water bath evaporating liquid nitrogen. Results verified operational capability, thus, it will be used for gaseous O_2F_2 tests. A pressure check of the general system has been performed and repairs completed. LOX checkout runs will be made following the installation of control instruments. Further research instrumentation installation is required before beginning FLOX research runs.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K Rocket Eng. OC0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.

STATUS: A total of seven test runs were made this month. The purpose of these tests was to develop fire valve controller stability for a rocket engine operating between 300 and 500 PSIA chamber pressures. All objectives were met successfully. The fire valves retained their fast response characteristics, the desired chamber pressures were obtained with good accuracy, and oscillations in chamber pressure were small in amplitude.

The test cell operations were curtailed this month because on October 14th modifications to the test cell structure were started and presently the system piping is being altered. Checkout of the new LH_2 system with Liquid Nitrogen is scheduled to be started early in November.

Operations should resume by mid-November with a series of tests to evaluate a transpiration cooled injector.

	J-2 M-1 HYDROGEN-OXYGEN GAS GENERATOR OR0152 (I.A.Johnsen)	Investigation of the gas generator for the Aerojet M-1 rocket engine program.

NOTE Ⓐ: Program has been cancelled.

	J-3 VACUUM ENVIRONMENT FACILITY OR0397 I.I.Pinkel I. A. Johnsen	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J		J-3 Vacuum Environment Facility (Cont)	

STATUS: Two successful LH_2 test runs were completed on the Centaur Arc Tank #4 in "J-3" test cell during the month of October. The last test, on the 10th of October, concluded the Centaur tests to be performed in J-3 test cell.

Presently, the test cell is being modified to accept the A. D. Little Company test configuration. The vacuum chamber has been evacuated to 2×10^{-6} torr and both LN_2 and water systems have been checked out. A. D. Little Company tests are scheduled to start November 18, 1963.

J-4 TANK TEST FACILITY LINDE TANK (I. I. Pinkel) (I. A. Johnsen) OFO 567		The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems.

STATUS: On October 4, this facility was used to test a new 10,000 gallon liquid hydrogen dewar to see if the dewar met specifications. The test lasted about five days, and it was found that about $1\frac{1}{4}$ times more hydrogen boiled off than was specified.

On October 21, 1963, the Centaur Arc Tank #4 was tested using liquid hydrogen as in previous tests. The purpose of this test was to evaluate the performance of the tank's insulation after a simulated flight test in J-3 facility.

During the test, a silver solder joint in the vent line cracked which caused the boil-off data obtained from the gas meter to be incorrect. However, the elapsed time boil-off of the liquid was comparable to previous test, so the test results were acceptable.

J-5 FLUORINE-HYDRAULICS LABORATORY (OR0789) (I. A. Johnsen)		The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with seven cubic feet of fluorine at pressures to 400 psi. The facility is presently being reworked to test FLOX and gaseous O_2F_2 as well as LF_2.

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SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
.1		J-5 Fluorine-Hydraulics Laboratory (cont)	

STATUS: During the first part of October, all mechanical and electrical items were completed and the test cell flow system was checked out with LO_2. On October 18, 1963, twenty-five test runs were completed on five test specimens at various FLOX concentrations and pressures from 25 PSIG to 400 PSIG. A sharp-edged Rulon "A" test specimen of an orifice configuration burned out at a FLOX mixture of 57% fluorine and a pressure of 400 PSIG.

On October 25, 1963, five new test specimens of the same materials used in the previous tests were exposed to concentrations of FLOX from 50% to 100% fluorine, and pressures from 25 PSIG to 400 PSIG. Thirty test runs were completed without reactions.

No difficulties were encountered in disposing of the FLOX mixture. On October 18, 1963, 62 pounds of FLOX were burned off and on October 25, 382 pounds were burned off.

Prior to the next test runs, differential pressure transducers will be inserted across each orifice test specimen to determine the point at which the material starts reacting with the FLOX.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K Rocket Eng. 0C0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective if to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.
		STATUS: Test cell operations were curtailed this month because of modifications to both the cell structure and to the system piping. All alterations have been completed and hydrostatic pressure checking has been finished on the altered piping system.	
		Operational checkouts of the new LH_2 system were held up pending receipt of additional temperature measuring instrumentation. This equipment is now on hand and is presently being installed. Preliminary tests with liquid nitrogen are scheduled for December. Prior to the porous face injector tests, the gaseous hydrogen flow line will be cleaned. Equipment is on order to provide cleaning to the 5 micron range.	
		J-3 VACUUM ENVIRONMENT FACILITY 0F0567(I.I. Pinkel) 0R0397(I.A.Johnsen)	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks to be studied.
		STATUS: Preparations continued for the Arthur D. Little Co. tank insulation tests. During this report period, liquid nitrogen and water checkout runs were performed on all NASA thermal environment systems. The high vacuum conditions required for this test program have not been obtained because of the high frequency of vacuum leaks in new components. Continuous leak detection has been required during the past month.	
		NOTE (A) : It is anticipated that checkout runs of the Arthur D. Little tank and components will begin in the second week of December with actual testing commencing in late December.	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	(Continued)		
		J-4 TANK TEST FAC. OG0851 (I.I.Pinkel)	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems.

STATUS: During this report period, no work was accomplished in this facility. The test requirements for the next test program have not been received.

NOTE (A) : Two previous programs were cancelled and the CENTAUR jettison insulation test added.

		J-5 FLUORINE-HYDRAULICS LABORATORY OR0789 (I. A. Johnsen)	The facility consists of a high pressure liquid fluorine system installed in a 38' dia. steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with seven cubic feet of fluorine at pressures to 400 psi. The facility is presently being reworked to test FLOX and gaseous O_2F_2, as well as LF_2.

STATUS: Ninety-six test runs on three run days were accomplished during November. The runs were made at various flow rates, pressures, and FLOX concentrations. Reaction of a majority of the test specimens with FLOX was obtained. After the second run day, it was discovered that the flow system downstream of the specimens had become contaminated from the reaction of the specimens with the FLOX. It was decided to run the next series of tests without trying to remove the contaminants. At the end of the third run day, it was found that the tank and lines upstream of the specimens had also become contaminated. It was then decided to completely clean the facility tanks, lines, and valves, so the contamination would not have an influence on the results of the test program. The cleaning is expected to take one week to accomplish. Testing should resume in mid-December.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K Rocket Eng. OCO-425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range of from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.

STATUS: The J-1 test cell has been undergoing a build-up program for the past month. Although the main emphasis has been in preparing for the testing of a transpiration cooled injector, some work has also been done on the liquid hydrogen system.

The following work was done during the month of December:

(1) Work has been started on the setup for the cleaning of the GH_2 fuel line.

(2) All IRCs for the liquid hydrogen system were installed.

(3) Additions to the control panel for the liquid hydrogen system were completed.

The following work is planned for January:

(1) Complete the cleaning of the GH_2 fuel line.

(2) Checkout of the control system for the liquid hydrogen fire valve.

(3) Installation of a new Potter flowmeter in the liquid oxygen system.

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SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J		J-1 HYDROGEN-OXYGEN (Continued)	
		The tentative date for a test firing with the transpiration cooled injector is late February. Manpower shortage could be a major problem if increased emphasis is placed on projects such as CENTAUR, B-1 Facility, or the operation of other cells at "J" Site. Therefore, the late February date is subject to further delay. NOTE (A) : Due to a manpower shortage the operation start date had to be extended.	
		J-3 VACUUM ENVIRONMENT FACILITY OFO-567 (I.I.Pinkel) ORO-397 (I.A.Johnsen)	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks to be studied.
		STATUS: One LH_2 test run was made in this facility on the Arthur D. Little Company's insulated tank during this reporting period. The test commenced on December 20 and was terminated on December 23 so contractual obligations at the test cell could be fulfilled. During the first 12 hours of the test, a cold guard system designed to prevent heat transfer down the neck of the tank was not operational. The remaining 44 hours of testing were conducted at specified conditions. Pressure measurements in the 10^{-7} Torr range were obtained during the majority of the test. At this writing, it is not known if the test correlates with theoretical results extrapolated from LN_2 testing at Arthur D. Little Co. The roof of the test cell is now being modified and is due to be completed by January 8. Further testing is scheduled to start January 20, 1964 on the above tank, or other A. D. Little tanks.	
		J-4 TANK TEST FAC. OGO-851 (I.I.Pinkel)	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems.
		STATUS: Since the test program for CENTAUR jettison insulation has not been received, no work could be accomplished during December.	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J		J-5 FLUORINE-HYDRAULICS LABORATORY ORO-789 (I. A. Johnsen)	The facility consists of a high pressure liquid fluorine system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine is passed through it. The system is capable of working with seven cubic feet of fluorine at pressures to 400 psi. The facility is presently being reworked to test FLOX and gaseous O_2F_2 as well as LF_2.

STATUS: Due to contamination buildup in the system, a complete cleaning and flushing was performed. Solvents used for this were: acetone, 30% nitric acid, deionized water, and acetone respectively. Following the cleaning, 79 runs were performed on December 10, 1963. New, high flow velocity tubular test pieces were used.

During this set of tests, KEL-F 82 reacted at 60%, 400 PSIG, and 5#/sec. flow; Teflon FEP reacted at 70%, 400 PSIG, and 5#/sec. flow; and Rulon A reacted at 100%, 300 PSIG at 4#/sec. Teflon TFE and KEL-F 81-3 did not react.

The system was refitted with new vent valves in the test closet and readied for the next set of tests. On December 18, 1963, 27 runs were performed. The tubular test specimens were again used.

During this set of tests, KEL-F 82 reacted at 75%, 200 PSIG, at 3#/sec. flow; Teflon FEP reacted at 85%, 400 PSIG and 5#/sec. flow; Halon reacted under static conditions following run at 85%, 400 PSIG, at 5#/sec. flow; and nickel-filled Teflon reacted at 100%, 300 PSIG at 4#/sec. flow.

Because of contamination from burnouts, the system is again undergoing a cleaning and flushing procedure. Also, due to faulty operation, all Hannifin Solenoids mounted in the test closet were replaced by Skinners for more positive actuation. The next anticipated run date will be in early January 1964.

J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K Rocket Eng. OC0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles. Presently, solid copper heat sink engines are being used. Ultimately, the program will progress to a highly instrumented liquid hydrogen cooled chamber.
		STATUS: Preparations continued during this report period for the testing of the transpiration cooled injector.	
		Continued on Page 24	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1	The following work was accomplished during January: 1. Installation of the hydrogen gas flow and vent lines was completed. 2. Cleaning of the hydrogen gas flow line was started. 3. The new liquid oxygen flowmeter was installed and the liquid oxygen line was cleaned and pressure checked. 4. The liquid oxygen flowmeter was checked out with liquid nitrogen. A constant discrepancy was noted between it and the liquid oxygen Venturi. This is being investigated. 5. Calibrations were made on the liquid hydrogen fire valve controller. The following work will be accomplished in February: 1. Cleaning of the hydrogen gas flow line will be completed. 2. Clean the porous face injector. 3. Pressure check and install the injector-engine assembly. 4. Install pressure pickups. 5. Install and checkout the Shawmeter. The tentative date for a test firing with the transpiration cooled injector is still late February.
		J-3 VACUUM ENVIRONMENT FACILITY OF0567 (I. I.Pinkel) OR0397 (I.A.Johnsen)	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied. STATUS: During this reporting period, testing was resumed on the first Arthur D. Little Co. aluminum-mylar multifoil insulated cryogenic tank. On January 20th, the tank was filled with liquid hydrogen; liquid nitrogen was used in the cold guard system with 80° F water environmental control surrounding the vacuum chamber. The tank was permitted to boiloff until January 23. The "boil-off" rate on this test was approximately 50% higher than anticipated from extrapolated date from liquid nitrogen tests performed at Arthur D.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J			Little Co., at Cambridge, Mass. To determine if thermal degradation of the insulation had taken place during the tank's six-month storage at Plum Brook, the tank was refilled with liquid nitrogen on January 23 to duplicate the tests at Cambridge. This test was allowed to "boil-off" until the 28th, and, once again the boil-off rate was higher than anticipated. The tank was refilled on the 30th with liquid hydrogen in the tank and cold guard systems, and it is anticipated that the test will be terminated by February 3. NOTE Ⓐ: A. D. Little tests have been extended to February 28, 1964.
		J-4 TANK TEST FAC. OG0851 (I.I.Pinkel)	The facility is a semi-enclosed vertical stand originally built to study cryogenic propellant loading and insulation problems. STATUS: A test program has not been received for the Centaur jettisonable insulation tests. NOTE Ⓐ : Latest information now indicates that testing will not begin until the first week of April.
		J-5 HYDRAULICS LABORATORY OR0789 (D.S.Gabriel)	The facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine, oxygen or mixtures of fluorine and oxygen are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 psi. STATUS: From January 1, to January 16, the cell was readied for a run following a general flushing and cleaning of flow tanks. As a precaution to prevent valve hang-up, the Hannifin solenoids were replaced with Skinners. The Skinners provide more positive action in the cold environment. On January 16, twenty-six runs were made during which Kynar, Kel-F 81A and Rulon A were burned out. On the 26th run, Rulon A burned out with additional reactions, causing extensive damage to the test cell. A complete survey revealed that it would take four to six weeks' work to rebuild the cell in a manner minimizing further delays from damage or contamination. Continued on Page 26

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
			Modifications and repairs include: 1. Flanging of flow tanks and system valves for ease of removal and cleaning. 2. Construction of a new test section bath. 3. Replace the test closet with a containment system utilizing a jet engine transport pod. 4. Replace, replumb and rewire all damaged equipment. As of January 31, the following has been accomplished: 1. One tank has been modified. 2. Liquid nitrogen tank bath has been repaired. 3. Test section bath has been constructed. 4. Engine pod is ready for installation. Testing is expected to resume in early March. NOTE Ⓐ: Test program has been delayed six weeks due to damages sustained in test cell explosion.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K Rocket Eng. OC0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Preparations continued during this report period for the testing of the transpiration-cooled injector. For approximately three weeks, a great deal of effort has been devoted to cleaning the gaseous hydrogen fuel line, with repeated flushing of Dow Chlorothene Nu passed through a 2-micron filter.

Difficulty has been experienced in obtaining an accurate determination of the size of the particles in the fluid samples taken from the line. Cox Instrument Company has been requested to take a sample of the fluid discharging from the 2-micron filter. Results of this analysis will be compared with those made by Plum Brook personnel.

However, on February 29, Lewis and Plum Brook engineers agreed that further efforts to clean the line would be of minor value. Work is now being directed toward the back-flushing of the porous-face injector. A 5-micron filter has been installed in the gaseous hydrogen pressurizing line to the liquid hydrogen tank, as well as the installation of an orifice assembly to measure the flow of pressurizing gas. The vacuum jacket on the liquid hydrogen tank has been pumped down to 50 microns and the dip tube vacuum jacket to 20 microns. The entire liquid hydrogen system is now ready for pressure checking and cold flows. Liquid hydrogen temperature and liquid level measuring instrumentation have to be connected.

(Continued on Page 24)

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J			The contract to fill the voids in the cell walls with grout was started this month. Problems were encountered when the grout flowed under the floor and caused the floor to rise. This distorted the cell piping. Necessary alterations were made to realign the piping. NOTE Ⓐ: As a result of the delay in determining the cleanliness of the gaseous hydrogen line, the tentative date for a test firing with the transpiration-cooled injector has now been extended to mid-March.
		J-3 VACUUM ENVIRONMENT FACILITY OF0567 (I.I.Pinkel) OR0397 (I.A.Johnsen)	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied. On February 3, the test started on January 20 was completed on the first A. D. Little Aluminum-Mylar multi-foil insulated tank. Test data indicated higher boil-off rates than on previous tests at A. D. Little Company. Tank inspection revealed some thermal degradation of the insulation had taken place near the brazed joint on the tank neck. The cause for this condition was not determined. The tank was returned to A. D. Little for further inspection and tests. NOTE Ⓐ: The second A. D. Little tank was scheduled for testing on February 17, but since the tank insulation was destroyed during a test at the A. D. Little Company facility, no new Plum Brook schedule has been established. Minor cell modifications for the ADL tank tests were continued during February. Contractor maintenance work in the cell prevented the starting of any major modification work. On February 6, a rapid chamber evacuation test was conducted to evaluate the pumping capacities required to simulate the launch profile of a missile. The test results are being analyzed and more tests are scheduled for March. Initial planning and purchasing of equipment for the Linde super-insulated test tank were completed this month. All equipment is scheduled to be delivered by early April and testing should start by mid-April.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
		NOTE Ⓑ: Test schedule change reflects present equipment delivery dates.	
		J-4 TANK TEST FACILITY OG0851 (I.I.Pinkel)	A facility to study LH_2 tank insulation.
		The detailed test program has not been received for the Centaur jettisonable insulation tests.	
		NOTE Ⓐ: Test program has been extended through September.	
		J-5 HYDRAULICS LABORATORY OR0789 (D.S.Gabriel)	The facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank and fluorine, oxygen, or mixtures of fluorine and oxygen, are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 psi.
		This report period has been spent rebuilding the test cell due to damage sustained in the run of January 16, 1964. As of February 29, the following repair and re-work has been accomplished:	
		(1) The second flow tank was flanged and valves rebuilt. Both tanks have been reinstalled.	
		(2) The jet engine shipping container has been modified and installed.	
		(3) The test section bath has been installed.	
		(4) The test section and nineteen vent valves have been rebuilt.	
		(5) All flow lines and operators on the flow tanks have been rebuilt.	
		(6) Test section valves and operators have been installed.	
		(7) A new burnoff system with surge tank was designed and installed.	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J			Work to be accomplished before testing can proceed: (1) Installation of LN_2 level switches. (2) Wiring valves and spark plugs for burnoff. (3) Installation and checkout of automatic flow controller. (4) Pressure check system to assure its pressure-tight capabilities. Stop all leaks. (5) Pickle the system with fluorine gas. (6) Perform the complete pre-run setup and checkout. A test operation is tentatively scheduled for March 10 and 11. NOTE Ⓐ: The test date has been re-scheduled from March 1 to March 10. The site rebuilding will take longer than originally planned because some of the personnel that were scheduled to work at the site had to be reassigned to other test facilities.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. OC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Early this month, cleaning of the porous-face injector was completed. This consisted of reverse flushing with Dow Chlorothene Nu passed through a 2-micron filter.

On March 11, two successful firings were made, using the porous-face injector with a Rockide-coated steel engine, at 300 PSIA chamber pressure. The results showed that the injector performed satisfactorily, with no evidence of hot spots. Face temperatures leveled off below 400° F. in less than one second.

No runs were scheduled during the week of March 16, as Lewis Research engineers requested a hold until the repaired Shawmeter was returned from the factory.

On March 26, two full duration firings were made, using the porous-face injector with the steel engine. Their purpose was to check out the Shawmeter, used to determine the combustion wall temperature. Although the engine throat was severely burned during the first run, results from these tests were conclusive enough to prove the Shawmeter unworthy of further testing. The flame discoloration had the same effect as during previous tests, that of driving the meter off scale, rendering the measurement valueless.

Pressure checking of the liquid hydrogen system began this month, but difficulty was encountered with facility hardware. This problem is being corrected and the system should be pressure checked and ready for cold flows with liquid nitrogen by mid-April.

Copper engine tests, using the porous-face injector are scheduled to start the week of April 13.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-3 VACUUM ENVIRONMENT FACILITY 0F0567 (I. I. Pinkel) 0R0397 (I. A. Johnsen)	This facility consists of a "zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

The test cell was inactive until March 13 because of the required mechanical demands to support other test cells. On March 14, a nude ionization guage was installed and the chamber was continuously evacuated until March 23, reaching an ultimate pressure of 2.8×10^{-8} mm of Hg. On the following day, the second in a series of rapid chamber evacuation tests was performed. This test was to determine if the diffusion pump had sufficient pumping capacity to simulate the ascent of a typical missile between the altitudes of 50 to 250 miles. A third rapid evacuation test was performed on March 26.

The major portion of the evacuation equipment required for the Linde tank super-insulation tests had been received by March 20 when Plum Brook welders started the fabrication of this system. Late deliveries of some equipment will postpone completion of this system until April 10.

NOTE Ⓐ : It is anticipated that testing of the Linde tank will begin in mid-April and continue for one month. The second Arthur D. Little tank is scheduled to arrive the week of May 3, but the second tank testing schedule has not been established.

		J-4 TANK TEST FACILITY 0G0851 (I. I. Pinkel)	A facility to study liquid hydrogen tank insulation.

Contact was made with the Cleveland engineer responsible for the jettisonable insulation tests. The program was discussed in general terms, but as yet no definite program requirements have been established. Lewis personnel will contact Plum Brook operation engineers when the facility build-up and instrumentation requirements have been finalized. No work was accomplished on this project.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-5 HYDRAULICS LABORATORY OV0789(D.S.Gabriel)	This facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank, and fluorine, oxygen, or mixtures of fluorine and oxygen, are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 psi.

The rebuilding of the test cell continued during the first half of this report period. Between March 1 and March 12, the liquid nitrogen bath level switches were installed, burnoff tower wiring (valve spark plugs, and instruments) was completed, the system was pressure-checked, evacuated, and pickled with fluorine gas.

On March 13, eight runs were made after complete pre-run setup and checkout was performed. Materials tested were Halon, Teflon FEP, KEL-F Amorphous, Kynar and Lucite. The Lucite reacted at 300 psi and 4 pound per second flow at 50% concentration. Additional reactions downstream blew out a section of 3/4" flow line, a 3/4" Annin 1600 series valve, and stressed a 3/4" Annin 3400 series flow control valve. Shrapnel did extensive damage to tubing, piping and electrical wiring near Tank #2. Repairs were begun immediately which included the following:

(1) Rebuilding fill valve, crossover valve, and damaged piping.

(2) Building up a new flow control valve which had the flange blown off and a possible stressed body.

(3) Installed a new bellows and spool piece on flow tank bath leading to Tank #2, and replaced the former 1/4" vent line with a 3/4" vent.

(4) Tubed in new operator lines and 3/4" vent.

(5) Rebuilt flow tank liquid nitrogen bath.

(6) Removed, cleaned, and reinstalled Flow Tank #2.

(7) Rewired all valves located near Tank #2.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		(8)	Modified burner heads on tower.
		(9)	Removed, cleaned, and reinstalled five downstream section valves.
		(10)	Evacuated system after pressure check.
		(11)	Pickled system and performed completed pre-run operation.
			On March 30 and 31, forty-six runs were made with the following materials: Halon, Teflon, FEP, Kynar, Rulon and Viton A. Due to reactivity of Viton-A, the concentrations were begun at 50%. Burnouts occurred on all five specimens. System damage was slight, consisting of contaminated flow valves, flow lines and burned out burnoff heads.
			Burnoff improvements will be made before the next run scheduled on April 9 and 10. Equipment for gaseous FLOX runs will be installed and checked out by mid-April.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. 0C0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On April 14, three full duration runs were made at a chamber pressure of 500 psia. The porous-face injector was used with the No. 2 copper engine. The object of the test was to determine if the transpiration-cooled injector produced a temperature profile along the engine walls different from that obtained with the copper face plate injector. Preliminary investigation of the data indicates this injector will produce nearly identical results for heat transfer studies. No further runs of this type are being scheduled. During the above tests, the fire valve controller did not perform satisfactorily on Pc and O/F control. Desired conditions could be obtained only by fixed valve position control. Therefore, further "Controller" checkout runs were scheduled using a steel engine with the porous-face injector. The controller conditions chosen were the same as those scheduled for the first runs with the liquid hydrogen-cooled engine.

On April 28, five runs were made to check the controller operation. However, the fuel pressure regulator developed trouble during the last two runs and failed to pass the required flow. Thus, the controller setup still remains to be finalized for operating at 300 PSIA chamber pressure. Runs will also be scheduled in the near future at 600 PSIA chamber pressure.

The liquid hydrogen system has been pressure checked to 200 PSIG. Several leaks were encountered, including leaky valve bodies. The system is again being readied for checking at higher pressures.

Controller checkout runs are expected to continue til mid-May.

NOTE (A) : Further controller checkouts are necessary before setup of the liquid hydrogen engine can be installed.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-3 VACUUM ENVIRONMENT FACILITY OF0567 (I. I. Pinkel) OR0397 (I. A. Johnsen)	This facility consists of a "Zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

During April, the test cell was being modified to accept the Linde super-insulated test tank. A separate vacuum manifold has been constructed for evacuation of the Linde insulation and a bleed valve has been installed for controlling the chamber vacuum in the diffusion pump range.

On April 22, the insulation and chamber were evacuated in preparation for a test run. During the evacuation, a small section of the Linde insulation vacuum bag was torn by the shifting of an ionization gauge, and a large chamber leak was located between the adapter flanges. Both of these items have been repaired and chamber pressures in the low 10^{-7} Torr range have been recorded. The best obtainable pressure on the Linde insulation was 100 microns, after four continuous days of pumping. To further reduce this pressure, a baking of the insulation under vacuum at 260°F. was initiated on April 28. Baking will continue until pressure of the insulation stabilizes. A pressure of 1×10^{-5} Torr in the insulation must be obtained before testing can start. It is anticipated that liquid hydrogen testing will begin on May 6 and terminate in late May.

Arrangements are being made to test an Arthur D. Little polyurethane foam insulated, or an aluminum-mylar multifoil insulated, tank in mid-July.

NOTE Ⓐ : Due to pre-operation difficulties, the Linde tank testing will start May 6.

NOTE Ⓑ : The A. D. Little insulated tank tests will begin in mid-July.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-4 TANK TEST FACILITY	A facility to study liquid hydrogen tank insulation.

A new vacuum-jacketed liquid hydrogen transfer line was installed in the cell during April. Lewis Research engineers associated with the Centaur jettisonable insulation test program are expected to provide information about the program on May 4.

New plans call for the installation and testing of a liquid hydrogen tank insulated by Arthur D. Little in the facility. The A. D. Little tank is to arrive at Plum Brook in early May. Personnel are not available to be permanently assigned to the A. D. Little test program at this time; therefore, this program will be undertaken when and if the manpower becomes available from other test cells.

NOTE Ⓐ : A. D. Little tank tests have been added to the "J-4" schedule.

NOTE Ⓑ : Centaur jettisonable insulation tests have been tentatively postponed until July.

	J-5 HYDRAULICS LABORATORY OV0789(D.S.Gabriel)	This facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank, and fluorine, oxygen, or mixtures of fluorine and oxygen, are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 psi.

On April 9 and 21, runs were made with liquid FLOX. All test specimens were burned out while making 24 runs on April 9, and 22 runs on April 21. In each instance, system damage incurred was minimal. On April 9, two burners were damaged during burnoff operations, and on April 21, one IRC was burned out on test section No. 5.

On April 29, gaseous checkout runs were made to determine functional operation and control of the gaseous FLOX system using liquid oxygen. The results of the checkout test indicated further modifications were needed. Control valve relocation, the installation of a flow surge dampener, and a new operating procedure have been instituted and will be checked out with liquid oxygen on May 1. The first FLOX run is scheduled for May 5, using 1/4" tubular test pieces similar to those run in liquid FLOX.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. OC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On May 8 and 13, eleven test runs were made. Their purpose was to complete the determination of fire valve controller gain settings which would produce stable performance over an operating range of 300, 450, and 600 PSIA chamber pressures. The porous face injector was found to be damaged following the tests on May 8, therefore, the high-flow copper face plate injector was used for the higher chamber pressure runs on May 13. The satisfactory results of these tests completed the research requirements of initial operating conditions for the liquid hydrogen cooled engine.

Effort for the balance of the month was directed toward the preparation of the liquid hydrogen system for operation with the liquid cooled engine. Minor modifications were made, both electrically and mechanically, and the entire system was successfully pressure checked to 1000 PSI. A vacuum of 50 microns has been maintained in the liquid hydrogen tank vacuum jacket.

On May 28, the liquid hydrogen system was filled with liquid nitrogen and several flow-tests were made. The tests showed that liquid hydrogen level and temperature instrumentation modifications are necessary and these modifications are presently being made. Three valves developed trouble and are now being repaired. Also, the controller has to be altered to improve its stability on weight flow control. Further tests of this nature are scheduled for the week of June 15th.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		

J-3 VACUUM ENVIRONMENT FACILITY

OF0567 (I. I. Pinkel)
OR0397 (I. A. Johnsen)

This facility consists of a "Zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

On May 8, an evacuation of the Linde super-insulated test tank, which had begun on April 25, was terminated when the aluminum foil vacuum bag was torn while attempting to verify the integrity of the vacuum bag. The final pressures reached during this evacuation were 3.8×10^{-4} Torr in the upper insulation and 12 microns on the lower insulation. The test requirement was 1.0×10^{-4} Torr on both insulation readouts.

On May 21, after the vacuum bag was repaired a re-evacuation of the insulation and chamber was initiated. Failure of the chamber to pump down to test conditions was traced to a leak in the welded Linde flange adapter. While attempting to bring the chamber and insulation to atmospheric pressure to repair the leak, the insulation was overpressurized and consequently destroyed. The formal test program for the Linde tank was abandoned; however, data will be obtained on neck heat transfer characteristics in early June.

It is anticipated that an Arthur D. Little polyurethane and aluminum-mylar multifoil insulated tank will be tested in mid-July.

NOTE Ⓐ: Schedule changes were required because of operational difficulties encountered with Linde tank testing as mentioned above.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-4 TANK TEST FACILITY	A facility to study liquid hydrogen tank insulation.

Due to the concentration on "J-3" test cell, the work on "J-4" test cell was not started until the latter part of May. This facility is now being readied to perform an insulation integrity and a heat flux test on the Arthur D. Little tank.

The jobs that have been completed for the A. D. Little tests are:

1. The liquid hydrogen transfer line was insulated.

2. The facility piping was cold-shocked and pressure checked.

3. The tank was installed.

4. Existing instrumentation has been checked and re-calibrated.

5. A liquid nitrogen spray bar, for cooling the exterior of the tank has been designed and is being built.

It is expected that the first test will begin June 8.

Work on the Centaur jettisonable insulation test was started this month:

1. The necessary vacuum pumps have been located.

2. A firing circuit is now being designed.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-5 HYDRAULICS LABORATORY OV0789(D.S.Gabriel)	This facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank, and fluorine, oxygen, or mixtures of fluorine and oxygen, are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 psi.

On May 1, a checkout of the system was made, using a new flow controller. After several check runs to set gains, successful automatic system control was achieved. Necessary system modifications included: Switching from downstream to upstream control, reduced Cv in the control valves, manual pressure control with the downstream valve, a surge chamber to damp out pulsations.

On May 5, a series of 32 runs resulted in routine burnout of all five specimens in various concentrations of 300 psi gaseous FLOX at 70° F. Flow velocities ranged from 50#/sec. to choked flow through the 1/4" diameter specimen orifice.

Installation of a larger surge chamber and line vent upstream of the condenser were indicated by run results; these were both installed for the May 19 run.

On May 14, checkout runs were made to see if a pressure feedback controller could be used in the system. After repeated unsuccessful attempts, it was decided to use manual control as long as it was satisfactory and practical.

On May 19, 15 runs similar to the May 5 runs were made, but in this case, three of the materials did not burn out. Minor system damage was done when line five, containing Viton A, reacted. Damage was limited to the burning of an Annin valve and several tubing lengths. Investigation of the system after clean-up revealed contamination in several lines and the dip tube on the receiver tank. These test run components will be disassembled and cleaned prior to the first of June tests.

Gaseous FLOX runs will be made for approximately three months. After this, a high pressure (1500 PSIG) system will be installed so that both high pressure liquid and gas can be run. The high pressure flow tank has been delivered and it will be installed as soon as the low pressure runs are completed.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. OC0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On June 19, the liquid hydrogen system was filled with liquid nitrogen and several flow tests were made. Prior to these tests, three valves had been reworked, and additional instrumentation had been added for both liquid hydrogen temperature and level measurements. The purpose of these tests was to checkout this new instrumentation, and to adjust the fire valve controller gain for stable operation on weight flow control. Results of these tests are as follows:

(1) Satisfactory operation of the controller was obtained with a LH_2 tank pressure of 300 PSIA, but not at 600 PSIA.

(2) Liquid hydrogen level and temperature instrumentation in the LH_2 tank did not work completely satisfactorily.

(3) Liquid hydrogen temperature instrumentation in the flow line performed satisfactorily.

The above problems are being worked on and should be corrected prior to the next series of tests scheduled for the week of July 13.

Work has begun on replacing existing instrumentation cables into "J-1" Test Cell with new cables, terminal boxes, conduit, etc., in an effort to "clean-up" the instrumentation system for the cell.

The site modifications of the new 5000 psi GH_2 trailers are now complete and the electrical contract of the trailer hardware wiring was completed. The plumbing of the trailer hardware is nearing completion and a performance checkout is scheduled for July.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-3 VACUUM ENVIRONMENT FACILITY 0F0567 (I. I. Pinkel) 0R0397 (I. A. Johnsen)	This facility consists of a "Zero leakage" high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

On June 22 and 23, the Linde "super-insulated" cryogenic propellant tank was tested with LH_2. The primary purpose of this test was to observe the degree that the cold boil-off gases would prevent heat transfer through the neck tube into the insulated tank under low boil-off conditions. During this test, the boil-off rate was approximately 0.1#/hr. Chamber pressure during the entire test was below 5×10^{-7} Torr. Test results are now being analyzed. The tank was dissected on June 30 to observe Linde's method of applying "super-insulation" to both curved and cylindrical shells, and to inspect for thermal degradation and damage on hidden layers of insulation. This concluded the Linde tests in the J-3 Facility.

The test cell is now being modified to accept the Arthur D. Little Inc. polyurethane and laminate insulated tank. This test program calls for an extended hard-vacuum with both LN_2 and water environmental shielding and is scheduled to begin in late July.

NOTE (A): The remainder of the program involving the Linde tank has been cancelled. The follow-up tests on a NRC tank have also been postponed.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-4 TANK TEST FACILITY OG0851 (I.I.Pinkel)	A facility to study liquid hydrogen tank insulation.

From June 9 through June 11, five tests were performed on an Arthur D. Little urathane foam insulated cryogenic tank. The objective of these tests was to determine the heat flux value of the insulation and to investigate the foam integrity under cryogenic conditions. The test summary is as follows:

Date	Test	Results
June 9	LN_2 Boil-off #1	Heat Flux = 96.8 BTU/hr ft^2
June 9	LN_2 Boil-off #2	Heat Flux = 96.3 BTU/hr ft^2
June 10	LH_2 Boil-off #1&2	Heat Flux = 93.0 BTU/hr ft^2
June 11	LN_2 in tank, spray foam with LN_2	Alumaseal bag blistered. Foam integrity - good.
June 11	LN_2 in tank, spray foam with LN_2	Air pockets under bag Foam integrity - good

All test objectives were met and the tank returned to Arthur D. Little.

Effort for the balance of the month was directed toward preparation for the Centaur Jettisonable Insulation Tests. The vacuum system was installed and the detonator circuit completed.

A LN_2 checkout of the system was completed on June 27, 1964.

The first of the Centaur series tests will be made on July 1, 1964.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-5 HYDRAULICS LABORATORY OV0789(D.S.Gabriel)	This facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank, and fluorine, oxygen, or mixtures of fluorine and oxygen, are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 psi.

The June runs were a continuation of the series started in May. Gaseous FLOX at 70° F and 300 psi pressure was run through five 1/4" diameter tubular specimens each run day.

On June 5, a series of eighteen runs resulted in the burnout of two specimens. Concentrations of 50 to 100% were run at flow velocities of 50 to 500 fps.

On June 16, ten runs resulted in burnout of only one specimen. Concentrations were 80 and 100%, and flow velocities again ranged from 50 to 500 fps.

On June 23, a decision was made to delay the planned high pressure tests in favor of spill tests. The spill tests will involve dumping approximately 15 pounds of FLOX on various test media. Reactivity and type of reaction are to be photographed. Necessary modifications to the test cell should be completed by the end of July. During build-up of the spill stand, gaseous runs will be continued.

On June 30, eight runs resulted in burnout of two specimen. Concentrations of 80 and 100% were run at flow velocities of 50 to 500 fps.

NOTE (A): The spill tests are tentatively scheduled for the last week in July, and one more gaseous FLOX run will be made prior to the spill tests.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425 (N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 PSI. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Efforts during the month of July were directed towards completion of plumbing and instrumentation of the 5000 PSI gaseous hydrogen trailers and in leak-checking the liquid hydrogen dewar vacuum jacket.

The 5000 PSI gaseous hydrogen trailers are now complete and checkout of the trailers will commence in August upon receipt of the modified flex hoses.

The leaks in the liquid hydrogen dewar vacuum jacket have been repaired and cold flow tests scheduled. The purpose of additional cold flow tests is to check out instrumentation and to adjust fire valve controller gain for stable operation above 300 PSIA tank pressure.

The liquid hydrogen-cooled rocket engine was received from Lewis Research Center on July 28. Since the engine was not pressure-checked at Lewis, the engine will have to be checked prior to its installation. It is anticipated that cold flow testing of the engine will commence early in September.

		J-3 VACUUM ENVIRONMENT FACILITY OR0399 (S.S.Manson) PG0852 (I.A.Johnsen)	This facility consists of a "zero leakage", high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

During the month, the test cell has been modified to accept the Arthur D. Little, Inc., polyurethane, fiberglas and aluminized mylar cryogenic propellant tank.

On July 27, a liquid nitrogen run was initiated to establish a qualitative comparison between J-3 test cell and the A. D. Little test cell in Cambridge, Massachusetts. This run was terminated on July 30 due to the large variance between test data and theoretical expectations. Analysis of the data obtained indicated faulty operation of the neck heat shield.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		The Arthur D. Little tank neck shield was reworked on July 31 by NASA personnel. All work was performed under the direction of the A. D. Little representative at Plum Brook. Further A. D. Little tests, using LN_2 and LH_2, will be performed in J-3 facility during the month of August. Upon completion of the Arthur D. Little tests, the test cell will be modified to accept a "multi-foil" insulated tank. as designed by the Materials and Sresses Section, Lewis Research Center. The estimated test date for this tank is November 1964.
		J-4 TANK TEST FACILITY	A facility to study liquid hydrogen tank insulation. QG0851 (I.I.Pinkel & S.S.Manson) OR0399 (I.A.Johnsen) On July 1, the first of a series of Centaur jettisonable insulation tests was performed. The primary purpose of these tests is to investigate methods of jettisoning the insulation from a liquid hydrogen-filled Centaur arc tank. This first test proved to be unsuccessful, although the detonators on both sides of the tank were exploded. The detonation did not propagate along the explosive cutting charges as planned. It is thought that the cold temperatures affected the performance of the detonators and that nicks on the ends of the cutting charges kept the detonation from propagating. On July 20, another test was performed on the same tank. This time, the detonators were mounted away from the tank wall and the ends of the cutting charges were known to be free of nicks. The detonation propagated along the full length of the cutting charges, but a combination of frost and a few uncut strands of the fiberglas cinch wrap prevented the insulation from falling off the tank. The Centaur tank has been returned to Goodyear to be reinsulated and is expected back about September 1 for further testing.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-5 HYDRAULICS LABORATORY 0V0789 (D.S.Gabriel)	This facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank, and fluorine, oxygen, or mixtures of fluorine and oxygen, are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 PSI.

On July 14, a series of ten runs resulted in burnout of four out of five test specimens. Gaseous flox at 70° F. and 300 PSI was run at flow velocities of from 50 to 500 FPS. The specimens were either 1/8" diameter X 1" tubular configurations or 0.2" diameter X 1/2" tubular configurations. Duration (30 minute) runs were made on the 1/8" specimens and normal 30 second runs were made on the other test pieces.

Burnout of Leg 5, Viton A, caused sufficient damage to the test facility to make extensive rebuilding necessary in order to perform further flow tests. A decision was made to delay system repairs in order to make flox spill tests as soon as possible. The first spill test is scheduled for August 3. System repair will continue whenever possible while the spill tests are being conducted.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J-1	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425 (N. D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 PSI. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

The liquid hydrogen-cooled rocket engine was assembled to an injector and installed in the thrust stand. All "secondary" plumbing systems to the engine were made up and connected. This included a liquid nitrogen cooling system and a vacuum manifold setup for the engine instrumentation housings. In order to make the instrumentation hook-up easier, modifications were made to the connections to the engine cooling tubes pressure taps. Also, modification had to be made to the engine chamber pressure-checking gear because it was unusable as received from Lewis.

On August 18, the liquid hydrogen engine chamber was pressurized to 50 PSIG and the outside wrap was checked for leaks. Also, a vacuum was pulled on the instrumentation housings. Leaks were found between the cooling tubes, putting pressure under the wrap, around the tubes. Leaks were also found in the engine wrap and into one instrumentation housing. On August 19, the engine was removed from the stand and sent back to Lewis for repairs.

The 5000 PSI gaseous hydrogen trailers were sent to Gas Handling for pressurizing to 3000 PSI with gaseous nitrogen for regulator performance tests. The pressurizing was halted when excessive leakage through the main remote ball valves on both trailers was found to exist. Upon disassembly of these valves, dirt was found in the seats. Dirt was also found in the main discharge lines of the trailer. It was also found that moisture in one of the regulators had sufficiently affected the working parts to make it unusable. The other regulator was found to be in "like new" condition. Dirt was also found in the 5000 PSI trailer gas cylinder, indicating a need for thorough cleaning. Efforts have begun toward having these trailers cleaned by an outside contractor. Performance tests will be delayed until cleaning and repairs are made.

On August 24, an attempt to run liquid nitrogen through the liquid hydrogen system for controller checkout at higher tank pressures and flow reates was aborted due to controller malfunctioning. The main electronic timer which controls all events sequencing, developed trouble and failed to work. By August 31, the controls group isolated the problem and were

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J-1	ROCKET SYSTEMS		

taking corrective measures. Controller checkouts are tentatively scheduled for the second week of September. It is anticipated that cold flow checkouts of the engine will begin in late September.

The engine testing has been rescheduled from September to October.

J-3 VACUUM ENVIRONMENT FACILITY
OR0399(S.S. Manson)
PG0852(I.A.Johnsen)

This facility consists of a "zero leakage", high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

On August 15, the testing of the Arthur D. Little, Inc. cryogenic calorimeter was concluded. This testing sequence was started on July 27 and a total of five different test conditions was made during the 18 run days. The tests included both liquid nitrogen and liquid hydrogen in the calorimeter and cold guard; warm water and liquid nitrogen in the calorimeter environmental surroundings; and hard vacuum and helium-purged environments. During all phases of testing, the boiloff rate was greater than expected. However, a high degree of correlation between different run conditions was established. The calorimeter has been returned to A. D. Little for further liquid nitrogen testing at their laboratory.

The next scheduled test is a foil insulated tank, developed by the Materials and Structures Division's Structures Protection Section. Testing is scheduled to start in November.

J-4 TANK TEST FACILITY
OG0851(I.I.Pinkel & S.S.Manson)
OR0399(I. A. Johnsen)

A facility to study liquid hydrogen tank insulation.

The Arthur D. Little, Inc. calorimeter tests were cancelled, so no manpower was expended in this stand during August.

The second Centaur arc tank test is now scheduled to start the end of September.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-5 HYDRAULICS LABORATORY 0V0789 (D.S. Gabriel)	This facility consists of a high pressure fluorine-oxygen system installed in a 38' diameter steel containment vessel. A test section is installed between a supply and receiver tank, and fluorine, oxygen, or mixtures of fluorine and oxygen, are passed through it. The system is capable of working with seven cubic feet of liquid at pressures to 400 PSI.

On August 3, 10, 17 and 25, spill tests were made with FLOX. These tests involved spilling from five to ten pounds of several liquid oxygen-fluorine mixtures onto various test media. The purpose of these tests was to determine the hypergolic reactivity of FLOX and to see how this reactivity affected dispersion of the toxic products. A total of 24 spills were made into the following media: Water, JP-4, sand, charcoal, limestone, asphalt, dirt, water-soaked sand, JP-4 soaked sand, coke, oil-soaked sand and concrete. Data was in the form of photographic and meterological information. Several severe reactions caused minor equipment damage, but this did not interfere with normal run scheduling.

Some progress was made in building up the high pressure flow system. The completion date for this rework has been rescheduled from September to October.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 PSI. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Most of the effort this month was devoted to liquid nitrogen flows in the liquid hydrogen system for fire valve controller checkout. The trouble in the main electronic timer which developed in August was corrected and on Sept. 10 and 15, several cold flows were made. Severe instability was encountered on both days at all conditions of tank pressures and flow rates. Reduction of the data showed need for a smaller trim in the fire valve. The valve was removed, a new plug and seat were made in the Machine Shop, and the valve was reinstalled. On Sept. 23, with the valve C_v reduced to almost half, another series of cold flows was made. The result was stability over a wide range of tank pressures and flow rates. Insertion of a restriction in the flow lines on Sept. 24, to simulate engine cooling tube pressure drop, had no apparent effect on performance stability.

On Sept. 30, several runs with liquid hydrogen were made to check out the entire engine cooling system. Good, stable performance was obtained from this controller over a range of tank pressures from 600 to 900 PSIG. The burnoffs also performed satisfactorily.

Considerable work was expended on the liquid oxygen system. The flow line was completely reworked to provide proper inlet conditions to each of two flow measuring devices. It was felt that the poor comparison of measurements from these devices was partly attributable to poor inlet conditions. The entire LOX system was also extensively cleaned by the flushing of NA500, and most of the valves were rebuilt. Upon reassembly liquid nitrogen flows will be scheduled for re-comparison of the flow measuring devices.

The 5000 PSI gaseous hydrogen trailers were being cleaned by Dow Industrial Co. during the last week of September. Sufficient parts are on hand for the reassembly of one of these trailers. Following this, performance tests with gaseous nitrogen at 3000 PSIG will be made.

One other event to be scheduled prior to the installation and cold flows of the LH_2 engine will be a hot firing using a steel engine. The purpose will be a final performance check of all propellant systems, supporting equipment such as the controller, and operating procedure.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-2 LIQUID HYDROGEN FACILITY OR0137 (I.A.Johnsen)	This is a liquid hydrogen facility capable of handling 145 pounds of liquid hydrogen at 250 psi.

Rebuilding of the cell was accomplished this month in preparation for acceptance tests to be run on the five foot test tank for the Cryogenic Propellant Tank Laboratory.

Modifications included:

1. Removal of old LOX tank and equipment.

2. Tubing in a new fill system including necessary purges and tank pressurization equipment.

3. Rebuilding of the vent system.

4. Installation of preliminary instrumentation.

Final cell modifications will be possible when Contractor-furnished equipment and attendant instrumentation becomes available.

A liquid nitrogen checkout, followed by a liquid hydrogen checkout, is planned for early October. First research runs are expected to commence sometime in December 1964. Additional checkout runs may be made prior to this date to validate instrumentation system operation.

		J-3 VACUUM ENVIRONMENT FACILITY OR0399 (S. S. Manson) PG0852 (I. A. Johnsen)	This facility consists of a "zero leakage", high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

Activity in the Test Cell has been limited during this month due to a lack of a firm research testing schedule, and demands of other test cells in the area. Minor modifications accomplished during this reporting period include the painting of the vacuum chamber and the LN_2 flash tank. All cryogenic lines have been insulated and covered during this month.

Several modifications to the Test Cell have been initiated this month. A proposal for extending the entrance of the Test Cell has received budget approval and is now being designed by the Civil Engineering Branch. A Purchase Request for caulking and painting of the

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SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		Test Cell has been prepared and is presently out for bids. A cost estimate for upgrading of the electrical equipment of the Cell to conform with accepted hydrogen environment conditions has been obtained. This proposal is now pending budget approval. These three modifications will greatly improve the operating conditions and safety of the Cell under long duration cryogenic insulation tests. The next scheduled test is a foil insulated double-guarded calorimeter as developed by the Materials and Stresses Division's Structures Protection Section. The anticipated testing date would be in late November or early December. Contract negotiation with Arthur D. Little, Inc. has provided funding for testing of two A. D. Little calorimeters in this fiscal year. The testing period dates for these tests have not yet been established.
		J-4 TANK TEST FACILITY OG0851(I.I.Pinkel & S.S.Manson) OR0399(I.A.Johnsen)	A facility to study liquid hydrogen tank insulation. No manpower was expended in this facility during the month of September. Work will resume upon the arrival of the second Centaur arc tank. The tank is scheduled to arrive at Plum Brook about the middle of October.
		J-5 HYDRAULICS LABORATORY OV0789 (D.S.Gabriel)	This facility handles up to 175 pounds of FLOX in various concentrations at pressures from 0-1500 PSIG, in both liquid and gaseous state. Specimens are tested under flow conditions for capabilities to withstand high fluorine concentrations, high flow velocities. The system also has an attached spill unit capable of spill testing with up to 30 pounds of FLOX. On September 1, 1964, two LOX spill tests were completed. The purpose of the tests was to determine the relative times between LOX and FLOX when spilled in JP-4 to simulate a launch pad accident. On the second test, a detonation on the spill pad occurred. The spill test equipment was damaged to some extent. Since the spill test data was complete, the damaged equipment was not rebuilt. Work began immediately on rebuilding the FLOX compatibility rig to resume liquid flow testing of non-metallic specimens at 1500 PSIG. Twenty-eight valves, two spool pieces, several

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		special fittings, and all test section fittings and holders were hydrostatically tested to 2250 PSIG. The high pressure tank was installed and the valves mounted in place. A complete rewiring and retubing was done to accommodate the new system and repair usable parts of the original low pressure system. A LOX checkout run was made on September 28 to verify operation of the automatic controller on the liquid system and check all system functions. Minor repairs were made and following a complete system retorque, runs will begin in early October.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

The liquid oxygen system was reassembled early this month and flow tests with liquid nitrogen were made on October 10 and 19 for cold shock and flow meter comparison purposes. These tests showed differences in weight flow measurements of approximately one per cent between a venturi and turbine type flow meter. These differences were considered satisfactory, since they were within the accuracies of the instruments.

In the September liquid hydrogen and nitrogen tests, the hydrogen tank liquid level optical type spot sensors were inoperative. When the liquid sensors were inspected, it was found that they had come apart in the tank. The entire liquid hydrogen flow system, upstream of the liquid hydrogen fire valve, was disassembled and inspected for the missing components. This was done to insure that the missing parts could not block the liquid hydrogen coolant passages in the engine. Different type sensors were installed but showed unsatisfactory operation during checkouts on October 21 and 29. These units are being re-checked at the present time.

The 5000 psi gaseous hydrogen trailer, No. 48, has been completely reassembled and pressure-checked to 3000 psi with gaseous nitrogen. On October 21 and 29, performance checks were made of the trailer and regulator assembly. The data indicates satisfactory pressure regulation with fairly good response characteristics.

A steel engine with a copper face injector assembly has been installed in the thrust stand for a hot firing scheduled for the first week of November.

NOTE: During November, the hydrogen gas trailers will be performance-checked to 5000 psi with nitrogen and hydrogen gas. Also, the liquid hydrogen-cooled engine will be installed in preparation for liquid nitrogen cold flow tests.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-2 LIQUID HYDROGEN FACILITY OR0137 (I.A. Johnsen)	This is a liquid hydrogen facility capable of handling 145 pounds of liquid hydrogen at 250 psi.
		On October 26, a successful liquid nitrogen checkout was made. Equipment was checked, boil-off and warm-up information was obtained. NOTE: The liquid nitrogen checkout was delayed due to the late delivery of the new burst discs, leaky regulators, and delays in the instrument installation. Preparations are now being made for a liquid hydrogen checkout run which is scheduled for mid-November. Instrumentation is being installed for the research runs which are scheduled for December.	
		J-3 VACUUM ENVIRONMENT FACILITY OR0399 (S. S. Manson) PG0852 (I. A. Johnsen)	This facility consists of a "zero leakage", high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.
		No manpower was expended in this facility during the month of October. Personnel will be assigned to the test cell as soon as a test date is established for the double-guarded calorimeter.	
		J-4 TANK TEST FACILITY OG0851 (I.I.Pinkel &S.S.Manson) OR0399 (I.A.Johnsen)	A facility to study liquid hydrogen tank insulation.
		No manpower was expended in this facility during the month of October. Work will resume about the middle of December after the second Centaur tank is delivered.	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

The November 3 run was canceled because of instrumentation difficulties.

On the November 9 run, two hard starts were experienced during preliminary ignition tries and since other difficulties had extended the operation time beyond the allotted work hours, the run was cancelled after these two starts.

On November 13, three successful ignition tries were accomplished.

On November 18, a successful series of steel engine hot firings were made with good performance from all systems. During these firings, liquid hydrogen was flowed through an engine bypass line to simulate the operational conditions that would be encountered in the liquid hydrogen-cooled engine. Since the tests were successful, no further steel engine firings will be made.

During the early November performance tests on the 5000 psi gaseous hydrogen trailer, leaks developed at three flanges, causing a delay in the testing. The necessary repair parts were received on November 23, and the trailer was reassembled. The performance checks at 5000 psi with both gaseous nitrogen and gaseous hydrogen will be done in December.

The instrumentation groups are working on the liquid hydrogen cooled engine instrumentation system. The delivery of the gold-cobalt thermocouple amplifiers was extended to December 2 and this will cause a delay in the system completion. The engine is scheduled to be installed in late December.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-2 LIQUID HYDROGEN FACILITY OR0137 (I. A. Johnsen)	This is a liquid hydrogen facility capable of handling 145 pounds of liquid hydrogen at 250 psi.
		During November, no work was accomplished in this area. A liquid hydrogen checkout is scheduled for December. The "K" Site five-foot tank is scheduled to be installed and tank testing started by the end of December.	
		J-3 VACUUM ENVIRONMENT FACILITY OR0399 (S. S. Manson)	This facility consists of a "zero" leakage", high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.
		During November, no work was accomplished in this area. The double-guarded calorimeter tank tests are scheduled to start in mid-March.	
		J-4 TANK TEST FACILITY	A facility to study liquid hydrogen tank insulation.
		No manpower was expended in this facility during the month of November. The test program scheduled for "J-4" has been cancelled and there are no immediate tests planned for this facility.	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-5 HYDRAULICS LABORATORY 0V0789 (D.S. Gabriel)	This facility handles up to 175 pounds of FLOX in various concentrations at pressures from 0-1500 psig, in both liquid and gaseous state. Specimens are tested under flow conditions for capabilities to withstand high fluorine concentrations, high flow velocities. The system also has an attached spill unit capable of spill testing with up to 30 pounds of FLOX.

Following the October 30 run, contaminated portions of the system were cleaned and rebuilt. In the interest of safety, all high-pressure valves were removed, checked, rebuilt, and reinstalled. The bellows seal helium supply system was also rebuilt. Preparations were made for the next run and test specimens installed.

On November 20, fourteen runs with fluorine and FLOX (80% fluorine) were made. All test sections burned out at flow rates to 2.1#/sec. and pressures to 1100 psi. Little system damage occurred but the flow lines were contaminated. The contaminated lines are being cleaned and similar high-pressure liquid tests are scheduled for December 10.

The high-pressure liquid testing is scheduled to be completed by early January. The cell will then be converted for high-pressure gaseous FLOX testing.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425(N.D.Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 PSI. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Most of the effort this month was devoted to cell modification and performance checking of the Feedback System's 5000 PSI GH_2 trailer regulator.

All leaks in the 5000 PSI GH_2 system that had developed during November were repaired and another series of checks were made with 2500 PSIG GN_2 on December 3. For these tests, an Apco pressure regulator was installed in the flow line. Since this regulator is required for low chamber pressure rocket engine firing, a check was needed to determine if there would be any interacting effects between regulators. The seat of the Feedback regulator leaked at outlet pressures above 1000 PSIG but it was considered within acceptable limits. During sixteen tests the Feedback regulator performed satisfactorily at varying flow rates from 6#/second to 18#/second and the data showed no interaction between the regulators.

On December 12, the trailer was pressurized to 4900 PSIG with GN_2. When full trailer pressure was put into the Feedback regulator, the seat leakage was so excessive that the performance check had to be canceled. The regulator was disassembled and it was found that the main operating parts had been damaged. The damaged parts were repaired by the machine shop. A survey of other Company regulators is being made for possible replacement of the Feedback regulator.

On December 17, the continuous liquid level probe, with a new control unit, and the liquid level spot sensors were checked with LN_2 in the LH_2 tank. Both units performed satisfactorily.

The instrumentation group continued their work on the liquid hydrogen cooled engine instrumentation. The gold cobalt thermocouple amplifiers were delivered on December 28 and are now being acceptance checked.

NOTE: The research rocket engine is now scheduled to be installed by mid-January.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-2 LIQUID HYDROGEN FACILITY OR0137(I.A.Johnsen)	This is a liquid hydrogen facility capable of handling 145 pounds of liquid hydrogen at 250 PSI.

Preparations were made for the LH_2 check-out. The test capsule is now scheduled to be delivered January 11. Final mechanical,electrical and instrumentation work cannot be completed until the test capsule has been installed.

J-3 VACUUM ENVIRONMENT FACILITY OR0399 (S. S. Manson)	This facility consists of a "zero" leakage, high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

No manpower was expended in this facility during the month of December. Preparations for the double-guarded calorimeter are scheduled to begin by mid-January. The double-guarded calorimeter tests are scheduled for mid-March.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-5 HYDRAULICS LABORATORY	This facility handles up to 175 pounds of FLOX in various concentrations at pressures from 0-1500 PSIG, in both liquid and gaseous state. Specimens are tested under flow conditions for capabilities to withstand high fluorine concentrations, high flow velocities. The system also has an attached spill unit capable of spill testing with up to 30 pounds of FLOX.

During the first two weeks of December the following measures were taken to prevent premature test specimen burnouts:

(1) The 'J' Site Helium manifold was cycle flushed with tri-chloroethane through a five micron filter.

(2) All the fluorine and helium equipment including the tanks, tubing, fittings, and valves were disassembled, cleaned and reinstalled using fluorine clean procedures.

On December 15, seven runs were made. Three test specimens experienced premature burnouts, one showed surface reaction from a previous run, one specimen cracked due to shock and could not be tested. Investigation showed particles in the helium system so the following steps were taken:

(1) A five micron filter and a cold trap were installed in the test section helium purge line.

(2) The test specimens were cleaned, examined with a magnifying glass and the cleaning solvent evacuated from the pores of the specimens.

(3) Specimen holders were cleaned and examined during specimen installation.

(4) To check pickling effects, two of the specimens were not pickled.

On December 23, six tests were made on four specimens. All specimens burned out prematurely. A fifth specimen which was not tested was examined and found to have metallic particles on its surface.

NOTE: Further helium purge system modifications and procedural changes will be made before the next checkout run which is scheduled for January 6.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425(N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

During January various mechanical system modifications were made to the test cell.

Due to the fact that the GH_2 Apco regulator had a sluggish response and minor seal leaks, it was decided to install a new Apco regulator. On January 27, the new unit was checked at various weight flows. It had sluggish response characteristics that were worse than the original unit plus the fact that it had a considerable overshoot of pressure on shutdown. Therefore, it was decided to reinstall the original Apco regulator.

The Feedback Systems regulator has been modified, rebuilt and reinstalled on the 5000 psi GH_2 trailer. The regulator has been pressure-checked to 3000 psi with GN_2 and if time permits, it will be checked out before the cooled engine is installed on February 6.

The vacuum system for both the fuel system and the engine cooling system was extensively reworked so that better vacuums could be obtained.

The liquid hydrogen-cooled engine instrumentation work was continued through January. All of the procured equipment was delivered by mid-January. Based on the remaining workload and assuming no major instrument operational problems are encountered, the first engine cold flow tests are scheduled to begin by mid-March.

NOTE: As noted above, the scheduled start date has been changed from January 15 to March 15.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-2 LIQUID HYDROGEN FACILITY OR0137(I.A.Johnsen)	This is a liquid hydrogen facility capable of handling 145 pounds of liquid hydrogen at 250 psi.

During January, one liquid hydrogen tests was made on the "K" Site research tank bottom package.

On January 12, the package was installed. Necessary piping and electrical work were completed by the 19th and a one hour warm helium check indicated that the seal configuration met the warm requirements. Its leak rate was approximately 5×10^{-9} cm^3/sec., at a seal differential pressure of 175 psi.

On January 21, a liquid hydrogen run was made. No leak larger than 1×10^{-6} cm^3/sec. was recorded. Greater mass spectrometer sensitivity could not be achieved because of an internal electrical drift. An attempt to obtain higher sensitivity by using helium was not successful. Due to possible external leakage sources, the recorded leaks could not be definitely traced to the internal seals.

Modifications to the leak detector and piping systems were made to eliminate the high background readings and to increase the leak sensitivity of the mass spectrometer.

NOTE: The run scheduled for January 28 had to be canceled because of a vacuum pump failure and the non-availability of liquid hydrogen. The next test is scheduled for the first week of February.

		J-3 VACUUM ENVIRONMENT FACILITY OR0399 (S. S. Manson)	This facility consists of a "zero" leakage, high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

No manpower was expended in this facility during the month of January. Build-up for the double-guarded calorimeter will begin in early February. The double-guarded calorimeter tests are tentatively scheduled to start in April.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-5 HYDRAULICS LABORATORY (OV0789) (D.S.Gabriel)	This facility handles up to 175 pounds of FLOX in various concentrations at pressure from 0-1500 psig, in both liquid and gaseous state. Specimens are tested under flow conditions for capabilities to withstand high fluorine concentrations, high flow velocities. The system also has an attached spill unit capable of spill testing with up to 30 pounds of FLOX.

A run was made on December 23, to see if the premature burnouts experienced in November had been eliminated by system modification. Premature burnouts were still experienced and the following additional modifications were made:

(1) A separate high pressure helium source was installed.

(2) A new dryer was added to the system.

(3) A sintered bronze filter was added.

(4) A filter was added to the test specimen purge line.

(5) All upstream bellows were flushed with filtered solvent

(6) The cold trap was removed from the helium purge line.

(7) The specimens were cleaned and surfaces evacuated to 30 microns.

(8) The purge system and check valves were cleaned and inspected at the test site.

(9) The entire flow system and high pressure helium system was dismantled and cleaned.

(10) The system was pickled for fourteen hours and the specimens for thirty minutes.

The January 12 run had to be canceled when three test specimens cracked while being immersed in LN_2. The January 14 run was canceled because there was an indication that the F_2 tank had developed a high pressure leak. On January 19, 14 runs were made on Teflon specimens. One specimen ran to its expected burnout point while the other three burned out prematurely. The last specimen was inspected and metallic particles were found on its surface.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	(Continued)	Using laboratory filter equipment, extensive samples were again taken from every conceivable point in the helium and F_2 flow system. All helium components were disassembled and inspected. The worst item appeared to be the brass particles from a Grove regulator in the helium purge system. The system will be reassembled using ultra clean methods and the Grove regulator will be replaced by an all aluminum unit. The next run is scheduled for February 2.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425 (N. D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

The regulator for the 5000 psi gaseous hydrogen trailer was reassembled and installed on the trailer; however, the regulator still has to be tested.

On February 1, the steel engine was removed from the stand and the liquid hydrogen-cooled engine was installed. The system for evacuating the liquid hydrogen engine instrumentation housings was completely reworked. Provision for remote isolation of each vacuum chamber and for the recording of the individual vacuums was added as requested by research engineers. All mechanical connections to the engine were made, including the liquid hydrogen coolant flow lines to the vacuum chambers, pressure transducers, and temperature probes. Considerable time was involved in locating and repairing leaks in the engine vacuum chambers. The liquid hydrogen system was pressure checked to 800 psig. Three valves required overhaul due to adverse weather effects. The liquid hydrogen engine manifold and tubes were pressure checked to 200 psig and a small leak was found in the wrap around the tubes.

The instrumentation system for recording the liquid hydrogen engine temperature data has been completely installed and checked out. The lines to "H" Building have been checked for noise, continuity, and patching.

On February 23, a tape recording of all channels of data on the 4 KC digitizer was reviewed by Lewis Research personnel. They expressed satisfaction with the noise level; therefore, the first liquid nitrogen cold flow through the liquid hydrogen engine was scheduled for March 3. One problem with the special platinum resistance balance panels has to be corrected prior to the March 3 run date. There is excessive voltage output when the sensor is at ambient temperature.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-2 LIQUID HYDROGEN FACILITY OR0137 (I.A. Johnsen)	This is a liquid hydrogen facility capable of handling 145 pounds of liquid hydrogen at 250 psi.

On February 2, a liquid hydrogen test was made on the "K" Site tank bottom feed-through package. Hydrogen sensitivity of 5×10^{-8} cm^2/sec was possible during this test, due to the successful modifications of the test cell and the mass spectrometer. Shortly after initiating transfer, a cold gas leak in excess of 3×10^{-6} cm^3/sec was recorded at a 40 psig pressure, but after the tank bottom was covered with liquid, the leak decreased. Shortly after pressurizing the tank to 175 psia, a leak of 5.6×10^{-6} cm^3/sec developed. This leak "cleaned up" and subsequently reappeared when the tank was vented and then repressurized. An attempt to heat cycle the package was unsuccessful due to the inability of the mass spectrometer to pump down the cold chamber to a stable pressure.

On February 4, the warm package was pressurized with helium to 175 psia. A sniffer probe with a maximum sensitivity of 1.5×10^{-7} cm^3/sec was used to detect any leakage source. Negative results were obtained on all welds and outer seals, but both inner conoseal rings showed leaks of approximately 1.5×10^{-4} cm^3/sec. The package was then disassembled for shipment back to the contractor. The bolt torques were checked and were found to be from 70% to 80% below pre-run values. This check was made after several heat cycles had taken place.

An instrumented test section with a modified bolting arrangement is due early in March. Twenty days have been allocated for testing this package.

		J-3 VACUUM ENVIRONMENT FACILITY OR0399 (S. S. Manson)	This facility consists of a "zero" leakage, high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

Preliminary modifications to the test cell for the double-guarded calorimeter test program were initiated this month. Modifications to the cell and checkout included:

(1) Installation of a 4" emergency vacuum chamber over-pressure line.

(Continued on Page 28)

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		

J-3 VACUUM ENVIRONMENT FACILITY (Continued)

(2) Leak-tightness checkout of the vacuum chamber.

(3) Initial fabrication of fill and vent probes for double-guarded calorimeter.

(4) Sizing of a control valve for rocket ascent simulation tests.

(5) Ordering of all hardware required for test support.

The double-guarded calorimeter testing is scheduled to start the middle of April.

J-5 HYDRAULICS LABORATORY (OV0789) (D.S. Gabriel)

This facility handles up to 175 pounds of FLOX in various concentrations at pressure from 0-1500 psig, in both liquid and gaseous states. Specimens are tested under flow conditions for capabilities to withstand high fluorine concentrations, high flow velocities. The system also has an attached spill unit capable of spill testing with up to 30 pounds of FLOX.

On February 2, 5, 12, and 19, FLOX research runs were successfully conducted. Premature burnouts were eliminated and all run days produced usable data.

On February 2, six runs were accomplished and one high-flow burnout recorded before the facility was shut down due to inoperative valves.

The specimens were replaced and heater wire was installed on the valve heads. The run was completed on February 5. Twenty-one runs, using various concentrations of FLOX, were made on February 5 and five specimen burnouts were recorded.

On February 12, twenty runs were accomplished and five burnouts were recorded. 100% liquid fluorine and 70% FLOX were used during this run.

On February 19, seventeen runs and five burnouts were recorded. 100% liquid fluorine, 70% FLOX and 60% FLOX were used during this run.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
			The February 26 test run was cancelled due to adverse weather conditions causing electrical power failures. This run is rescheduled for the week of March 1, and will complete the current FLOX program. A short test program has been scheduled for the month of April to determine the cause of premature burnouts which occurred during the months of November and December 1964.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		
		J-1 HYDROGEN-OXYGEN 28K ROCKET ENG. PC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		On March 3, liquid nitrogen was flowed through the cooling tubes of the liquid hydrogen-cooled engine. The test goals were to cold shock the engine with liquid nitrogen and to check the calibration of the temperature measuring instrumentation at liquid nitrogen temperatures. Tests were run at tank pressures of 400 psig and 600 psig and weight flow rates were 10.7 lb./sec. and 20 lb./sec.	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS		This was the first time that the engine had been cold shocked and, structurally, the engine showed no harmful results from the liquid nitrogen tests. Both engine coolant temperature measurement systems were unsatisfactory and they provided no usable data. The temperature of the liquid nitrogen in the engine was higher than anticipated and platinum resistor output voltage exceeded full scale. The lead wires of the gold cobalt thermocouples were adding EMF to that produced by the junction, and thereby completely distorted the output data. On March 9, the liquid hydrogen engine was returned to Lewis Research Center for repairs. The entire gold-cobalt thermocouple system was replaced by a chromel-constantine thermopyle system. The platinum resistors will remain, but minor modifications are required. The liquid hydrogen engine was returned to Plum Brook on March 29. Reassembly and installation began immediately in preparation for a liquid hydrogen cold flow through the cooling tubes scheduled for April 2. Hot firing of the engine is scheduled for mid-April, if the liquid hydrogen cold flow data is satisfactory. The new APCO regulator, which had shown sluggish response characteristics during initial tests in January, has been disassembled and modified. The outlet pressure sensing circuit has been altered to increase sensitivity during low flow rates. On March 29, several flow checks were made, showing much faster response of the regulator. This regulator will be used for the first hot firing of the liquid hydrogen engine. The Feedback Systems regulator that had been previously rebuilt was used for the above flow checks. Excessive seat leakage was still a major problem. A survey of the field of large pressure regulators has resulted in the ordering of a unit from Sky Valve, Inc., of Syracuse, New York. Delivery is expected within two months. This unit will replace the existing Feedback Systems regulator for one of the 5000 psi gaseous hydrogen trailers. If this first regulator gives satisfactory performance, a second unit will be purchased for the remaining high-pressure trailer. The remainder of the month was devoted to cell maintenance and general preparation for the first hot firing of the liquid hydrogen cooled engine. A new porous-face injector was also backflushed with NA-500 solvent.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS	J-2 LIQUID HYDROGEN FACILITY OR0137 (I.A. Johnsen)	This is a liquid hydrogen facility capable of handling 145 pounds of liquid hydrogen at 250 psi.

The instrumented test package was received on March 9 at Plum Brook. A warm helium check on March 12 indicated that a leak in excess of 10^{-4} cm^3/sec. was present. On March 13, the package was dismantled and tested with a portable probe. No leaks greater than allowed by the specifications were found on the conoseals or on fourteen of the fifteen instrument connectors. One feed-through connector was found to have a faulty weld with a leak in excess of 10^{-5} cm^3/sec. The package was returned to the contractor in California for repair.

Repairs cannot be made until a new feed-through connector is available. Since the lead time will be approximately 10 days, the capsule will not be available for testing at Plum Brook until approximately April 10.

		J-3 VACUUM ENVIRONMENT FACILITY PG0852 (S. S. Manson) OR0399 (I.A. Johnsen)	This facility consists of a "zero" leakage, high vacuum tank for testing insulated liquid hydrogen tanks in low pressure environment. The effectiveness of various types of insulation on liquid hydrogen tanks is to be studied.

The test facility is undergoing modification and checkout for the double-guarded calorimeter tests. The calorimeter is scheduled to be delivered the second week of April, and testing will probably begin the first week of May.

The following tasks were completed during this reporting period:

(1) Dewar H-30 was derimed and evacuated. The rate of vacuum rise was monitored and results indicate that the vacuum jacketing is sound.

(2) Initial fill and vent modification were started on the dewar to make it compatible with the research program.

(3) Designs and procurement for the missile ascent simulation portion of the test program were completed.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOF)	DESCRIPTION
J	ROCKET SYSTEMS		

All of the required parts are scheduled to be delivered by April 30.

(4) The vacuum chamber emergency vent system was installed and checked out.

Lewis personnel have indicated a need for the test facility to conduct tests under a newly issued contract with Arthur D. Little Company. The tests are tentatively scheduled for the 1st and 3rd quarters of FY66.

J-5 HYDRUALICS LABORATORY

0V0789
(D.S. Gabriel)

This facility handles up to 175 pounds of FLOX in various concentrations at pressure from 0 - 1500 psig, in both liquid and gaseous states. Specimens are tested under flow conditions for capabilities to withstand high fluorine concentrations, high flow velocities. The system also has an attached spill unit capable of spill testing with up to 30 pounds of FLOX.

On March 1, thirteen research runs were made on five test specimens. Although flow rates of 4 lb/sec and pressures of 1000 psi were reached, three of the burnouts were classed as premature, based on previous data.

On March 19, a run was made to determine if metal particle contamination was the cause of premature burnouts. Five teflon test samples were prepared. Two were left uncontaminated. The other three samples were deliberately contaminated with brass filings, stainless steel filings, and a combination of brass and stainless steel, respectively. Only one premature burnout was encountered. The other burnouts occurred far beyond previous data in flow rate and concentration. It appears that metal particles have not been the cause of the consistent failures experienced during December 1964 and January 1965. Further metal contamination tests have been suspended.

On March 30, the final research run was made, completing the Lewis Research Center program. In this test, the five specimens were burned out during 33 runs, with 70%, 75%, and 85% FLOX concentrations and 100% LF_2. The test cell will be deactivated and maintained on a standby basis.

SITE	LOCATION	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES		
J-1	ROCKET ENGINE SITE		
		28K ROCKET ENGINE PC0425 (N.D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On April 6, a liquid hydrogen cold flow test on Engine #1 was attempted. Flow conditions were approximately five pound/second for 15 seconds with a tank pressure of 700 psig. The test was aborted due to excessive hydrogen leakage from the engine cooling tubes during the pre-cool flow. Post run pressure checks revealed cracked solder joints in the vacuum chamber connections, an opening at one location in the engine wrap, and some small leaks in the joint between the cooling tubes and the exit manifold. No conclusive engine temperature data was obtained from either the new Chromel-Constantan thermocouples for the previously installed platinum resistors.

Five additional days of cold flows were made this month for the purpose of proving the temperature measuring instrumentation. Because the test engine was known to leak, liquid nitrogen was used, eliminating possible fire hazard.

On April 15, data was obtained which showed that the Chromel-Constantan thermocouples were operating properly.

Examination of the recorded temperatures showed that the results were strongly influenced by the methods used to install the thermocouples.

The remaining four run days were devoted to obtaining data from the platinum resistors. On April 26, the sensors performed satisfactorily.

On April 27, the liquid hydrogen Engine #1 was removed from the test stand and returned to Lewis Research Center. Tentative plans are to discard the present method of attaching the temperature measuring instrumentation to the outside of the engine cooling tubes. Work is presently

SITE	LOCATION	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
			underway to determine the best method of installing the Chromel-Constantan thermocouples directly into the liquid hydrogen flow in the cooling tubes. Engine #1 will be used as a test unit for this installation. Liquid hydrogen-cooled Engines #2 and #3 were brought to Plum Brook this month for pressure checking. A small leak in the cooling tubes of Engine #2 could not be located during preliminary low pressure gas checks. A leak around one tube pressure tap on Engine #3 was repaired and the engine then proved to be pressure tight. Following a cold shock in a liquid nitrogen bath on April 27, both engines were hydrostatically pressure checked to 900 psig with helium. Small leaks at tube pressure taps in both engines showed up at approximately 600 psig. Leakage was also observed from the cooling tubes into the voids beneath the engine wrap on Engine #2. This engine was returned to Lewis Research Center on April 30. Engine #3 was satisfactorily repaired and is now leak-tight at 600 psig with helium gas. Engine #3 is scheduled to be cold shocked with liquid hydrogen during the first week of May. Following satisfactory performance during this test and a post run high pressure gas check, it will be returned to Lewis. Liquid hydrogen temperature measuring instrumentation will then be installed. Engine #1 will then be cold flowed with liquid nitrogen to check the thermocouples installed directly in the liquid hydrogen flow in the cooling tubes. No tentative date has been set for the first hot firing of a liquid hydrogen-cooled engine.
J-2	LIQUID HYDROGEN TEST STAND		
		"K" SITE TANK TESTS OR0137(I.A.Johnsen)	Tests are to be run on a instrumented tank bottom for a 13-foot diameter test tank.
			Failure of the "K" Site, 13-foot diameter, tank during hydrostatic testing at the contractor's plant delayed shipment of the test fixture until April 28. Therefore, J-2 hydrogen testing will not be possible until early May. On April 12, a leak test was made on NASA serrations. The test fixture utilized a 2-inch 150 psi stainless steel blind flange. The "standard" four concentric serrations were

(Continued on Page 28)

SITE	LOCATION	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES		

J-2 LIQUID HYDROGEN TEST STAND

"K" SITE TANK TESTS (Continued)

sealed with a Schedule 80 dead soft aluminum gasket. The serrations had a 8.3 X 10^{-7} cm^3/sec chilldown (cold gas) leak rate; once liquid hydrogen covered the flange, no leak larger than 5 X 10^{-8} cm^3/sec. was detected (maximum mass spectrometer sensitivity 5 X 10^{-8} cm^3/sec.). The test was run for 26 minutes at 175 psid and for 44 minutes at 265 psid.

J-3 VACUUM ENVIRONMENT TANK

TANK INSULATION TESTS
PC0852 (S. S. Manson)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

The double-guarded calorimeter test program has been delayed approximately two to four months due to a calorimeter failure during hydrostatic testing by the NASA contractor. Since this type of failure may be repetitive, a redesign of the calorimeter may be required.

The following tasks were completed during this reporting period:

(1) The H-30 storage dewar has been modified into a research dewar for "J-3" cell.

(2) Vent lines for the H-30 dewar and cold guard vent lines were completed.

(3) The dewar pressurizing and vent purge panels were completed.

(4) The water environment system was checked out. The water was heated from 45° F. to 95°F.

(5) Fabrication of the controlled evacuation rate plumbing was initiated. This will enable the vacuum chamber pressure to be controlled to simulate the ascent of a missile for a 90-second period.

(6) Assembly and checkout of an absolute back pressure regulation system for the calorimeter and cold guard vents were initiated. This system, using mercury reservoirs, will dampen changes in atmospheric pressure by a factor of 150.

SITE	LOCATION	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D. Sanders)		A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The objective is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On May 7, liquid hydrogen was flowed through the cooling tubes of Liquid Hydrogen Engine #3. A total of five runs was made. Tank pressures ranged from 200 psig to 700 psig, and liquid hydrogen weight flows from 5 to 20 lb/sec. There was no evidence of any hydrogen leakage during these tests. A post-run gas pressure check showed a minor leak had developed at a cooling tube pressure tap joint. This is a silver solder joint and is repairable. The engine was then returned to Lewis for installation of temperature measuring instrumentation.

On May 20 and 21, liquid nitrogen was flowed through the cooling tubes of Liquid Hydrogen Engine #1. This engine had been returned from Lewis with chromel-constantan thermocouples installed in the liquid flow in the cooling tubes. No conclusive temperature data was obtained from these tests. The delta-temperature measuring setup gave answers of as high as 6° when a reading of zero should have been obtained.

On May 28, liquid nitrogen was flowed through a small section of a liquid hydrogen-cooled engine. Approximately 25 feet of copper tubing to the test piece inlet was immersed in liquid nitrogen in an attempt to recondense any gas in the liquid nitrogen flow stream. Three difference test setups were tried: first, the test section was completely immersed in a liquid nitrogen bath; second, the test section was left in the atmosphere with no liquid nitrogen around it; and third, the test section was left in the atmosphere, but liquid nitrogen was flowed into an insulated box around the thermocouple installation. A maximum of 0.25 degree ΔT was recorded during any of the above tests. These results indicate that previous test results may have been distorted by at least two factors: first, vapor may have been in the

SITE	LOCATION	RESEARCH INSTALLATION & DESCRIPTION
J	ROCKET SYSTEM TEST SITES	
		liquid stream to the test pieces; and second, the thermocouple junctions may not all have been at the same temperature. Further tests are being planned to eliminate these variables and their effects. Based on the above-mentioned test results, emphasis has now been placed on performing some smaller-scale tests. Their purpose would be to evaluate various methods of thermocouple installation, insulation of the units from ambient conditions, and data readout methods. Full scale engine testing may be temporarily halted until satisfactory results are obtained from the small-scale tests.
	J-2 LIQUID HYDROGEN TEST STAND	
		"K" SITE TANK TESTS OR0137(I.A.Johnsen) — Tests are to be run on an instrumented tank bottom for a 13-foot diameter test tank. Several warm helium checks of the "K" Site test fixture were made in early May. Leak indications were sometimes evident, but no definite source could be located. An attempt was made on May 11 to test the package in liquid hydrogen. Shortly after chilldown, the mass spectrometer indicated full scale reading. The test was terminated when the capsule vacuum rose significantly. The conoseal gaskets were replaced when leakage was detected at the inner seal tap. Further testing with a special probe, after an extended period of pressurization, revealed that five instrument connectors were leaking beyond specification limits. One leak was in excess of 3×10^{-5} cm/3/sec. The package is being shipped back to Lockheed for repair, or redesign and rework.

SITE	LOCATION	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEM TEST SITES			
	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS PC0852(S. S. Manson)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		Due to the failure of the double-guarded calorimeter during hydrostatic testing, the manpower expended in this test cell has been marginal. However, the following tasks were completed during this recording period:		
		(1) The mercury constant backpressure system has been completed. The accuracy of this sytem will be verified upon the procurement of an accurate manometer. Another constant backpressure system based on the "Cartesian Diver" principle will also be tested to establish the advantages of each system.		
		(2) Initial checkout of the controlled evacuation system was completed.		
		(3) Modifications to the H-30 dewar were completed.		

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425(N.D. Sanders)		A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Two newly-designed high-pressure Bendix optical level sensors were checked out in the facility liquid hydrogen tank. On June 2, the tank was filled with liquid nitrogen and on June 4, it was filled with liquid hydrogen. The tank was pressurized to 1000 psig on both days. The sensors proved to be reliable and will be used in the tank as high-level and low-level indicators.

On June 22, liquid hydrogen was flowed through a small section of a liquid hydrogen-cooled engine. Thermocouples immersed in the stream of liquid hydrogen were terminated on a copper tube in an insulated box. Liquid nitrogen flowing through the copper tube kept the terminations at a constant temperature. A temperature differential measuring system gave results of 0.17 degree . A Delta T of zero should have been obtained. On June 27 and 28, the simulated engine cold-flow test was repeated. The inlet piping to the test piece was changed in an attempt to eliminate any two-phase flow. No appreciable improvement in the data was obtained. Future tests will be performed to try to obtain the Delta T of less than 0.1 degree.

The Flowmatics 5000 psi regulator is being hydrostatically pressure checked and will be mounted on a 5000 psi gaseous hydrogen trailer early in July. Following the installation the regulator will be tested.

SITE	SITE NAME RESEARCH INSTALLATION & DESCRIPTION
J	ROCKET SYSTEM TEST SITES
	J-2 LIQUID HYDROGEN TEST STAND "K" SITE TANK TESTS OR0137(I.A.Johnsen) Tests are to be run on an instrumented tank bottom for a 13-foot diameter test tank. The cell has been put in a "standby" condition, since the contractor's redesigned package is not expected for some time. Related torque relaxation and cryogenic sealing tests are presently being conducted and are showing promising results.
	J-3 VACUUM ENVIRONMENT TANK TANK INSULATION TESTS PCO 852 (S. S. Manson) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. Due to the delay in the test program, manpower expended in this test cell has been very small. A series of tests performed on absolute pressure-controlling devices was inconclusive. Both the Cartesian diver and mercury-compensating devices do compensate for changes in barometric pressure; however, neither was capable of maintaining a constant back-pressure of ± .1 mm of Hg for extended periods as requested by the research engineers. During the weeks of June 21 and June 28, the facility was used to check out vacuum instrumentation for use at "K" Site.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	ROCKET SYSTEMS TEST SITES		
	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE PC0425 (N. D. Sanders)	A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		Most of the testing this month was limited to flowing LN_2 through a small section of a liquid hydrogen cooled engine. The goal was to develop a satisfactory installation of thermocouples designed to measure the temperature difference between two stations one inch apart in the LH_2 flow stream. Various configurations were used in the physical layout of both the thermocouple reference junctions and the copper extension wires in an attempt to eliminate noise and external EMF effects. The results have not been satisfactory. Efforts are still being expended in this direction.	
		The installation of the four-inch Flowmatics pressure regulator on a 5000 psi trailer has been completed and satisfactory pressure checked to 3000 psi. A performance check will be made August 4.	
	J-2 LIQUID HYDROGEN TEST STAND		
		"K" SITE TANK TESTS OR0137 (I.A.Johnsen)	Tests are to be run on an instrumented tank bottom for a 13-foot diameter test tank.
		No manpower was expended in the facility during this report period. Cryogenic sealing and bolt relaxation tests were continued as part of another related experiment.	
		The Lockheed Modified Test Capsule is scheduled to be delivered to Plum Brook in November.	

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEM TEST SITES			
	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS PCO 852 (S. S. Manson)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		Due to the lack of a definitive test program, manpower expenditures in the test cell have been limited to maintenance for this reporting period.		
		Tests on an absolute back pressure device were continued during this month. The Cartesian-Diver device is still not capable of maintaining a constant back pressure of ± 0.1 mm for extended periods. An electrical circuit is being constructed to control the temperature of the device to 0.1°F. to minimize temperature - pressure fluctuations.		

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
	August 1965			
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PCO 425 (N. D. Sanders)		A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		Three days this month were devoted to testing of research hardware. These tests again consisted of flowing LN_2 through a small section of a liquid hydrogen cooled engine. To date, all attempts at accurately measuring a very small temperature difference between two stations one inch apart in the LN_2 flow stream have proved to be unsuccessful. Typical troubles encountered have been excessive drift of thermocouple output, erratic output,		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	false indications of a temperature difference, and inconsistency in the results. A variety of installations have been tried, but none have produced dependable, accurate data. New approaches to the problem are being considered but no definite decision has been made as to the next step in the program. The four-inch Flowmatics pressure regulator installed on a 5000 psi gaseous hydrogen trailer has been performance-checked using gaseous nitrogen. Trailer pressure (regulator inlet pressure) ranged from 5000 psig down to 2000 psig. Flow rates were between 1 and 34 lb./sec. The test results were very encouraging. Leakage through the regulator seat was negligible. Response characteristics were satisfactory. The only difficulty encountered with the regulator was the excessive wear on the Teflon seat. According to the Flowmatics Company, this is not a typical trouble, and a slight change in operating procedure should eliminate this problem. Following the installation of a new seat, the next step will be a complete performance check with gaseous hydrogen.
	J-2 LIQUID HYDROGEN TEST STAND	<u>"K" SITE TANK TESTS</u> OR0137 (I.A. Johnsen) Tests are to be run on an instrumented tank bottom for a 13-foot diameter test tank. No manpower has been expended in the cell this month. No further status reports will be submitted until testing is resumed.
	J-3 VACUUM ENVIRONMENT TANK	<u>TANK INSULATION TESTS</u> PG0852 (S.S. Manson) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. It is expected that at least two months will be required before the calorimeter is insulated and delivered to Plum Brook. Tests continued this month on an absolute backpressure device. The Cartesian diver manostat was found to be capable of maintaining a constant backpressure of 0.5 mm for extended periods.

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SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-5 HYDRAULICS LAB			
		HADLEY VALVE TESTS		Valve tests with liquid fluorine.
		The Hadley valve assembly was tested to a limited extent this month.		
		On August 11, the valve was cycled fifty-one times in liquid fluorine at 20 psi. In spite of the fact that considerable seal leakage was encountered, after testing no visible damage was evident. A decision to continue testing was agreed upon in spite of leakage in both the shaft seal and valve seal.		
		Subsequent attempts to fluorine cycle the valve were unsuccessgul. On August 19, termination of testing was necessitated when an IRC burst and burned following pressurization of the liquid fluorine in the valve assembly. On August 26, the test was terminated when Valve 199 on the fluorine trailer could not be opened because the stem had stripped from the valve yoke.		

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PCO 425 (N. D. Sanders)		A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		The 5000 psi gaseous hydrogen trailer No. 48 was filled with gaseous hydrogen to 3000 psig early this month. Performance checks of the trailer four-inch Flowmatics regulator were then conducted on September 15. Due to pressure pick-up calibration problems the tests results were inconclusive. The performance trends, however, were encouraging, showing good response and stable regulation. Testing was resumed on September 29 with 2500 psig trailer pressure. Investigation of the data showed stable regulation over a wide range of flow rates. Response characteristics looked good, but were obviously affected by the lack of an "accumulator" volume in the dome pressure supply line. An accumulator will be installed before the next checkout runs.			
		The four-inch pressure regulator that was received from the Sky Valve Company of Syracuse, New York on September 21, is now being installed on the remaining 5000 psi		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	gaseous hydrogen trailer No. 47. All electrical hardware on this trailer is being modified to comply with the current safety committee standards. Performance testing of this regulator will start in November. No research hardware testing was done at Plum Brook this month. Small-scale tests were conducted at Lewis Research Center-Cleveland. These consisted of flowing liquid nitrogen through a small section of a liquid hydrogen cooled rocket engine. The problem of measuring a very small temperature differential between two points one inch apart in a liquid hydrogen stream has not yet been satisfactorily solved.
	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS PF0852 (S.S.Manson) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. Fabrication of the copper calorimeter by the Atomic Energy Commission in Paducah, Kentucky is scheduled to be completed October 1. The calorimeter will then be insulated at Linde and the PB test program will be started. Eventually, a self-evacuating type insulation will be developed. The major manpower expenditure in this reporting period has been updating the test cell equipment to Class 1, Group B, Division 1 standards. The cartesian diver back pressure regulator has been approved by the research engineers and is now being incorporated into the calorimeter and cold guard vent systems.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-5 HYDRAULICS LAB	<u>HADLEY VALVE TESTS</u> Valve tests with liquid fluorine. On September 13, testing of the modified Hadley valve was completed. The valve was cycled 2400 times in liquid fluorine at pressures between 20 to 100 psi. The tests were terminated when the valve operator upper bearing seized. Several other deficiencies were encountered. Leakage on both the shaft and flow seals was excessive. The valve could not be opened if chilled down while closed or if a greater than 20 psid existed on the seal. It was also found that the seal had a slight score mark.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PCO 425 (N. D. Sanders)		A hydrogen-oxygen rocket engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Gaseous hydrogen performance checks of the Flomatics regulator on hydrogen trailer No. 48 were conducted at 3 000 psig, on October 5. The test data showed that the slow response characteristics indicated in last month's tests have been satisfactorily corrected by the addition of an accumulator installed in the dome pressure supply line.

The Sky Valve pressure regulator has been installed on gaseous hydrogen trailer No. 47. The installation of the mechanical and electrical hardware should be completed by mid-November.

Three days this month were devoted to testing research hardware. These tests consisted of flowing liquid nitrogen and liquid hydrogen through a small section of a liquid hydrogen cooled engine. The tests were conducted to determine the temperature differential between two points one inch apart in the coolant stream. The results of the tests were satisfactory with both liquid nitrogen and liquid hydrogen flows. The thermocouples will now be installed on the liquid hydrogen cooled engine #3 in preparation for test firing during January.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS PF0852 (S.S. Manson)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		The double guarded calorimeter was delivered to Lewis Research Center-Cleveland on October 12. The calorimeter was helium leak checked on October 28 and sent to Linde to have the insulation installed. It is expected that the calorimeter will be returned to Plum Brook the latter part of December and that the research testing will be started by mid-January.		
		A test on a super-insulated self-evacuating panel is scheduled for December. Panels of this insulation will be bonded to a Centaur arc tank that was tested in J-3 and J-4 Test Cells, two years ago. Phillips discharge vacuum gauges will be attached to the panels to allow pressure monitoring during both the tank fill and the chamber evacuation.		

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D. Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Early this month, the installation of all mechanical hardware on #47 gaseous hydrogen trailer (5000 ps) was completed, and the electrical equipment installation is now almost completed. Depending on the "J-1" test schedule, the initial pressure-checking and operational tests should begin by mid-December.

Liquid hydrogen Engine No. 3 was delivered to Plum Brook November 30. The thermocouple setup which proved satisfactory during October's small scale tests has been installed on this engine. The engine has a total of four instrumentation stations which will measure both the liquid hydrogen temperature and pressure. A "facility shakedown" test, consisting of the hot firing of a steel engine, is scheduled for early December. This steel engine has been installed in the test stand and final hookup of all systems is being completed. Following the "facility shakedown" tests, liquid hydrogen Engine No. 3 will be installed in the test stand, cold flowed and hot fired. The hot firing will occur in late December or early January.

A liquid hydrogen system check was made this month. The liquid hydrogen tank was pressure-checked and filled with liquid nitrogen. Some minor problems were encountered such as leaks through valve seats and body halves. The valves are being repaired.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES (Continued)			
	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS PF0852(S.S. Manson)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		The air-filled semi-panel for attachment to the Centaur arc tank was delivered on November 30. The carbon dioxide backfilled semi-panel is not scheduled to be delivered until the first part of January. Therefore, testing of the conductance capability of the air-filled semi-panel will be done during the month of December, with cryo-pumping tests scheduled for early January.		
		The double-guarded calorimeter is expected to be delivered early in January; however, testing of this tank is dependent upon completion of the semi-panel tests. Therefore, the earliest possible test date is mid-February for the double-guarded calorimeter.		

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	ROCKET SYSTEMS TEST SITES		
	J-1 ROCKET ENGINE SITE		
		28-K ROCKET ENGINE PC0425 (N.D. Sanders)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		On December 10, eight hot firings were made with a rockide-coated steel engine. The objective was a final "facility shakedown" test prior to installing Liquid Hydrogen Engine #3. Although, mechanically the facility functioned properly, the fire valve controller did not supply the desired chamber pressure or the required percent of fuel. Post-run investigation disclosed errors in several phases of the setup of the input signal to the controller. A thorough investigation of the controller gave no indication of malfunctioning of any circuit. Another series of runs, identical in purpose to this set, is scheduled for the first week in January. It is hoped that the Liquid Hydrogen Engine #3 can be installed in the test stand immediately following this next series of tests.	
		No testing was done on #47 gaseous hydrogen trailer (5000 psi) this month. Initial pressure-checking and operational tests should begin by mid-January.	
	J-3 VACUUM ENVIRONMENT TANK		
		TANK INSULATION TESTS PG852 (S.S. Manson)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		Test data has been recorded on the air-filled semi-panel insulation as attached to the Centaur arc tank. The purpose of this test is to determine the conductance capabilities of the insulation panel--i.e., the ability of gases to flow from all regions of the panel while being evacuated.	

SITE	SITE NAME RESEARCH INSTALLATION & DESCRIPTION
J	ROCKET SYSTEMS TEST SITES (Continued) TANK INSULATION TESTS (Continued) Initial tests on this panel insulation were conducted from December 20 to December 22. During this test, an atmospheric compressive load was maintained on the panel. Since an ultimate pressure of 150 microns was achieved, the atmospheric compression on the panel was a major factor in slowing or preventing the flow of gases within the panels. On December 22, the atmospheric compressive load was removed from the panel. Since that time, pressure readings on the panel have steadily decreased. At this reporting time, the pressure is 10 microns. These test conditions will be maintained until January 11, when the Centaur tank will be filled with liquid hydrogen to test the cryo-pumping ability and ultimate vacuum of the panel. A carbon dioxide backfilled semi-panel is scheduled to arrive in mid-January. This panel will be tested only for cryo-pumping ability. If this test does not produce a satisfactory vacuum ($<10^{-4}$ torr), evacuation and subsequent carbon dioxide backfilling of the panel will be conducted at Plum Brook. The double-guarded calorimeter is expected to be delivered in early January; however, testing of this tank is dependent upon completion of the semi-panel tests. Therefore, the earliest possible test date is mid-February for the double-guarded calorimeter.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28-K ROCKET ENGINE PC0425 (N.D. Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		On January 5, four hot firings were made with a rockide-coated steel engine. The objective of the test was a final performance check of all propellant systems, supporting equipment, and operating procedure. The results of the test were satisfactory.		
		The next three weeks were devoted to the installation and pressure checking of liquid hydrogen engine #3 and its supporting equipment. On January 25, three liquid hydrogen cold flows were made. The objectives of this test were to prove the temperature measuring instrumentation and to verify the structural integrity of the engine. An identical instrumentation setup had been checked out previously in a small test section under low pressure and low flow rates. Preliminary investigation of the temperature data showed the results to be satisfactory. The main problem now appears to be the struct-		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	ROCKET SYSTEMS TEST SITES	28-K ROCKET ENGINE (Continued) ural integrity of the engine. Small leaks in the engine caused minor fire damage to some test cell instrument wires. Before another liquid hydrogen test run is made, all exposed wires in the area around the engine will be placed in metal conduit or wrapped with fire and heat-resistant tape. Liquid hydrogen engine #4 is scheduled to arrive at Plum Brook on February 4, for an initial cold shock and high pressure gas leak check. The results of these tests will determine whether engine #3 or #4 will be used for a hot firing. NOTE: Because of the above reasons the hot firing has been rescheduled to March. No testing was done on #47 gaseous hydrogen trailer (5,000 psi) this month. Initial pressure checking and operational tests should start the first part of February, and will take about four weeks.
	J-2	"K"SITE TANK TEST OR0137(I.A.Johnsen) Tests are being conducted on the instrumented tank flange for the "K"Site 13-foot diameter test tank. The K-Site instrumentation lid was returned to Plum Brook on January 10, for acceptance testing. This lid had been at Lockheed for repairs and testing since May 1965. Preliminary warm checks with gaseous helium indicated leakage in two of the 15 connectors. Replacement of the connectors was done at Plum Brook by Lockheed personnel. One of the connectors had to be replaced twice because of excessive leakage. Following repairs, the lid was leak checked in a warm condition and all connectors appeared good. The lid was then cold shocked with liquid nitrogen and another connector failed. The lid has been returned to Lockheed for further re-design and/or repair.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS PG0852 (S.S. Manson)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

During this reporting period, the Centaur arc tank was qualified for testing under vacuum conditions by hydrostatic testing to 33 psi, cold shocking and leak checking.

On January 11, a test run was performed using liquid nitrogen with a gaseous nitrogen chamber purge.

On January 28 a test run was made to determine the ultimate cryopumping ability of the insulation. The insulation pressure was 130 microns prior to liquid hydrogen filling. The final vacuum produced by cryopumping was 1.3×10^{-4} Torr.

The next test run is scheduled for February 1. Test conditions will be liquid hydrogen in the tank with a gaseous nitrogen chamber purge to evaluate ground hold conditions.

A carbon dioxide backfilled semi-panel is scheduled to arrive in early February. This panel will be tested only for cryopumping ability. If this test does not produce a satisfactory vacuum ($< 10^{-4}$ Torr), evacuation and subsequent carbon dioxide backfilling of the panel will be conducted at Plum Brook.

The double-guarded calorimeter was received on January 25. Testing of this calorimeter is dependent upon completion of the semi-panel tests. Therefore, early March is the earliest possible test date for the double-guarded calorimeter.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D.Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

The final series of performance checks on the high pressure gaseous hydrogen trailer No. 48 were completed this month. The evaluation report of the 4-inch Flowmatics regulator on this trailer is now being finalized. This trailer has been in use for several months and has been giving satisfactory performance.

Liquid hydrogen cooled engine No. 4 arrived at Plum Brook February 24. On February 28, the engine was pressurized to 600 psig while immersed in liquid nitrogen. No indication of leakage was observed. Following warm-up to

(Continued on Page 30)

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	ROCKET SYSTEMS TEST SITES J-1 ROCKET ENGINE SITE	<u>28K ROCKET ENGINE</u> (Continued) ambient temperature, the engine was repressure-checked to 600 psig and again no leakage could be found. The engine was then sent back to Lewis-Cleveland for the installation of the temperature and pressure instrumentation. The engine is scheduled to be returned to Plum Brook during the week of March 21. Approximately $1\frac{1}{2}$ weeks will be required to install the engine prior to cold flow tests with liquid hydrogen. Considerable effort has been expended this month toward the goal of minimizing the exposure of instrumentation and control cabling to any fire which might occur in the test cell. Conduit runs are being extended as close as is practical to flow control valves and to temperature and pressure transducers. This work should be completed by mid-March.
	J-3 VACUUM ENVIRONMENT TANK	<u>TANK INSULATION TESTS</u> PG0852(S.S.Manson) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. During February, four test runs were performed, to various Linde semi-panel type insulation configurations which were attached to the Centaur sector tank. All test panels were evacuated by cryopumping on the lower one-third of each panel. On February 1, a test was made to evaluate the ultimate vacuum of the evacuated panel by both diffusion and cryopumping techniques, while the panel was continiously subjected to atmospheric compressive load. The lowest pressure obtained in this test was 8.0×10^{-4} torr. The February 9 test was identical to the February 1 test, except that the atmospheric compressive load was removed from the test panel. The lowest pressure obtained in this test run was 7.2×10^{-5} torr.

J ROCKET SYSTEMS TEST SITES

J-3 VACUUM ENVIRONMENT TANK

TANK INSULATION TESTS (Continued)

On February 18, a test run was made to evaluate the ultimate vacuum of the carbon dioxide backfilled semi-panel by cryopumping action alone. The test panel had been exposed to atmosphere for about one week, so some degree of diffusion was expected to limit the ultimate pressure. The final test results as monitored at three vacuum locations were:

Near side	20 microns
Mid-panel	25 microns
Far side	6 microns

The evacuated panel was also monitored during this test. The ultimate vacuum obtained in this panel by diffusion and cryopumping techniques was 5.1×10^{-5} torr. The ultimate vacuum obtained by cryopumping only, was 5 to 6×10^{-4} torr.

On February 24, since it was felt that atmospheric diffusion had limited the cryopumping ability of the carbon dioxide panel, the panel was re-evacuated and backfilled with instrument grade carbon dioxide. Paladium oxide was also added to the panel to act as hydrogen to water converter. Since the test program for the evacuated panel was completed, the same procedures were accomplished on this panel. The final test results are as follows:

If the test results are still unacceptable, this test program will be temporarily deleted until testing of the thermal effectiveness of this insulation as applied to the double-guarded calorimeter is completed. Contractual obligations on the double-guarded calorimeter necessitate its return to Linde by April 1.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D. Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Engine No. 4 was delivered to Plum Brook on March 16. This engine has six instrumentation stations for measuring liquid hydrogen temperature. Leakage from the chamber to the outside was discovered during a final pressure check of the engine-injector assembly. Provisions had been made between the cooling tubes for the installation of hot gas side thermocouples. Sealant failure in these unused holes allowed the leakage. The situation was corrected at Plum Brook by Lewis-Cleveland personnel. Another cold shock pressure-check procedure showed that the repairs were satisfactory. Engine No. 4 has been installed in the test stand and is being prepared for a liquid hydrogen cold flow early in April.

Liquid Hydrogen Engine No. 5 was cold shocked in a liquid nitrogen bath and pressure checked to 600 psig this month. No evidence of any leakage could be found. The engine was then returned to Lewis-Cleveland for installation of the instrumentation.

The conduit extensions mentioned in the status report for February are completed. Instrumentation wires are reconnected and all circuits are being checked out.

The first performance checks of the Sky Valve regulator installed on high pressure Gaseous Hydrogen Trailer #47 showed severe oscillations in regulated outlet pressure. The use of a built-in adjustment feature gave no appreciable improvement in the regulator's performance. No recommendations have been received from the Sky Valve Company concerning this problem.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
	J-3 VACUUM ENVIRONMENT TANK	

TANK INSULATION TESTS
PG0852(S.S.Manson)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

The eleventh, and final, test on the Linde semi-panel type insulation was completed on March 1. Test pressures obtained in the carbon dioxide cryopumped panel were 50, 30, and 27 microns at various pressure taps. Data obtained at Plum Brook compared favorably with data obtained by Linde throughout the entire test program. Although several techniques for obtaining lower panel pressures are still to be tried, the test program was terminated to permit testing of the double-guarded calorimeter in fulfillment of contractual obligations.

The test insulation on the double-guarded calorimeter is identical in composition with the semi-panel insulation; however, the insulation was not encapsuled in panel form casing material. The test period began on March 18 and terminated on March 28 with twenty-four hour data acquisition on March 23 and 25.

The apparent "K" valve for the insulation obtained in this test was 3.0 to 3.5 BTU/hr ft^2, which makes it the best insulation tested to date in "J-3" cell.

Test operations will be terminated on April 1, by action of the Area 20 Safety Committee in regard to the electrical safety of the test cell. A review safety meeting is scheduled for April 5 to determine if a revised system is acceptable.

Pending approval of the Area 20 Safety Committee, the double-guarded calorimeter will be reinsulated with 8 panels of Linde insulation and is scheduled to be tested in mid-May.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES			
	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D.Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		Engine No. 4 was cold flowed with LH_2 on April 8. The coolant temperature instrumentation did not operate within the acceptable accuracy limits. Minor changes were made in the instrumentation before engine #4 was hot fired on April 22. During the hot firing the engine was prematurely shutdown because of low coolant flow. The data showed that the coolant control valve was choked because of the high rate of heat flux into the coolant during engine combustion. Changes in the programming and sizing of the coolant valve are being investigated. Engine #4 was too badly damaged to be used again.		
		On April 26, LH_2 cooled engine #6 was cold shocked and pressure checked. No leakage was found. The engine was sent back to Lewis-Cleveland for the installation of temperature instrumentation. This engine will be hot fired in late May.		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
	J-3 VACUUM ENVIRONMENT TANK	

TANK INSULATION TESTS
PG0852 (S.S. Manson)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

During this reporting period the test cell work has been progressing on the upgrading of the electrical systems to Class I, Group B, Division II rating. This action is in accordance with the Area 20 Safety Committee review of April 5. It is anticipated that the facility will be ready for testing by May 13.

The double-guarded calorimeter, insulated with eight Linde semi-panels, is scheduled for test program initiation between May 23 and 31.

The following individual test series are anticipated for this program:

(1) Ground hold thermal performance.

(2) Controlled evacuation of the vacuum chamber to simulate boost environment thermal performance.

(3) Space environment thermal performance.

TANK INSULATION TESTS (Continued)

a. Panels valved off from chamber.

b. Panels open to chamber.

(4) Permeability effects on the insulated system during a prelaunch period and resulting vacuum performance demonstration.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	

28K ROCKET ENGINE
PC0425 (N.D. Sanders)

A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On May 3 and 11, several liquid nitrogen cold flows were made with liquid hydrogen engine #3. The purpose of these tests was to determine the pressure drops across the engine and downstream control valve versus weight flow. On the basis of these tests, the control valve is being replaced with another valve that has a 60% greater flow capacity (C_V = 320).

On May 18, seven hot firings were made with a rockide-coated steel engine. The purpose of these tests was to develop a procedure for slowly bringing chamber pressure up to its full value. The copper injector was damaged during these firings. The suspected cause of damage was the programming of the LOX purge valve. Because of the electrical circuitry, the LOX purge valve closed when the LOX control valve opened. A change in the circuitry has been made to keep the purge on until the LOX flow builds-up pressure in the injector dome.

Another steel engine hot firing will be made during the first week of June to verify that the cause of injector damage has been eliminated and to improve the slow start-up procedure developed during the last hot firing.

During the hot firing of liquid hydrogen engine #4, the coolant valve was choked because of the high rate of heat flux into the coolant during engine start-up. This problem is being investigated by the controls group at Lewis-Cleveland and at Plum Brook. It has been proposed that a control valve upstream of the engine, as well as the one downstream, may be needed.

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SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	ROCKET SYSTEMS TEST SITES J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS 0R0852(S.S.Manson)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		During this reporting period, an intensive effort has been maintained to upgrade all electrical systems to Class I, Group B, Division II rating. This task was completed on May 16. Since this date, manpower has been primarily scheduled for preparing the double-guarded calorimeter for testing. The anticipated test date is June 6. The test program will consist of the following individual test series: (1) Ground hold thermal performance test (2 day test period). (2) Controlled evacuation of the vacuum chamber to simulate boost environment thermal performance (5 day test period). (3) Space environment thermal performance with insulation panel evacuation by carbon dioxide cryopumping (4 day test period). (4) Space environment thermal performance with insulation panels exhausting to chamber vacuum (4 day test period).		

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425(N.D.Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		On June 1 and June 11, a total of 16 hot firings were made with a rockide coated steel engine. The purpose of these tests was to develop engine start-up procedures that would give a slow rise in chamber pressure. Engine start-ups were successfully made with both a high and a low Pc injector at 300 and 150 psia chamber pressures.		
		Two new hydraulic control valves have been installed in the LH_2 flow lines. This valve upstream of the engine will control inlet manifold pressure. This is an entirely		
		Continued on Page 26		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
	J-1 ROCKET ENGINE SITE (Continued)	new system including the controller, and must be checked out completely. A large valve has been installed downstream, and will control LH_2 weight flow through the engine. LH_2 cold flow tests with Engine #4 are scheduled for mid-July. Hot firing tests are scheduled for late July or early August. The hot firing tests will not be run until satisfactory performance has been achieved with the entire LH_2 system. Analog studies of the LH_2 system are being conducted by the Plum Brook Controls group. Various methods of controlling the coolant during engine combustion are being investigated.
	J-3 VACUUM ENVIRONMENT TANK	<u>TANK INSULATION TESTS</u> OR0852 (I.A. Johnsen) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. Test runs of June 2, 8 and 15 were aborted due to an excessive boiloff rate in the cold guard section of the double-guarded calorimeter. Test data for these runs was not obtained as the hydrogen level could not be maintained for a sufficient period of time to obtain meaningful boiloff data. The high rate of heat flux in the guard section can be directly attributed to a lack of cryopumping in the tank guard insulation. Since the last test date, several large leaks in the guard insulation system have been located and repaired with Narmco cement. A leak in the LH_2 calorimeter is impossible to repair without disassembling the calorimeter. A larger evacuation system has been installed in an attempt to overcome the leakage. The next test run is planned for July 5.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D.Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

The study of various methods of controlling the liquid hydrogen coolant flow through the engine was completed in early July. The decision was made to control the engine inlet pressure during both the transient and steady state portions of the hot firing and to control weight flow only during the steady state portion.

On July 21, Liquid Hydrogen Engine #4 was cold flowed with liquid hydrogen. The purpose of this test was to check out the two new hydraulic control valves and the new pressure controller.

With the modifications as determined from the July 21 run, another liquid hydrogen cold flow was made on July 28. After one run, the seat in the liquid hydrogen tank pressurization regulator had to be replaced. The cold flow was completed on July 29. All test objectives were successfully accomplished.

A hot firing of Liquid Hydrogen Engine #4 is scheduled during the first week of August.

On July 7, Liquid Hydrogen Engine #7 was pressure checked to 700 psig with gaseous nitrogen. No leaks were found. The engine was then returned to Cleveland.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS ORI327(I.A.Johnsen)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

The test run of July 11 was aborted due to a high boiloff rate of the guard tanks of the double-guarded calorimeter. The high boiloff was caused by a hydrogen leak from the measure tank into the guard insulation. A 4-inch diffusion pump installed in the guard evacuation line failed to overpower the leakage.

As three previous test runs were also aborted for identical reasons, the upper half of the guard insulation was removed, allowing unrestricted venting of the leak into the chamber vacuum system. Since four of the eight Linde test panels were ruptured by thermal movement in the previous runs, each panel was also allowed to vent to the chamber to produce the hard vacuum initially planned to be obtained by carbon dioxide cryopumping.

Test data under these conditions was acquired from July 25 to July 29. The approximate Q/A for the three panel thick shingle insulation was 0.85 BTU/hr. ft^2. A test run of May 25 established a Q/A of 0.39 BTU/hr.ft^2 for the basic insulation concept. The higher heat flux is predominately contributed by the insulation casing material. This completed the test program with Linde under Contract NAS3-6289.

No test programs are currently scheduled for this facility.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	
		28K ROCKET ENGINE PC0425 (N.D. Sanders) — A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		On August 4, an attempt was made to hot-fire liquid hydrogen cooled engine #4. Several problems which developed during the day prevented more than a low Pc ignition checkout run. Both liquid level measuring units in the liquid hydrogen tank failed to operate properly. Leakage through the seat of the liquid hydrogen weight flow control valve during tank pressurization decreased the available liquid hydrogen for a test run. A broken stem in the Flomatics pressure regulator on the gaseous hydrogen trailer #48 required the trailer pressure to be bled down to the 2400 psi manifold pressure.
		On August 11, a successful hot firing of liquid hydrogen engine #4 was made. During the run, the liquid hydrogen weight flow and engine inlet pressure controls performed properly. The engine appeared to be cooled satisfactorily, although several of the leaks
		(Continued on Page 28)

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE (Continued)	

28K ROCKET ENGINE (Continued)

which had previously been repaired, reappeared. Several cracks were also discovered in the mesh surface of the porous face injector.

Investigation of the data showed that the gaseous hydrogen fuel flow was only 9% of the total weight flow, instead of the desired 15%. As a result, a series of steel engine hot firings were made on August 18 to check out the entire fuel weight flow control. During these tests, the desired fuel flow again was not obtained. Severe oscillations also occurred in gaseous hydrogen regulator outlet pressure.

On August 22, gaseous nitrogen flows through the fuel system indicated that a modification to the fuel pressure regulator had eliminated the pressure oscillations. During the week of August 22, the controls group made several modifications to the fire valve controller. On August 31, another series of hot firings of a steel engine was made. The results of these tests were completely satisfactory. The gaseous hydrogen fuel flow showed no evidence of the oscillations which had occurred during the previous tests on August 18. The desired gaseous hydrogen weight flow was obtained with the fire valve controller performing properly.

Liquid hydrogen cooled engine #5 will be brought to Plum Brook and installed in the test stand immediately. A hot firing of this engine is tentatively scheduled for the week of September 12.

	J-3 VACUUM ENVIRONMENT TANK	

TANK INSULATION TESTS
OR1327(I.A.Johnsen)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

Since completion of the double-guarded calorimeter test program on July 29, the main effort in the facility has been directed in upgrading the electrical systems to meet Class I, Group B, Division II requirements. This effort will be maintained until mid-September, whereupon testing of the Centaur arc tank will begin.

The arc tank has been insulated at Linde with six panels of carbon dioxide backfilled insulation. The objective of this program will be to measure the carbon dioxide cryo-pumping ability of each panel.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D. Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Liquid hydrogen cooled engine No. 5 was received September 1, and was installed in the test stand on September 6. The hot firing, scheduled for the week of September 12, was delayed one week because of excessive noise on the cables to "H" Building.

On September 22, a successful hot firing was made. The desired run duration of 8 seconds at 300 psia chamber pressure was obtained. Post-run pressure checks showed the engine to be pressure-tight. The temperature data from the hot gas side thermocouples corresponded with the expected values. The absolute and differential temperature measurements from the thermocouples immersed in the liquid hydrogen coolant stream were questionable. A temperature gradient with depth in the coolant tube was indicated.

Based on the results of the September 22 test, the immersion depth of the liquid hydrogen coolant thermocouples is being changed. This work is being done at Plum Brook by Lewis-Cleveland personnel, while the engine remains in the thrust stand. Two defective thermocouples will be replaced. The next hot firing is scheduled for the first week of October.

On September 26, liquid hydrogen cooled engine No. 8 was cold shocked and pressure checked to 900 psi. It was found to be pressure tight and was returned to Cleveland for installation of instrumentation.

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SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS OR1327(I.A.Johnsen)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		During this reporting period, the main effort in the facility has been directed in upgrading the electrical systems to meet Class I, Group B, Division II requirements. This task is expected to be completed by October 10.		
		Cryopumping tests of Linde semi-panels as attached to the Centaur arc tank are scheduled to begin on October 24. Various grades of carbon dioxide and gaseous nitrogen will be evaluated.		
		The Arthur D. Little gold mylar insulated calorimeter is scheduled for testing in January.		
		The double guarded calorimeter with a purge multilayer insulation system is scheduled for April testing. Both ground hold and space environment thermal effectiveness will be evaluated. Rapid evacuation tests to simulate a typical missile ascent will also be performed to evaluate transient heat fluxes.		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	

28K ROCKET ENGINE
PC0425 (N.D.Sanders)

A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Nine hot firings of LH_2 Engine No. 5 were made during three days this month. Five of these firings were good data producing runs. Run duration averaged approximately ten seconds. The engine was pressure checked following each series of runs and found to be pressure tight.

Data from the liquid hydrogen coolant thermocouples showed a definite temperature gradient with depth in the coolant stream. This phenomenon is being explored by repeating run conditions and varying the thermocouple immersion depth. The absolute liquid hydrogen temperature measurements compare favorably with the expected results. Data from the hot gas side thermocouples has been satisfactory.

Run conditions to date have been as follows:

Chamber pressure - 300 psig
LH_2 engine inlet manifold pressure - 600 psig minimum; 900 psig maximum
LH_2 coolant weight flow - 11.0#/sec. minimum; 16.0#sec. maximum

The next series of runs is scheduled for the first week of November. The immersion depth of several liquid hydrogen thermocouples has been readjusted. For these runs previous conditions will be repeated. The next step in the program will be to increase chamber pressure while duplicating other previous run conditions.

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SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE	28K ROCKET ENGINE PC0425 (N.D. Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On November 1, three hot firings were made with LH_2 cooled engine No. 5. The series of tests at a chamber pressure of 300 psia is completed. The lower range of coolant system parameters was extended to a weight flow of 9.7 lb/sec at an inlet manifold pressure of 600 psig.

During post run pressure checks, three small leaks were discovered in the engine cooling tubes. The engine was removed from the stand and sent to Lewis-Cleveland for repairs. Engine No. 6 was received on November 10, following re-adjustments on the LH_2 thermocouples' depths. Initial pressure checks showed a leak at Station No. 6 so the engine was returned to Lewis-Cleveland for repairs. On November 21, Engine No. 6 was returned. Pressure checks were satisfactory, and the engine was installed in the stand. The next series of tests are scheduled for the first week of December. These tests will be at 450 psi chamber pressure.

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SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE (Continued)	

28K ROCKET ENGINE

Several performance tests were made this month with the Skyvalve pressure regulator for the high pressure GH_2 trailers. Results were unsatisfactory. Further tests of the Skyvalve will not be made. In spite of contractor and NASA efforts, the regulator persormance was unstable at high flow rates.

J-3 VACUUM ENVIRONMENT TANK

TANK INSULATION TESTS
OR1327 (I.A. Johnsen)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

On November 18 the cryopumping performance of six Linde self-evacuating multi-layer insulation panels was tested. Three test panels were backfilled with instrument grade CO_2, and the remaining three panels with water pumped GN_2. All six panels were attached to a Centaur Arc Tank. Under atmospheric ground hold conditions, with the tank filled with LH_2, the CO_2 panels cryopumped into the low 10^{-5} torr range. They remained at this pressure during the duration of the test. The GN_2 backfilled panels were capable of cryopumping to the low micron range during the ground hold portion of the test. As would be expected the cryopumping action of the GN_2 panels was considerably more sluggish than the CO_2 panels. Under space vacuum conditions, all panel pressures increased to the 20 to 100 micron range. Subsequent investigation of the panels showed they were leaking on the surface next to the tank wall, which explained the high test pressures. The leaks occurred when a vacuum was drawn in the vacuum chamber. This has been a continuing problem with the self-evacuating insulation system. Since these panels are not repairable, this test completed the testing of panel insulation systems.

The Arthur D. Little Gold-Mylar insulated calorimeter is scheduled for testing in February. A fifty-gallon vacuum insulated flash dewar is under fabrication to minimize cold guard liquid hydrogen consumption.

The double-guarded calorimeter, with a purged multilayer insulation, is scheduled for testing in April. Both ground hold and space environment thermal effectiveness will be evaluated. Rapid evacuation tests to simulate a typical missile ascent will be performed to evaluate transient heat fluxes.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE PC0425 (N.D. Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		During December, six test firings with Engine No. 6 were attempted and four were successfuly completed, on two run days. Three of these tests were at a chamber pressure of 300 psia. The test conditions duplicated previous runs with Engine No. 5, to allow comparison of data between the two engines. The final test was made at 450 psia Pc. This was the first time one of the LH_2 cooled engines was tested at a chamber pressure above 300 psia. The engine performed satisfactorily during all runs. However, several hot-gas-side thermocouples at critical locations became defective. The loss of these thermocouples reduced the amount of data obtainable and, therefore, Engine No. 6 was removed from the test stand. Since the engine is still pressure-tight, Lewis-Cleveland personnel are attempting to repair the defective thermocouples.		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE (Continued)	28K ROCKET ENGINE (Continued) Before each series of runs, metals of various melting temperatures were plated onto the engine combustion wall. We wanted to confirm the engine wall temperature data of the hot-gas-side thermocouples by observing which metals did not melt during the tests. Photographs of the platings were taken before and after each firing for comparisons. The results compared favorably with the thermocouple data. Engine No. 9 was cold-shocked and pressure-checked to 1200 psig this month. The engine is pressure-tight and was returned to Lewis-Cleveland for installation of all instrumentation. Engine No. 7 is being completed in Lewis-Cleveland, and should arrive at Plum Brook during the first week of January. Engine testing is scheduled for the week of January 16.
	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS OR1327(I.A.Johnsen) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. A 50-gallon vacuum-insulated liquid hydrogen flash dewar was installed this month. The dewar will be used to minimize cold-guard liquid hydrogen consumption on the Arthur D. Little gold-mylar insulated calorimeter. This calorimeter is scheduled for testing in March. The double-guarded calorimeter, with a purged multilayer insulation, is scheduled for testing in April. Both ground hold and space environment thermal effectiveness will be evaluated. Rapid evacuation tests to simulate a typical missile ascent will be performed to evaluate transient heat fluxes.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	
		28K ROCKET ENGINE YPC0425 (N.D.Sanders) — A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		LH_2 cooled engine No. 7 was received at Plum Brook on January 5 and was installed in the test stand on January 12. A two-day installation delay was caused because of the added requirement to purge the area between the engine and the instrument boxes.
		On January 20, four test firings were made, two tests at 300 psia chamber pressure and two at 450 psia. Holes were found in two cooling tubes after the final run, and the engine was sent to Lewis-Cleveland for repair on January 23.
		We have spent considerable time on cell maintenance this month. New operator lines were installed to all the LF_2 ignition system valves. The K bottle supply for loading the GH_2 systems' regulators was replaced by two of the area's permanent storage bottles.
		Engine No. 6 is scheduled to be returned early in February for a short series of tests at chamber

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	28K ROCKET ENGINE (Continued) pressures of 600 psia and possibly 700 psia. The purpose of these tests will be to find the upper limit of chamber pressure that the engine can be run at and still be satisfactorily cooled by the existing LH_2 system. Engine No. 8 is being instrumented in Lewis-Cleveland and should be completed near the end of February. The four stations of hot-gas-side thermocouples are being installed differently than on previous engines. This engine will be initially tested at 300 psia to compare temperature data from the other engines.
	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS YOR2023 (I.A.Johnsen) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. A 50-gallon liquid hydrogen dewar designed to minimize calorimeter cold guard consumption was evacuated, cold shocked and leak tested. The dewar will be mounted on the test cell roof next month. The double-guarded calorimeter was helium leak tested. A leak rate of approximately 2×10^{-4} cc/sec was established between cold guard and measure volumes. The neck tube leak rate was below 10^{-8} cc/sec. The environmental baffles were repaired, leak tested and installed during this report period. The cryopumping ability of several gases at liquid nitrogen temperatures was established. These tests are being performed to find the optimum gas to use with the self-evacuating insulation program. (Continued on Page 28)

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SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-3 VACUUM ENVIRONMENT TANK (Continued)	

TANK INSULATION TESTS (Continued)

The gases tested this month were:

Gas	ULTIMATE CRYO-PUMPED VACUUM
Freon 12 (CCl_2F_2)	1.0×10^{-3} Torr
Freon 22 ($CHClF_2$)	2.5×10^{-2} Torr
Acetylene (C_2H_2)	8×10^{-7} Torr
Propane (C_3H_8)	2×10^{-7} Torr
Carbon Dioxide (CO_2)	8×10^{-3} Torr
Rough Vacuum (1×10^{-1} Torr)	5×10^{-3} Torr

The next scheduled test program is the Arthur D. Little gold-mylar insulated calorimeter and is scheduled for the month of March.

Improvements to the self-evacuating insulation concept will be tested in July and August. The system will again be retested after a 30 day storage period to determine degradation due to atmospheric permeability.

The projected schedule for the insulation technology program at Lewis-Cleveland indicates almost continuous testing throughout the 1968 fiscal year.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			

28K ROCKET ENGINE
YPC0425 (N.D.Sanders)

A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

LH_2 cooled Engine No. 6 was installed, pressure checked, and cold shocked by February 6. One unsuccessful attempt was made on February 9 to hot fire this engine at a chamber pressure of 600 psia. The coolant inlet manifold cracked approximately one second after ignition and the run was terminated by the safety circuit. Temperature and pressure cycles during previous runs had apparently weakened the engine in this area. Design changes have been incorporated in later engines to reduce the possibility of this failure recurring.

Engine No. 8 was installed and cold shocked on February 21. The installation of the hot-gas-side thermocouples at four stations on this engine has been changed in an attempt to better the quality of the combustion-wall temperature data. Hot firing of this engine is scheduled for early March.

J-3 VACUUM ENVIRONMENT TANK

TANK INSULATION TESTS
YOR2023 (I.A.Johnsen)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

During this reporting period, the major activity was preparing the test cell for the Arthur D. Little calorimeter. The IRC and auxiliary trailer purged boxes and conduit were completed. The only non-explosion permanent equipment remaining in the cell is the thermocouple box.

A simulated A.D.L. cold guard coil was installed to checkout the operation of the LH_2 supply system. A temperature of $-417^{o}F \pm 1^{o}F$ was maintained on a liquid hydrogen consumption of 200 gallons/hour. No leaks were encountered during the seven hours of testing.

The A.D.L. calorimeter is scheduled to arrive in the first week of March. The insulation consists of five layers of gold mylar separated by silk netting material. The heat flux will be evaluated under LN_2 and LH_2 conditions.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE	28K ROCKET ENGINE YPC0425 (N.D.Sanders)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On March 8, two successful hot firings were made with LH_2 cooled engine No. 8. Chamber pressure of 300 psia, and coolant inlet manifold pressure of 700 psig, were held constant for each run. Coolant weight flow was changed from 12.5 lb/sec for the first run, to 11.2 lb/sec for the second run. After the second firing, two small holes in the engine cooling tubes were discovered during pressure checks. The engine was returned to Cleveland on March 10.

The next series of research data runs in J-1 will be with a copper engine (wire wrap profile). The installation of all temperature instrumentation on LH_2 engine No. 9 was held up pending the results of tests on engine No. 8. It will take approximately three months to complete this engine. During this time, copper engine tests will be made. The goal of these tests is to extend the range of the hot-gas-side heat transfer data obtained in previous copper engine tests.

A rockide coated steel engine was installed in the test stand on March 29. A short series of tests will be made with this engine to verify proper start-up procedures. A very short Pc rise-time is required for the copper engine tests.

	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS YOR2023 (I.A.Johnsen)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

Testing of the Arthur D. Little calorimeter began on March 16 and continued to March 30. The calorimeter is insulated with five layers of gold mylar foil with 14-mesh silk netting separators. An LN_2 heat flux of 0.32 BTU/hr ft^2 was measured. This corresponded to the heat flux obtained at Arthur D. Little and insured calibration of the facilities. A heat flux of 0.39 BTU/hr ft^2 was obtained with LH_2 testing.

The next scheduled test program will be the Linde self-evacuating multilayer insulation system. An exact test date for this system has not been established due to the uncertainty of obtaining copper for the calorimeter construction.
Checkout of a boiloff back pressure regulation system will be made next month.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			

28K ROCKET ENGINE
YPC0425 (N.D. Sanders)

A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

Nineteen (19) test runs were made on four run days this month. These tests, using a rockide-coated steel engine with a copper-face injector, were made to verify proper start-up procedures. A very short Pc rise-time is required for the copper engine tests which are next on the schedule.

The series of tests on April 4 were terminated after only four starts because of troubles with the fire valve controller. On April 11, only one run was made. Controller problems again caused an early termination. A burned-out check valve in the liquid fluorine ignition system allowed only three runs on April 21. The troubles with the controller had been cleared-up before this series, and it performed properly during each run.

On April 26, eleven runs were made. Chamber pressure was 300 psia for all runs. Satisfactory fast-starts were verified for 15 and 20 percent fuel. The third attempt to start with 28 percent fuel ended with a detonation in the LOX dome of the injector. Damage to the injector was extensive.

A new porous-face injector has been installed for the completion of these start-up tests. It is hoped that one more series of tests, scheduled for the first week of May, will conclude the rapid-start tests at 28 percent fuel. The No. 3 copper engine can then be installed for the heat transfer tests.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS YOR2023(I.A.Johnsen)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

No manpower was assigned to the test cell during this reporting period.

The following major cell modifications are being contemplated for future test programs:

(1) The addition of a Kinney Model KDH-850 vacuum pump to the existing mechanical pump system. This will provide a total roughing capacity of 1150 C.F.M. The additional pump will be used for rapid evacuation of the chamber to duplicate the ascent of a missile for studying interstitual pressures of a multilayer insulation system. The additional pump should permit duplication of the missile ascent curve for a total of 3 minutes, covering the pressure range from atmosphere to one micron.

(2) A 12- to 15-inch extension to the chamber to permit additional cold-guard insulation for the calorimeters.

(3) A longer cryogenic baffle will be required with the chamber extension to insure continuous environmental control to the outer layer of tank insulation.

An exact test date for the next program (Linde self-evacuating panels) has not been established due to the uncertainty of the fabrication completion date of the calorimeters.

reporting period.

The following major cell modifications are being contemplated for future test programs:

(1) The addition of a Kinney Model KDH-850 vacuum pump to the existing mechanical pump system. This will provide a total roughing capacity of

(Continued on Page 30)

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YPC0425 (N.D. Sanders)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

On May 10, five successful test firings were made. A new porous-face injector was used with a rockide-coated steel engine. These tests were made primarily to develop a very short chamber pressure rise-time with a 28 percent fuel mixture. Two runs were made with this porous-face injector to compare the start-ups at 15 and 20 percent fuel with those obtained previously with the copper-face injector. All goals were successfully accomplished.

Copper engine No. 3 has been installed in the test stand. Final connections of all pressure pickups and engine thermocouples are nearly completed. Hot firings of this engine are scheduled for the first week of June.

LH_2 engine No. 10 was cold shocked and pressure checked on May 11. The engine was pressure-tight and was returned to Lewis-Cleveland for installation of all thermocouple instrumentation.

A considerable amount of work was accomplished this month on the instrumentation system between "J-1" Test Cell and the Auxiliary Instrument Trailer. New conduit runs were installed, new cable was pulled, and new termination boxes have been installed in the test cell. Signal conditioning equipment has been relocated and a new scanner system has been installed in the Auxiliary Trailer. Improvements in the data quality and instrumentation capacity are expected; also, the general area appearance will be improved.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-3 VACUUM ENVIRONMENT TANK		
		TANK INSULATION TESTS YOR2023(I.A.Johnsen)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		No work was accomplished in the facility during this reporting period. Preliminary sketches for the addition of a 14" extension to the vacuum chamber, an additional 850 C.F.M. roughing pump and a longer baffle were completed this month. Engineering for these jobs will be handled by the Plum Brook Engineering Division, and is expected to be completed by July 15.	

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YPC0425 (N.D. Sanders)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

A total of ten test firings were made on four run days this month using two different copper engines. These tests were made to extend the hot-gas-side heat-transfer data obtained in earlier tests with copper engines No.'s 1 and 2.

On June 9, 13 and 14, nine test firings were made on copper engine No. 3. Run conditions were 300 psia chamber pressure with fuel weight flows of 15, 20, and 28 percent. Thermocouple rods had been installed at several additional axial locations along the engine. Static and differential pressures along the engine axis were also obtained during the firings.

Following the above tests, copper engine No. 2 was installed in the test stand. This engine had thermocouple installations at locations 60 degrees apart in the chamber. The purpose of testing with this engine was to determine if a circumferential temperature profile was produced in the combustion chamber by the injector. One test firing was made on June 29, at a chamber pressure of 300 psia, and a fuel weight flow of 15 percent. Investigation of the low Pc, porous-face injector immediately after the run showed the face plate was beginning to warp. Therefore, it was decided to eliminate any further copper engine testing with this injector and to save it for the future liquid hydrogen engine tests.

Copper engine No. 2 will be reinstalled in the test stand with the old high Pc porous-face injector used for previous liquid hydrogen engine tests. This injector has severe face-plate warpage. The effect of this warpage on the combustion chamber temperature profile will be investigated.

Liquid hydrogen-cooled engine No. 9 arrived at Plum Brook this month. Installation of this engine in the test stand will begin immediately after the completion of the copper engine tests.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-3 VACUUM ENVIRONMENT TANK		
		TANK INSULATION TESTS YOR2023(I.A.Johnsen)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		A holding pump and evacuation line were installed to allow rapid cycling of the chamber diffusion pump.	
		The Linde tank without insulation was installed for checkout of the back-pressure control system. The testing of this system is expected to be completed in July.	
		Drawings have been completed for the installation of a 14" chamber extension, an 850 C.F.M. roughing pump, and a longer cryogenic baffle.	
		It is anticipated that the semi-system insulation will be ready for testing by mid-August.	

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	

28K ROCKET ENGINE
YPC0425 (N.D. Sanders)

A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

A total of six test firings were made on three run days this month. Copper engine No. 2 was used for all tests, with two different injectors. The purpose of these tests was to determine if a circumferential temperature profile was produced in the combustion chamber by the injectors.

On July 7, one run was made with the old high Pc porous-face injector which had been used for the previous liquid hydrogen cooled engine tests. This injector had severe warpage on the face plate. Run conditions were 300 psia chamber pressure and 15% fuel.

On July 14, a second run was made with this same engine-injector combination. For this run, the engine had been rotated 30 degrees C.C.W., with respect to the injector, from its previous position. Run conditions again were 300 psia chamber pressure and 15% fuel. Since thermocouples had been installed in the engine chamber at locations 60 degrees apart, this rotation allowed a temperature comparison at 30 degree intervals.

On July 21, three successful firings were made in four attempts. A low Pc copper-face injector was used with copper engine No. 2. Chamber pressure again was 300 psia, but with two fuel weight flows, 15 and 20 percent fuel, for the first two runs. The third run programmed a slow rise in chamber pressure (approx. 1.5 seconds to full value), to simulate the liquid hydrogen cooled engine start-ups.

This month's tests completed the current program of copper engine firings. Liquid hydrogen cooled engine No. 9 is now being installed in the test stand. The hot firings of this engine will be delayed slightly, pending the completion of the modifications to the instrumentation system into the test cell. The major

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1	28K ROCKET ENGINE (Continued) delay will be due to the installation of a new patch board, scheduled to be delivered August 4. Testing of liquid hydrogen engine No. 9 should begin by mid-September.
	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS YOR2023(I.A.Johnsen) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. The test cell is being prepared for the Linde Self-Evacuating Multilayer Insulation Test Program. This program is scheduled to start in late September. The constant backpressure vent system for both the calorimeter and cold guard tanks is being fabricated. The system is expected to maintain a constant pressure within 0.0002 of a psi. Instrumentation at the control trailer for use with the scanner system is almost complete. Local readings will be taken from a digital voltmeter system. Parts have been received for the constant temperature environmental control system. It is anticipated that the major emphasis for next month will be the completion and checkout of the backpressure control system.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	
		28K ROCKET ENGINE YPC0425(N.D.Sanders) — A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		Most of this month's activity was in preparation for the hot firing of liquid hydrogen cooled Engine No. 9. This engine had been installed in the test stand on July 28. The temperature and pressure instrumentation has been connected, and at present the complete instrumentation system is being checked out. Since the last firing of a liquid hydrogen cooled engine, all instrument cables between the test cell and the auxiliary instrument trailer have been replaced and a new patchboard installed. A liquid nitrogen cold flow for a system checkout is scheduled for September 1. The hot firing of Engine No. 9 is scheduled for Sept. 8.
		Two other liquid hydrogen cooled engines were cold-shocked in liquid nitrogen, pressure-checked, and returned to LeRC-Cleveland this month. Engine No. 8 had a nickel plating over some holes which had occurred during the last hot firing. Engine No. 12 is a new engine and the cold-shock/pressure-check is a standard procedure for all new engines before installation of temperature instrumentation. Both engines checked satisfactory.
	J-3 VACUUM ENVIRONMENT TANK	
		TANK INSULATION TESTS YOR2023(I.A.Johnsen) — Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		Preparations are nearly completed for the testing of the Linde self-evacuating multilayer insulation. The insulated calorimeter is scheduled to arrive in mid-October. The test program has therefore been rescheduled to start the first part of November.

SITE	SITE NAME RESEARCH INSTALLATION & DESCRIPTION
	J-3 (Continued) TANK INSULATION TESTS (Continued) The constant backpressure vent system control valves have been installed and are being readied for their electronics. The delta P transducers for this system had to be refabricated in an explosion-proof box and are near completion. The constant temperature control system heat exchanger is being fabricated and is expected to be installed within the next two weeks. The controlled evacuation system is being readied for the test program scheduled for the first part of next year. Necessary parts for the 850 cfm roughing pump arrived and the pump was then test operated. It is expected to be installed the latter part of this year. Major emphasis during the next two weeks will be checkout of all vacuum measuring equipment and the constant backpressure system.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE YPC0425 (N.D.Sanders)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		On September 1, liquid nitrogen under high pressure was flowed through Liquid Hydrogen Cooled Engine No. 9 for a system cold shock and pressure check. Two more liquid nitrogen cold flows were made on September 8 during which all instrumentation, controls, and mechanical hardware systems were completely checked out.		
		On September 15, two hot firings were made with Engine No. 9. Both firings were with 300 psia chamber pressure and 700 PSIG coolant inlet manifold pressure. Coolant weight flow was changed from 12.65 lb/sec. for the first run to 15.35 lb/sec. for the second run. During postrun pressure checks, two small holes in the engine cooling tubes were discovered. Only four out of the thirty originally installed hot-gas-side thermocouples were judged capable of producing dependable data for any further tests. The engine was returned to Lewis-Cleveland on September 20.		

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	28K ROCKET ENGINE (Continued) Two new porous-face injectors for the U-tube contour engines were back-flushed with trichloroethane solvent this month. These will be stored at Plum Brook until testing with the U-tube type engine begins. The next engine scheduled to be fired in "J-1" will be liquid hydrogen engine No. 10. This engine became damaged structurally during the installation of the hot-gas-side thermocouples. It has been repaired and is presently being tested for both leaks and structural integrity. The estimated delivery date to Plum Brook is October 9.
	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS YOR2023 (I.A.Johnsen) Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied. The aluminum double-guarded calorimeter has been fabricated by Lockheed, and is being insulated at Linde. The semi-panel system is anticipated to be ready for testing in early November. The remote reading Veeco ionization gage has been checked out and is currently being installed as a permanent addition to the cell. The eductor system has been sized for the constant backpressure vent system. Checkout of this system has been delayed due to an apparent leak in the backpressure reference transducer system. The chamber extension, baffle and concrete vacuum pump base have been cancelled. The Plum Brook Engineering Design Division is now planning on shock mounting the Kinney vacuum pump.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YPC0425(N.D.Sanders)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		Liquid Hydrogen Cooled Engine No. 10 was received, cold shocked, and pressure checked to 1000 PSIG this month. The copper face injector to be used with this engine arrived at Plum Brook on October 30. These items are now being assembled for immediate installation in the test stand. The hot firing of this engine is tentatively scheduled for mid-November.	
	J-3 VACUUM ENVIRONMENT TANK		
		TANK INSULATION TESTS YOR2023(I.A.Johnsen)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		The aluminum stackable double-guarded calorimeter insulated with Linde self-evacuating panels was received at Plum Brook on October 30, and testing will start during the week of November 13. The initial test sequence consists of a ground-hold heat flux followed by a simulated missile ascent and a space-hold heat flux. After a 30-day soak period, the sequence will be repeated to determine degrading effects of the long-term storage. Principle problem areas in the test cell are the controlled backpressure vent system and the controlled environment temperature system. Due to extensive cell modification since the last test program, checkout of various sub-systems have now been initiated.	

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	

28K ROCKET ENGINE
YPC0425 (N.D. Sanders)
(C&ECD - L. Bryant; RSD - G.D. Mackay)

A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.

The hot firing of LH_2 cooled Engine No. 10, scheduled for November, was cancelled. Twenty hot-gas-side thermocouples, out of a possible total of thirty-two, were found to be inoperative during pre-run checks. Ten had been deleted because of difficulties during original installation, and ten more failed during pre-run LN_2 cold shocks.

The GH_2 fuel line is presently being modified in the test cell. This change will allow installation of either the new U-tube design or the old wire-wrap design engines in the test stand. A series of hot firings of a rockide coated U-tube design steel engine is tentatively scheduled to begin in December. These tests will be run to determine injector performance and ignition start-up procedures.

TANK INSULATION TESTS
YOR2023 (I.A. Johnsen)
(CRD - J.R. Faddoul, I.E. Sumner, and J.R. Barber; RSD - T.C. Cintula)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

A test run was started November 27 on the Linde semi-panel insulation applied to the aluminum stackable double-guarded calorimeter. The test sequence consisted of ground hold performance followed by a rapid evacuation to space hold conditions. The net heat flux under each condition of testing was slightly higher than desired; however, it was still low enough to represent an excellent insulation system. The same test sequence will be repeated after a 30-day air environment soak to determine the degradation to the insulation. The final test will be at space vacuum conditions with the insulation panel valves open to the vacuum chamber.

The next test program will be the "Transient Venting of a Multilayer Insulation" which will probably begin in early March.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YPC0425 (C&ECD - L. Bryant; RSD - G. D. Mackay)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for the design of nuclear rocket nozzles.
		On December 21, the Rockide-coated steel U-tube engine, fitted with a 300 Pc injector, was test fired. The injector performance and ignition start-up procedures were tested. The test data is applicable to liquid hydrogen cooled U-tube engines which are scheduled to be tested at J-1 site. A total of five successful test firings were made, two for ignition tests and three for injector performance.	
		The 500 Pc U-tube injector will now be installed for a similar performance evaluation. This injector will subsequently be used for both liquid cooled U-tube and copper engines.	
		A series of cold flow tests to determine injector pressure drop characteristics is scheduled for January.	
	J-3 VACUUM ENVIRONMENT TANK	TANK INSULATION TESTS YOR2023 (CRD - J.R. Faddoul, I.E. Sumner, and J.R. Barber; RSD - T.C. Cintula and D.G. Perdue)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		During December, the environmental tank was altered to accept the KD-850 vacuum pump, and an additional ionization gage was added for measuring tank pressure.	
		The Linde semi-panel insulated calorimeter is undergoing a 30-day atmospheric soak which will be terminated in January. The same test sequence which was conducted on November 27, 1967 will be repeated. This test is scheduled for the week of January 8.	

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE YPC0425 (C&ECD - L.Bryant; RSD - T.C.Cintula)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.
		A total of 12 test firings was made this month on 2 U-tube contour rockide-coated steel engines with a 500 Pc porous face injector. Desired chamber pressure for these runs was 400 psia. The test firings were made to develop start-up techniques, such as valve sequencing and position settings, applicable to research engines.		

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 (Continued)			
		28K ROCKET ENGINE (Continued)		
		Both steel engines experienced erosion of the rockide coating, with the loss of some metal at the throat, and are now being repaired at Lewis-Cleveland. Upon completion of repairs, the series of tests will be continued at chamber pressures of 600 psia.		
	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS YOR2023 (CRD - J.R. Faddoul, I.E. Sumner, and J.R.Barber; RSD - D.G.Perdue)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		The program for the "Light-Weight Multi-Layer Insulation System", Contract No. NAS3-7953, was completed on January 26.		
		Two tests were conducted. The first test was conducted during the period from January 8 to January 16 to determine the insulation performance after a 30-day atmospheric soak period. The second test was conducted January 22 and 23 to determine the insulation performance at space-hold conditions with the valves to the insulating panels open to the chamber. The results from the second and third tests are similar to the results obtained from the first test conducted on November 27, 1967.		
		The KD 850 vacuum pump is presently being prepared for installation into the test cell.		
		The copper calorimeter is in Lewis-Cleveland being prepared for the J-3 vacuum chamber lid. Tests for the copper calorimeter are scheduled for March 1968.		

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YPC0425 (C&ECD - L Bryant; RSD - TC Cintula)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.

A total of 12 test firings were made this month on the U-tube contour steel nozzle with a 500 Pc porous face injector.

Optimum valve settings and position sequences now have been established for 400 and 600 Pc slow and fast rise start-ups for this test configuration. During the last reporting period, the 300 Pc slow rise start-up was evaluated.

On February 21, an 800 Pc test firing was attempted with this nozzle-injector combination. The firing resulted in destruction of the solid steel nozzle. There was only minor damage to the injector and to the test facility.

Delivery of three new solid steel U-tube contour nozzles is expected shortly, and the next test is scheduled for the week of March 25.

		TANK INSULATION TESTS YOR2023 (CRD - JR Faddoul, IE Sumner, & JR Barber; RSD - DG Perdue)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

No test operations were scheduled during February. The month was spent preparing the test cell for the next configuration. The equipment is being modified to accept the copper heat transfer tank. The KD-850 vacuum pump was installed, and check-out runs are scheduled for March. The major portion of the instrumentation changes for the copper heat transfer tank are scheduled to be completed in March, and tests are scheduled to start in April.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YPC0425 (C&ECD - L. Bryant; RSD - TC Cintula)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.
		This reporting period was spent in rebuilding the test cell. All major systems have been checked and the cell is expected to resume research operations in the first week of April.	
		The initial test firings will be with the H-Tube Contour Steel Engine with a 500 Pc injector. Firings at chamber pressures of 400 and 600 PSIA will be made to determine if previously established valve settings and position sequences are still optimum.	
		Wire wrap contour LH_2 cooled engine #12 will be installed immediately following the steel engine checkout. The purpose will be to determine if a new thermocouple configuration is suitable for research data. If successful, this engine will be returned to Lewis-Cleveland for complete instrumentation.	
	J-3 VACUUM ENVIRONMENT TANK		
		TANK INSULATION TESTS YOR2023 (CRD - JR Faddoul, IE Sumner & JR Barber; RSD - DG Perdue)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		No test operations were scheduled during March. Efforts were devoted to preparing the test cell for testing the copper heat transfer tank in April. The KD 850 vacuum pump was checked out and 80 percent of the cell instrument work was completed.	
		Insulation is presently being installed on the copper heat transfer tank. Tests are scheduled for April.	

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YPC0425 (C&ECD - RJ Quentmeyer; RSD - T Cintula)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.
		A total of 19 test firings were made during April. The test configuration was the steel U-tube contour nozzle with the 500 Pc injector. These test firings were to evaluate start-up characteristics, and to substantiate optimum performance from previously established valve settings after rebuilding. The facility is now being prepared to accept the LH_2 cooled wire wrap engine #12. Test firings will be made at chamber pressures of 300 and 450 psia. This test configuration will be used to evaluate two different methods of thermocouple installation for measurement of LH_2 cooling properties. This program will start in May.	
	J-3 VACUUM ENVIRONMENT TANK		
		TANK INSULATION TESTS YOR2023 (CRD - JR Faddoul, IE Sumner & JR Barber; RSD - DG Perdue)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		No test operations were performed during April. The instrument equipment required to measure boiloff was not delivered on schedule. Efforts were devoted to preparing instrumentation and control equipment for the test operation. Vacuum pump-down checks were performed to determine the capabilities of the controllers. The test cell work is 90% complete. The research tank insulation installation is completed. Research tests will start in May pending receipt of the Hastings flowmeter.	

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	

28K ROCKET ENGINE
YPC0425
(CRD - RJ Quentmeyer;
RSD - T Cintula)

A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.

A total of four test firings were made this month on the wire-wrap LH_2-cooled engine #12, with a low Pc copper injector with cooling holes. Two runs at a chamber pressure of 300 psia were full-duration firings suitable for data acquisition. One six-second test firing was made at 450 Pc, and useful data were obtained. During all runs, engine performance was excellent. Temperature measurements were consistent at all stations.

Wire-wrap engine #6 is now being installed for investigation of engine coolant flow characteristics. A LN_2 cold flow test is planned for the end of the month.

The next research test program will be the LH_2-cooled U-Tube Contour Engine. Test firings are expected to begin in late June.

J-3 VACUUM ENVIRONMENT TANK

TANK INSULATION TESTS
YOR2023
(CRD - JR Faddoul,
IE Sumner & JR Barber;
RSD - DG Perdue)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

During May, the test cell and research tank were being prepared for June testing. Efforts were devoted to checking boiloff and pressure measuring instrumentation. The remaining work to be completed is as follows:

(1) Connection of thermocouples and pressure transducers thru the chamber lid.

(2) Insulation of the bottom cold guard on the research tank.

(3) Installation of research tank in vacuum chamber.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE YPC0425 (CRD - RJ Quentmeyer; RSD - TC Cintula)		A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.
		This month has been spent in preparing the liquid hydrogen cooled U-tube contour engine for test firings. Engine #1 was found to be leaking at a brazed joint around the coolant tubes after cold shocking and pressure testing. It was returned to Cleveland for repair. Engine #3 was acceptable after cold shocking and pressure testing. Engine instrumentation can now be installed. The manifold piping necessary for this engine is essentially complete except for qualification checkout. Test firing of Engine #3 is scheduled for late July.		
J	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS YOR2023 (CRD - JR Faddoul, IE Sumner & JR Barber; RSD - DG Perdue)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		On June 26 and 27, boil-off tests were conducted on the copper heat transfer tank. The tank and insulation were tested at vacuum chamber pressures of 760 and 100 TORR. Nitrogen gas was used to purge the chamber and helium gas was used to purge the insulation. The boil-off rates were 1568 SCFH at at 760 TORR and 1020 SCFH at 100 TORR. The test was terminated because of difficulty with the interstitial pressure measuring system. The test will be rescheduled to be completed in July.		

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YOR0425 (CRD - RJ Quentmeyer; RSD - TC Cintula)	A hydrogen-oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.
		This month has been spent in preparing the liquid hydrogen cooled U-tube contour engine for test firings. A test run date of August 1 has been established. This will be the first firing of a liquid cooled engine of this configuration in "J-1" Test Cell. Considerable effort has been spent in the fabrication of the manifold piping for this engine. All manifold piping has now been cold-shocked, X-rayed and pressure-checked. Following the test of the liquid hydrogen U-tube contour engine, the facility will be modified for the installation of either the copper wire wrap engine or the copper U-tube engine for heat transfer studies. Nearly one month of build-up time will be required for either engine.	

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	(Continued)	
	J-3 VACUUM ENVIRONMENT TANK	

TANK INSULATION TESTS
YOR2023
(CRD - IE Sumner & JR Barber; RSD - DG Perdue)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

During July, nine boil-off tests were conducted on the copper heat transfer tank. The insulation used on the copper tank was a composite design of 30 layers of double aluminized mylar separated by dexiglass and a fiberglass sublayer wrapped in a sealed mylar bag. The multilayer insulation was purged with nitrogen and the fiberglass was purged with helium. The purges were discontinued for space hold conditions. The results of the tests are as follows:

Date	Vacuum Chamber Press. (Torr.)	Helium Purge to the Insulation (psia)	Boil-off Rate (SCFH)
7/10/68	760.0	100.0	1605.0
7/11/68	100.0	30.0	1191.0
7/11/68	10.0	10.0	975.0
7/12/68	1.0	5.0	700.0
7/16/68	6.2×10^{-6}	0.0	5.77
7/16/68	2.4×10^{-4}	0.0	6.22
7/18/68	4.0×10^{-2}	1.0	60.0
7/19/68	2.0×10^{-1}	1.0	380.0

7/31/68 Conducted four-hour, controlled pumpdown simulating the "K" Site pumpdown rate on the 7' tank.

Three additional tests are scheduled during August. After completion of these tests, the copper tank will have additional insulation installed, and the same series of tests will be repeated.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE	

28K ROCKET ENGINE
YOR0425
(CRD - RJ Quentmeyer; RSD - TC Cintula)

A hydrogen/oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.

The LH_2 cooled U-tube contour engine was fired on August 8, at a chamber pressure of 300 psi. Although the firing was successful, several engine coolant tubes burned out at a location 2 inches from the injector. At this area, localized heating of the entire circumference of the engine was evident.

To investigate the circumstances of the localized heating, an instrumented, forged steel, U-tube contour engine is being installed. The low Pc porous face injector is having additional hydrogen holes drilled over half of the injector circumference to provide a cooling profile. This configuration is scheduled for testing on September 5.

The next test program will be the copper U-tube contour engine. This program is expected to be completed by October 15 and be followed by testing of a fully instrumented LH_2 cooled U-tube engine.

J-3 VACUUM ENVIRONMENT TANK

TANK INSULATION TESTS
YOR2023
(CRD - IE Sumner & JR Barber; RSD - DG Perdue)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

During August, three controlled pumpdown tests were made. The tests were conducted on August 12, 13, and 16. A four-hour controlled pumpdown simulating the "K" Site pumpdown rate on the 7' tank, a one-hour controlled pumpdown rate, and a controlled pumpdown rate simulating the Saturn ascent, were conducted. The insulation used for these tests was the same as used for the space hold tests during July. A repeat of the Saturn ascent pumpdown will be conducted in September. Then, additional insulation will be installed on the copper tank and the same series of tests which were conducted during July and August will be repeated.

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
J	J-1 ROCKET ENGINE SITE			
		28K ROCKET ENGINE YOR0425 (CRD - RJ Quentmeyer; RSD - TC Cintula)		A hydrogen/oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.
		Test firings were made on September 5 and 7 on the U-tube contour steel engine and low Pc porous face injector configuration. Both runs were at a chamber pressure of 300 psia. The injector was modified for these firings by adding additional fuel coolant holes at the injector circumference. These holes provided 15%, 7-1/2%, and 3-3/4% additional fuel coolant capabilities to the injector, based on complete circumferential coverage. A Kistler crystal high-frequency transducer indicated stable combustion throughout each test run. The next test date or engine configuration has not been established.		
	J-3 VACUUM ENVIRONMENT TANK			
		TANK INSULATION TESTS YOR2023 (CRD - IE Sumner & JR Barber; RSD - DG Perdue)		Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		During September three controlled pumpdown tests were made. The tests were conducted on September 13, 20, and 23. All the tests were conducted to simulate the Saturn ascent pressure curve. Difficulty was encountered in pumping the chamber from 1 Torr to 10^{-4} Torr because of nitrogen gas condensing on the fill and vent pipes inside the vacuum chamber. A Saturn ascent pressure curve test using helium in the vacuum chamber instead of nitrogen is scheduled for October. After this test additional insulation will be installed on the copper tank and the back pressure control system will be modified to control from atmospheric pressure to the high vacuum region.		

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YOR0425 (CRD - RJ Quentmeyer; RSD - TC Cintula)	A hydrogen/oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.

On October 15, a test firing was made with the U-tube contour steel nozzle and low Pc porous face injector configuration. The injector was modified for this test by having additional fuel coolant holes drilled along the injector circumference. These holes were sized to provide 3-3/4%, 2%, and 0% additional fuel coolant capabilities to the injector, based upon complete circumferential coverage. The firing was made at a chamber pressure of 300 psia.

The U-tube copper nozzle and modified low Pc injector configuration was tested on October 29 and 31. Heat transfer data was obtained for the following test parameters:

Pc	% Fuel
150	15-1/4
300	15-1/4
300	20
300	24
400	15-1/4

The U-tube copper nozzle will continue to be tested during the month of November. The copper nozzle will be mated to the high Pc modified porous face injector to obtain heat transfer data at the following conditions:

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	J-1 ROCKET ENGINE SITE (Continued)	

28K ROCKET ENGINE (Continued)

Pc	% Fuel
500	15-1/4
600	15-1/4
600	20
600	24
800	15-1/4

Late in November, a U-tube contour copper nozzle and unmodified high Pc porous face injector configuration will be tested. The test facility will terminate operations with this firing.

J-3 VACUUM ENVIRONMENT TANK

TANK INSULATION TESTS
YOR2023
(CRD - IE Sumner & JR Barber; RSD - DG Perdue)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

On October 2 a test was conducted to simulate the Saturn ascent pressure curve. Helium was used to purge the insulation and vacuum chamber for this test. A simulated altitude of 300,000 feet was obtained in less than three minutes. The space hold boil-off was 3.8 SCFH.

The upper tank was removed from the chamber and is presently being insulated for tests starting in the latter part of November.

The aluminum tank was delivered to Goodyear Company, Akron, for preinsulation fabrication. This tank will be completed for testing in December.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YOR0425 (CRD - RJ Quentmeyer; RSD - TC Cintula)	A hydrogen/oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.

A total of eleven test firings were made in the month of November with the instrumented copper nozzle of U-tube contour and modified porous face injector. Heat transfer data were obtained for the following listed test parameters:

Pc	% Fuel
150	15 1/4
500	15 1/4
600	20
600	24
800	15 1/4

An additional test was added to the program and is scheduled for December 10. This test will investigate the effect of various hydrogen flowrates thru the peripheral coolant holes in the injector. Heat transfer data will be compared for the following conditions:

Pc	% Fuel
600	15 1/4
600	24
800	15 1/4

This information will complete the copper nozzle test program. No future test programs are anticipated for J-1 Test Cell.

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
J	(Continued)	
	J-3 VACUUM ENVIRONMENT TANK	

TANK INSULATION TESTS
YOR2023
(CRD-1E Sumner & JR Barber; RSD - DG Perdue)

Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.

On November 25, 26, and 27, sixteen steady state data points were taken. The insulation system used for this test was 30 layers of mylar separated by silk netting for the MLI and a 3/4" thick fiberglass matting covered with a mylar bag for the sublayer. The upper tank was used for this test. Helium and nitrogen gases were used for the vacuum chamber gases. The results are listed below:

Boiloff in SCFH	Chamber Press. in TORR	Sublayer He Purge (PSIG)	Chamber Gas
5.5	1×10^{-5}	---	He
24.5	1×10^{-3}	---	"
199.0	1×10^{-2}	---	"
555.0	1×10^{-1}	---	"
1460.0	1.0	---	"
2030.0	10.0	---	"
2700.0	100.0	---	"
2730.0	760.0	---	"
9.52	1×10^{-6}	---	GN_2
14.6	3×10^{-4}	0.1	"
57.0	3×10^{-3}	0.5	"
76.0	1×10^{-1}	1.0	"
232.0	1.0	2.0	"
960.0	10.0	5.0	"
940.0	100.0	10.0	"
3000.0+	760.0	38.0	"

Three Saturn Ascent Pressure Tests are scheduled for this insulation system in December, which will complete the program on the copper tank in J-3. J-3 is the only facility presently capable of rapid pumpdown testing. A strong case was made to try a new configuration before the facility is bulldozed. Therefore, the aluminum test tank was sent to Goodyear for installation of a foam sublayer and is due back on December 6. Multilayer insulation blankets have been fabricated and will be installed when the tank is received. Testing will be carried out from December 16 through December 20, and the program will be terminated.

SITE	SITE NAME	RESEARCH INSTALLATION	& DESCRIPTION
J	J-1 ROCKET ENGINE SITE		
		28K ROCKET ENGINE YOR0425 (CRD - RJ Quentmeyer; RSD - TC Cintula)	A hydrogen/oxygen engine operated over chamber pressure range from 200 to 900 psi. Heat transfer is measured from the combustion gases to the chamber wall. The object is to extend heat transfer theory into the region required for design of nuclear rocket nozzles.
		On December 10, four test firings were made with the U-tube contour copper nozzle and a modified porous face injector. These runs were made at identical conditions to previous runs, to compare heat transfer effects of different injector designs. This series of runs was in addition to the original "finish up" program. No further rocket engine tests are scheduled for the facility.	
	J-3 VACUUM ENVIRONMENT TANK		
		TANK INSULATION TESTS YOR2023 (CRD - IE Sumner & JR Barber; RSD - DG Perdue)	Various liquid hydrogen tanks will be tested under a vacuum environment. The effectiveness of various types of insulation will be studied.
		During December, six Saturn Ascent pressure tests were conducted and six steady state data points were taken. Four Saturn Ascent pressure tests were performed on the copper tank and two on the aluminum tank. All the steady state tests were performed on the aluminum tank. Insulation and testing of the aluminum tank was an addition to the original project closeout program.	

SITE	SITE NAME RESEARCH INSTALLATION & DESCRIPTION
J	J-3 (Continued)

TANK INSULATION TESTS (Continued)

The insulation system used for the aluminum tank consisted of a 3/4"-thick, high-density foam over the aluminum tanks, with a mylar vapor barrier covering the foam. Three MLI insulating blankets, consisting of ten alternate layers of mylar and dexiglass each, covered the vapor barrier. The results of the tests are listed below:

Copper Tank

Date	Boiloff in SCFH	Chamber Press. in TORR	Press. Curve	Chamber Gas
12-2-68	2730-5.5	$760-1 \times 10^{-5}$	Saturn Ascent	He
12-3-68	3000-9.5	$760-1 \times 10^{-6}$	Saturn Ascent	GN_2
12-4-68	*	$760-1 \times 10^{-6}$	Saturn Ascent	GN_2
12-4-68	*	$760-1 \times 10^{-6}$	Saturn Ascent	He
Aluminum Tank				
12-20-68	800-9.0	$760-1 \times 10^{-5}$	Saturn Ascent	GN_2
12-27-68	1400-7.7	$760-6 \times 10^{-6}$	Saturn Ascent	He
12-30-68	8.0	7.8×10^{-6}	Saturn Ascent	He
12-31-68	7.7	7.8×10^{-6}	Saturn Ascent	He
12-31-68	14.4	2.3×10^{-4}	Saturn Ascent	He
12-31-68	65.0	1×10^{-2}	Saturn Ascent	He
12-31-68	750.0	1.0	Saturn Ascent	He
12-31-68	1300.0	100.0	Saturn Ascent	He
12-31-68	1400.0	760.0	Saturn Ascent	He

*Not applicable. Tank was empty and warm during these tests.

The completion of the tests on the aluminum tank terminates the programs for J-3.