

OPERATIONS OF THE PILOT PLANT PUMP FACILITY ("G" SITE)
July 1, 1961 to July 1, 1962

1. Between July 1, 1961 and September 26, 1961, five (5) test operations were conducted with LH_2 . The pump under test had a 0.6 hub tip ratio and ran at a speed of 15,000 RPM. Objectives were the loading limits of axial flow pumps and the reliability of similar pumps in dissimilar liquids. Sufficient data was taken to plot the characteristics of the 0.6 hub tip ratio pump.

2. The test facility was in a maintenance status between October 1961 and April 1962.

3. At the present time a 0.7 hub tip ratio pump is being tested. One run of this pump with LN_2 occurred before the end of the Fiscal year.

4. Operations of the Turbine Facility ("G" Site)

In the period between November 1961 and January 1962, 12 runs were made on the NERVA, 3 stage turbine. One run was made in June on the HYNUT, 6 stage turbine using N_2 gas.

of the pump suction and discharge lines.

d. "D" Site - Turbine Test Facility:

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

e. "E" Site - Dynamics Laboratory:

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

f. "F" Site - Hydrogen Flow Facility:

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

g. "G" Site - Pilot Plant:

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

h. Central Control:

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

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

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

1/28/1963

PLUM BROOK STATUS REPORT (continued)

ITEM NO	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
3	PUMP & TURBINE "G" Site Pilot Plant	Turbine Building F5A (Pinkel)	Liquid hydrogen cool bearing tests for three stage liquid hydrogen axial flow pump

STATUS: The turbine facility at the Pilot Plant has not been in use for approximately one year. Design of a three stage pump with liquid hydrogen cooled bearings has been completed. A temporary rig is being installed to support investigation of the hydrogen cooled bearing design. The resulting information will be incorporated into pump designs for future testing at "A" Site. The three stage pump parts are scheduled for delivery by mid March and checkout runs will start approximately the first week of April.

PLUM BROOK ROCKET SYSTEMS FACILITIES STATUS REPORT		CONTINUED	
SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
G	PUMP & TURBINE	<u>LH₂ Bearing Test</u> F5A (Pinkel)	Liquid hydrogen cool bearing tests for three stage liquid hydrogen axial flow pump. The resulting information will be incorporated into pump designs for future testing at "A" Site.
			<p>STATUS: The facility systems are being installed. The three stage pump parts are scheduled for delivery by mid March and check-out runs will start approximately the first week of April.</p>
		<u>LH₂ Pump</u> Pump Building (Pinkel)	Small scale axial flow liquid hydrogen pump .6 to .7 hub to tip ratio.
			<p>STATUS: A series of research runs have been completed on the .6 and .7 LH₂ axial flow pumps. Four LN₂ runs and five LH₂ runs were completed for the 0.7 rotor. Three LH₂ runs were completed for the 0.6 rotor. A total of 654 data points were taken; of the 654 data points 67% were considered useful. The remainder of the points were discarded due to instrumentation problems. Research data collected a G Site collaborated with water loop data taken at Lewis Research Center. Research hardware operated with minimum trouble. There were minor problems with the research rig instrumentation and the dewar.</p>
		<u>LH₂ Pump</u> (Pinkel)	Small scale axial flow liquid hydrogen pump .8 hub to tip ratio .
			<p>STATUS: Modifications are to be made on the building, pressure and vent system and vacuum jacketed piping to facilitate the use of the standard 6000 gallon Dewars. The pump housing is being modified to accept the .8 hub to tip ratio impeller. Anticipated run date is July 1963.</p>

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
G	PUMP & TURBINE	<p><u>LH₂ Bearing Test</u> F5A (Pinkel)</p> <p>STATUS: The facility systems are approximately 50% completed. The three stage pump parts originally scheduled for delivery by mid March have been delayed. Anticipated delivery date is estimated as mid April. Check out runs will start 1 May.</p> <p>Note (A) - Approximately one month delay due to non-availability of 3 stage axial flow pump hardware.</p> <p><u>LH₂ Pump</u> (Pump Building) F5A (Pinkel)</p> <p>STATUS: Site is undergoing modification to accommodate the 0.8 LH₂ pump and standardized dewars. The following design modifications have been completed or are underway: (a) Control panel layout - 90% completed, (b) Minor building additions - 100% completed, (c) Vacuum jacket inlet and discharge lines - 90% completed, (d) Facility piping system - 10% completed, (e) Standard dewar control panel - 100% completed, (f) Up-dated safety system - 5% completed. The anticipated run date is the last week in July or the first week in August 1963.</p>	<p>Liquid hydrogen cool bearing tests for three stage liquid hydrogen axial flow pump. The resulting information will be incorporated into pump designs for future testing at 'A' Site.</p> <p>Small scale axial flow LH₂ pump 0.8 hub to tip ratio.</p>

April 1963

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
G	PUMP & TURBINE	(TURBINE BUILDING) PUMP - 3 STAGE (RUNNING GEAR CHECKOUT) F5A (Pinkel)	<p>Running gear proof check of 3 stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site.</p> <p>STATUS: Note (A) : In order to obtain proper clearances, various pump parts had to be sent back to Cleveland for re-machining. Within 30 days after altered parts are returned the pump should be ready for operation.</p> <p>Presently the control tank instrumentation is being installed and the control panel is 50% complete. 50% of the cell piping is completed but this work and cell instrumentation work cannot be completed until the pump is installed.</p> <p>(PUMP BUILDING) PUMP - LH₂ F5A (Pinkel) Small scale axial flow LH₂ pump 0.8 hub to tip ratio.</p> <p>Site modifications to accommodate the new axial flow pump and standardized LH₂ dewars are proceeding as follows: (a) The cryogenic piping system design and specifications have been completed. (b) The gas manifold system design is 50% completed. (c) The new control panel layout drawings have been completed and necessary equipment has been ordered. (d) Instrumentation equipment purchase requests have been prepared. (e) The building modifications bids will be opened on May 10, 1963.</p>

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
G	PUMP & TURBINE	(TURBINE BUILDING) PUMP - 3 STAGE <u>RUNNING GEAR</u> <u>CHECKOUT</u> F5A (Pinkel)	Running gear proof check of three stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site. STATUS: All pump parts which required re-machining for proper clearances have been altered and a preliminary assembly of the pump has been completed. The pump is presently undergoing final assembly in the test cell and modifications to piping system to fit the pump are underway. Tests should commence in mid-June. <hr/> (PUMP BUILDING) PUMP - LH ₂ F5A (Pinkel) Small scale axial flow LH ₂ Pump, 0.8 hub to tip ratio. NOTE (A) : Contractual award lead time has resulted in an estimated two months delay in operations schedules. STATUS: Design of all operations systems is complete. The cryogenic piping system has been advertised for contractor bids. Control panel hardware has been received and assembly is approximately 10% completed. Building modifications have been started. Installation of a new instrument cable trough between the control room tank and the test cell has been started

G

PUMP
&
TURBINE

(TURBINE BUILDING)
PUMP - 3 STAGE
RUNNING GEAR
CHECKOUT
(Pinkel)
OFO 554

Running gear proof check of three stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site.

STATUS: Difficulties were encountered during assembly of the pump and several parts required modification. Shortage of manpower delayed installation of piping system. All systems are now ready for a July 2, LN₂ run.

NOTE (A) : Scheduled start date was moved from June to July. Pending unforeseen problems with the pump and/or facility, all testing should be completed by early September.

(TURBINE BUILDING) Turbine MK 15. & NERVA Turbine.
TURBINES

NOTE (B) : It has been assumed that tests of the MARK 15 turbine have been cancelled.

NOTE (C) : Original test schedule of September 1963 has been deferred until March 1964. (NERVA Turbine)

(PUMP BUILDING)
PUMP - LH₂
(Pinkel)
OFO 553

Small scale axial flow LH₂ Pump, 0.8 hub to tip ratio.

STATUS: (a) Building modification will be completed by the first week in August. (b) Control panel assembly is 25% completed. (c) Installation of new instrument cable between control tank and test cell is 50% completed. (d) Fabrication and installation of cryogenic piping - contract not awarded. (See Note A)

NOTE (A) : The test schedule for the LH₂ pump has been delayed approximately 45 days. This schedule delay resulted from anticipated delays in pump hardware delivery and a "no bid" response from contractors solicited for the cryogenic piping system fabrication. This no bid response was attributed to an insufficient time of 60 days for contract completion. Since pump parts will be delayed, the contract was re-advertised with an 80-day contract completion date.

July 1963

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP & TURBINE	(TURBINE BUILDING) <u>PUMP - 3-STAGE</u> <u>RUNNING GEAR</u> <u>CHECKOUT</u> OF0554 (Pinkel)	<p>Running gear proof check of three-stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site.</p> <p><u>STATUS:</u> During July, three attempts were made to run the three stage pump with LN₂. The following problems were encountered during runs; (a) gas supply to balance piston was insufficient, (b) balance piston diameter was too large and the pump siezed, and (c) carbon seals leaked while pump was running.</p> <p>The results of the running gear proof checks indicate a requirement for pump modification. The pump is presently being modified for a second series of proof checks which will start during the first week in August.</p>
		(TURBINE BUILDING) <u>NERVA TURBINE</u> (I. I. Pinkel) OF0 554	<p>NERVA turbine</p> <p><u>STATUS:</u> Turbine research scheduled for March 1964. Facility modification work will commence pending receipt of firm research requirements.</p>
		(PUMP BUILDING) <u>PUMP - LH₂</u> (I. I. Pinkel) OF0 553	<p>Small scale axial flow LH₂ pump, 0.8 hub to tip ratio.</p> <p><u>STATUS:</u> (a) Building modifications have been completed. (b) Control panel assembly is 50% completed. (c) Bids have been opened for the cryogenic piping contract. The contract will be awarded during the first week in August. (d) Bids for the LH₂ manifold and facility piping will be opened August 13, 1963. (e) Pump hardware should be available for assembly and installation during late September or early October.</p>
			<p>NOTE (A) : The first tests have been rescheduled for mid-December due to delays caused by contract administration.</p>

SITE	LABORATORY RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	<p>PUMP & TURBINE</p> <p>(TURBINE BUILDING) <u>PUMP - 3-STAGE</u> <u>RUNNING GEAR</u> <u>CHECKOUT</u> OF0553 (Pinkel)</p> <p><u>STATUS:</u> During the month of August, four attempts were made to run the 3-stage axial flow LH₂ pump in LN₂. The following problems were encountered during these runs: (a) When pressure was applied to thrust piston to simulate thrust, the pump rotor seized because the stack-up nut had not been tightened properly. (b) Bearing position transducer did not function properly in LN₂ when pressure was applied to thrust piston. This was caused by the large volume of N₂ gas flowing thru the labyrinth seal. (c) Excessive wear on the rear carbon seal for the short run duration at low speed (30 min. at 4000 RPM). The wear should have been negligible. The pump parts are now at Lewis being modified to allow the bearing position transducer to be mounted in a manner to eliminate the effect of differential temperature. Provisions are also being made for a positive seal between the thrust piston and the bearing vent areas. It is anticipated that pump parts will be available for testing in LN₂ during the first week in September.</p> <p>(TURBINE BUILDING) NERVA turbine. <u>NERVA TURBINE</u> OF0554 (Pinkel)</p> <p><u>STATUS:</u> A work order has been prepared for installation of new instrumentation cable to the turbine rig. Design work has been started for modification of the mechanical system. Material for the control panels has been received. Transducers are on order, explosion-proof lighting has been installed. There are no anticipated delays in the testing which is scheduled for early March.</p> <p>(PUMP BUILDING) Small scale axial flow LH₂ pump, 0.8 <u>PUMP - LH₂</u> OF0553 (Pinkel) hub to tip ratio.</p> <p><u>NOTE (A):</u> It is anticipated that the facility will not be in operational status for LH₂ pump testing prior to Dec. 15. Pump hardware should be available for assembly by late Sept. or early Oct. A one to two month delay of the facility is attributed to late award of contracts for the piping systems.</p> <p><u>STATUS:</u> (a) Installation of explosion-proof lighting has been completed. (b) Control panel - 75% complete (c) LH₂ transfer system - contract awarded - 0% complete (d) LH₂ manifold and facility piping system - contract awarded - 0% complete.</p>	<p>Running gear proof check of three-stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site.</p>

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
G	PUMP & TURBINE	<p>(TURBINE BUILDING) <u>PUMP - 3 STAGE</u> <u>RUNNING GEAR</u> <u>CHECKOUT</u> OF00553 (Pinkel)</p>	<p>Running gear proof check of three-stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site.</p> <p><u>STATUS:</u> Additional design modifications to the three stage pump are underway. It is anticipated that shop work will be completed on October 22. Depending on the availability of manpower in the Cleveland shops. Additional testing will start during the first week in November.</p> <p>NOTE (A) : "G" Site testing of the three stage pump was scheduled for completion by late September. This has been delayed until early December because of the numerous pump modifications. This may delay the starting date of February 1, 1964 for testing of this pump at "A" Site.</p> <p>(TURBINE BUILDING) NERVA turbine. <u>NERVA TURBINE</u> OF0-554 (Pinkel)</p> <p><u>STATUS:</u> The turbine building and systems are in the process of updating to accomodate the NERVA turbine.</p> <p>NOTE (B) : The NERVA turbine is now expected to arrive at Plum Brook on or about September 1964. The operations schedule has been changed to testing during October 1964.</p>
		<p>(PUMP BUILDING) <u>PUMP - LH₂</u> OF0-553 (Pinkel)</p>	<p>Small scale Axial flow LH₂ Pump, 0.8 hub to tip ratio.</p> <p><u>STATUS:</u> (a) The pump hardware is scheduled to be out of the machine shop by the last week in October or early part of November., (b) Control panels are 85% completed, (c) The LH₂ transfer system is scheduled for completion on November 15, (d) LH₂ manifold and facility piping system are scheduled for completion by Mid-December, (e) All valves are ready for installation, (f) The purchase request for installation of new instrumentation cable has been approved, and the work is scheduled for completion by contract during early October. LH₂ pump testing is scheduled for the third week in December.</p>

SITE	LABORATORY	RESEARCH INSTALLATION (FOR)	DESCRIPTION
G	PUMP & TURBINE	<p>(TURBINE BUILDING) PUMP - 3 STAGE <u>RUNNING GEAR</u> <u>CHECK-OUT</u> OFO-553 (Pinkel)</p>	<p>Running gear proof check of three-stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at 'A' Site.</p> <p><u>STATUS:</u> The latest scheduled delivery of parts for the Three-Stage pump is November 1. Assuming that this date is met, testing should begin late in the week beginning November 4.</p>
		<p>(TURBINE BUILDING) NERVA Turbine. <u>NERVA TURBINE</u> OFO-554 (Pinkel)</p>	<p><u>STATUS:</u> Updating to accommodate the NERVA turbine continues on the turbine building and systems. Delivery of the test vehicle is scheduled for September, 1964.</p>
		<p>(PUMP BUILDING) <u>PUMP-LH₂</u> OFO-553 (Pinkel)</p>	<p>Small scale Axial flow LH₂ Pump, 0.8 hub to tip ratio.</p> <p><u>STATUS:</u> Modification of the pump building and associated systems continues. The control panels are 90% complete, and the GH₂ manifold contract work is completely finished. NASA personnel are now installing tubing, valves, transducers, etc. Although the facility piping is approximately 85% complete, there will be a delay pending receipt of LH₂ transfer lines, now scheduled for delivery by mid-December. Work on the instrumentation cable contract has begun, but is proceeding less rapidly than desired because of lack of hardware. Scheduled completion for this phase of work is now November 15.</p> <p><u>NOTE (A):</u> Because of reputed quality problems with pump hardware, delivery of the final product has been delayed to the end of December, 1963. This fact, plus contract completion delays necessitates rescheduling LH₂ pump testing to the latter part of January, 1964.</p>

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP & TURBINE	<p>(TURBINE BUILDING) <u>PUMP - 3 STAGE</u> <u>RUNNING GEAR</u> CHECK-OUT OFO-553 (Pinkel)</p> <p><u>STATUS:</u> Parts for the three-stage pump were received on November 8. However, a preliminary attempt at assembly revealed the necessity for several rework items. This rework was subsequently accomplished in the Plum Brook shops and a successful mating of parts was accomplished.</p> <p><u>NOTE (A):</u> Before a final assembly is completed and testing begun, delivery of pump O-Ring seals is required. If the seals are delivered as promised, the test program should begin the week of December 2.</p>	<p>Running gear proof check of three-stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site.</p>
		<p>(TURBINE BUILDING) OFO-554 (Pinkel)</p> <p><u>STATUS:</u> Delivery of the test package is scheduled for September, 1964. Turbine Building equipment and systems updating continues to accomodate the NERVA Turbine.</p>	<p><u>NERVA Turbine.</u></p>
		<p>(PUMP BUILDING) <u>PUMP-LH₂</u> OFO-553 (Pinkel)</p> <p><u>STATUS:</u> Pump building modifications continued throughout the month of November. Contract work covering the installation of instrument and TV cables is now approximately 70% complete, with completion expected by early December. Another contract item is the placing of N₂ and He filters and storage bottles, which is approximately 50% finished. Delays in the delivery of LH₂ transfer lines have caused subsequent delays in the completion of other items as well, although the next scheduled run date of late January 1964, remains unchanged. There has been no change in the status of pump hardware since last month's report.</p>	<p>Small scale Axial flow LH₂ Pump, 0.8 hub to tip ratio.</p>

SITE	LABORATORY RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	<p>PUMP & TURBINE (TURBINE BUILDING) <u>PUMP - 3 STAGE</u> <u>RUNNING GEAR</u> <u>CHECK-OUT</u> OFO-553 (Pinkel)</p>	<p>Running gear proof check of three-stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at "A" Site.</p> <p><u>STATUS:</u> This pump was operated in LN₂ on December 5, 9, 13, 16, and 20, 1963. Earlier runs were plagued with various difficulties, but these were gradually eliminated by installing new pump seals, a new aluminum balance piston, and correcting some electrical problems with the Schaevitz position transducer. During the most recent run, operation was generally satisfactory with the exception of a slight seal chatter at low balance piston loads.</p> <p>An additional LN₂ run is scheduled for January 2, 1964 at 8000 RPM to check seal performance after further run-in. This proving successful, testing with liquid hydrogen will begin, continuing through the month of January.</p> <hr/> <p>(TURBINE BUILDING) NERVA Turbine. <u>NERVA Turbine</u> OFO-554 (Pinkel)</p> <p><u>STATUS:</u> An investigation is now underway to determine whether the NERVA turbine should be run at "C" Site or "D" Site. If testing with nitrogen only is required, then operation at "G" Site is possible and desirable. However, if hydrogen running is contemplated, then "D" Site should be used for the following reasons:</p> <ol style="list-style-type: none"> (1) "G" Site dynamometer is not capable of absorbing the required horsepower. (2) "G" Site is not equipped with sufficient features to provide safe operation with hydrogen. <p>If both nitrogen and hydrogen running are required, it would be logical to do both at "D" Site, thus saving one setup. Investigations will continue to determine the exact test objectives so that the proper conclusions might be reached.</p> <p>NOTE (A) : Delivery of the test package is now scheduled for December 1964.</p> <p>(Continued on Page 21)</p>

SITE	LABORATORY RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP & TURBINE (continued) (PUMP BUILDING) <u>PUMP-LH₂</u> OF0-553 (Pinkel)	Small scale Axial flow LH ₂ pump, 0.8 hub to tip ration. <p><u>STATUS:</u> This reporting period saw a continuation of the planned pump building modifications. Instrumentation and TV cable installation is now complete, as is the installation and proof pressure checking of GN₂, GH₂ and service air filters. The major obstacle to completion of the job is the delivery of a jacketed LH₂ transfer pipe (shipped December 20, 1963) and the calibration (by Lewis) of a flowmeter to be installed in the LH₂ system. Also required is the receipt and installation of balance panels.</p> <p>The pump is scheduled for delivery to Plum Brook in January 1964 and no change from the planned February 1, 1964 test date is now contemplated.</p>

January 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	(TURBINE BUILDING) PUMP, 3-STAGE RUNNING GEAR CHECK OUT OF0553 (Pinkel)	<p>Running gear proof check of three-stage liquid hydrogen axial flow pump. Information obtained from proof checks may be used to modify this pump before testing at 'A' Site.</p> <p>STATUS: The pump was operated in liquid nitrogen on January 3, with the aluminum balance piston. At that time, excessive vibration was encountered at high speed. It was decided to return rotating components to Lewis Research Center for rebalancing. On reassembling, new seals with increased compressive load, were installed.</p> <p>(Pinkel & Manson) Centaur tank will be filled with liquid hydrogen and the boiloff rates monitored.</p> <p>STATUS: The second Centaur PTV insulation Test was completed on January 22 through January 24. Test objectives were successfully completed. Eight pressure rise tests were performed at four ullage points. Boiloff rate was substantially greater than that anticipated; therefore, the actual boiloff test was terminated after 10.5 hours. This increased boiloff rate was caused by failure of the vacuum bulkhead between the liquid hydrogen and liquid oxygen tank. 9150 gallons of liquid hydrogen were used, of which 8300 gallons were actually boiled off during the test.</p> <p>Two or three PTV insulation panels apparently failed in addition to five panels which failed during the first test. At this time, no further test runs are anticipated.</p> <p>Continued on Page 22</p>

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	(Continued)		<p>A break-in run in liquid nitrogen was attempted on January 21, to prepare for a hydrogen run. However, the Schaevitz transducer failed, and it was again necessary to disassemble the pump. Another transducer was coldshocked through 20 cycles and installed.</p> <p>Since Project Fab liquid hydrogen dewars are out of service, the pump inlet adapter was modified to include a remote operated relief valve. This will permit the use of H-3 or H-4 dewars. A liquid hydrogen run* was made on January 31. Following the run, it was decided that no further runs would be necessary, so the pump will be shipped to "A" Site for testing. * Burn off malfunction required test to be stopped before test objectives were obtained.</p> <hr/> <p>(TURBINE BUILDING) NERVA Turbine. NERVA Turbine OF0554 (Pinkel)</p> <p>STATUS: There has been no change in the status of this program since the last report. The program objectives remain undefined and the turbine delivery data continues to slide. No site modifications are in progress or in the planning stage.</p> <hr/> <p>(PUMP BUILDING) Small scale axial flow LH₂ pump, 0.8 PUMP-LH₂ hub to tip ratio. OF0553 (Pinkel)</p> <p>STATUS: The first section of cryogenic piping was received in Lewis for calibration, but was found defective. The flange which should mate with the research pump was male instead of the intended female. The vendor will furnish the correct flange, but a serious delay to calibration of the section cannot be avoided. The remaining cryogenic piping is promised for shipment on February 7. Installation of instrumentation transducers, balance panels, power supplies, etc., is currently in process. Probe actuators and associated equipment are also in hand.</p> <p>NOTE (A): Due to the fact that the pump was not received until January 20, and the cryogenic piping difficulties mentioned above, the first run date has been rescheduled to the week of March 16.</p>

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	<p>(PUMP BUILDING) PUMP-LH₂ OF0553 (Pinkel)</p> <p>The research pump, torquemeter, and turbine have all been aligned and are firmly bolted to the test stand. Rotating pump parts are now being balanced. All sections of the cryogenic piping, except one, are now on hand, and the required instrumentation holes have been machined. The flow meter section of this piping was calibrated at Lewis Research Center and is scheduled to be returned to Plum Brook by March 1.</p> <p>A speed control checkout was made on February 27. Work is now continuing on the installation of cryo-piping, associated valves, transducers, instrument probes, etc. The first pump run is scheduled for the week of March 16. This run may have to be delayed due to a shortage of liquid dewars since there are four other test facilities which are using the two existing dewars. The one possibility is that H-7 dewar, which is in the "standardization program", could be completed by Lewis personnel and delivered to Plum Brook before March 16.</p> <hr/> <p>(TURBINE BUILDING) NERVA Turbine OF0554 (Pinkel)</p> <p>NOTE (A): The NERVA Turbine test program was cancelled.</p>	

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	<p>(PUMP BUILDING) <u>PUMP-LH2</u> 0F0553(I.I.Pinkel)</p> <p>As a result of the turbine speed control run reported last month, it was determined that additional air flow capacity was required. Accordingly, the cell line size was increased to 4", and a 4"-speed control valve was procured and installed.</p> <p>The research pump was assembled with a blank rotor in preparation for a liquid nitrogen pump torque loss determination run.</p> <p>With respect to the facility, the cryo-piping is now completely installed. Final stages of work are in progress</p> <p>NOTE (A) : Lewis engineers have requested a two-week extension of the test program.</p>	<p>Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio.</p> <hr/> <p><u>CENTAUR</u> Insulation test for Centaur 0V0687(D.S.Gabriel) vehicle.</p> <p>On March 17, the Centaur liquid hydrogen tank was deflated from 6 PSIG to atmospheric pressure. This was a test to determine the effect of the insulation on the structural rigidity of the tank. No adverse effects were observed as the tank was deflated. Further testing is not anticipated and the Centaur tankage will be removed from "F" Site. on the mounting of transducers, plus the connection of the necessary tubing.</p> <p>NOTE (A) : Because of the difficulties experienced with the turbine speed control, the first liquid hydrogen run is now scheduled for April 17.</p>

April 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	<u>(PUMP BUILDING)</u> <u>PUMP - LH₂</u> OF0553 (I.I. Pinkel)	Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio . On April 2,3, 7, 15, and 28, the pump was operated with a dummy rotor and with liquid nitrogen as the working fluid. These tests were to determine the torque losses caused by all rotating gear associated with the test pump rotor. These runs were unsuccessful because of speed control problems and the inability to record consistent torque. All efforts to remedy these problems were unsuccessful. Inspection of the disassembled pump revealed that the seals were only slightly worn, but there were flat spots on the forward bearing rollers--a condition which may have been a result of bearing skipping. The bearing has been replaced and a run was scheduled for May 1. If the run is successful, a hydrogen run will be scheduled for the week of May 4.

May 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	<u>(PUMP BUILDING)</u> <u>PUMP - LH₂</u> OF0553 (I.I.Pinkel)	<p>Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio.</p> <p>On May 1, the pump was operated successfully with a dummy rotor and using liquid nitrogen as the working fluid. Purpose of the test was to determine the rotating torque losses. This test was successfully repeated on May 8 with liquid hydrogen.</p> <p>Subsequently, the pump was torn down, then reassembled with the 0.8 hub-to-tip ratio impeller, plus necessary instrumentation. An attempt was made to complete a pump performance test on May 21, but due to difficulties experienced with both instrumentation and the liquid hydrogen dewar, no test was possible.</p>

June 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	(PUMP BUILDING) PUMP - LH ₂ OF0553 (I.I.Pinkel)	<p>Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio.</p> <p>During the month of June, three research data runs were attempted.</p> <p>On June 5th, the pump and other systems were operating normally when a circuit breaker tripped and caused the pump to shut down before any data could be obtained. The run was subsequently cancelled.</p> <p>On June 12, the hydrogen supply was depleted before the digitizer and speed control problems could be resolved. No data was obtained.</p> <p>On June 16 a speed control adjustment was made.</p> <p>On June 23, two hydrogen dewars were used to increase the liquid supply. Data was recorded, but upon playback of the tape at Lewis, it was discovered that the site digitizer failed to operate properly. Approximately two-thirds of the data was lost.</p>

July 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	(PUMP BUILDING) PUMP-LH ₂ RF0553 (I.I.Pinkel)	Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio. On July 17, a pump run was attempted. During the run the speed control valve failed, and it was necessary to abort the test after taking seven data points. The newly installed remote NPSH system functioned properly during the test but it had slow pressure response. Control valves have now been modified to give a higher flow coefficient (Cv). Although the digitizer had been extensively reworked prior to this test and tapes taken on preceding days indicated normal operation, the print out of run data revealed that the digitizer had malfunctioned and part of the data was non-usable. An additional test that was scheduled to be run on July 31 was cancelled because of a new digitizer problem and by unresolved turbine speed controller problems.

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	<p>(PUMP BUILDING) PUMP-LH₂ RF0553 (I.I. Pinkel)</p>	<p>Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio.</p> <p>On August 6, the pump was tested and 45 data points were obtained.</p> <p>On August 21, 44 data points were obtained. The automatic flow control which was used for the first time this month functioned properly.</p> <p>The primary problem at "G" Site stems from erratic operation of the data acquisition system. All data from the August 21 run was rendered useless by faulty zero and EC recordings, and the run scheduled for August 28 had to be cancelled because of erratic operation of the data acquisition system. The digitizer has been a chronic source of trouble during the test series with the 0.8 ratio pump.</p> <p>The data system at "G" Site is a local installation and the equipment is very antiquated. Because of its extreme age, the electronics can be expected to require large amounts of maintenance and, at best, some data will continue to be lost. The equipment is undergoing intensive maintenance with the hope of getting "just one more job done". Some alternate solutions are being investigated.</p> <p>NOTE: Because of lost data and run cancellations, the test program has been extended from the first of November to the end of January.</p>

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	(PUMP BUILDING) PUMP-LH ₂ RF0553(I.I.Pinkel)	Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio. On September 4 a successful run of the LH ₂ pump was made. On September 14, a second attempt was terminated by a hydrogen explosion within the Test Building. The intensity of the detonation was great enough to heavily damage the test hardware, the building structure, and the loop. Considerable additional damage was caused to adjacent buildings and the two liquid hydrogen dewars. Full details of the blast are not yet known. However, an investigation committee was formed, and a report will be issued as soon as all the facts are known. Information on metallurgical analysis is still pending at this time.

September 1964

SITE	LABORATORY	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
G	PUMP AND TURBINE	<p>(PUMP BUILDING) <u>PUMP-LH₂</u> RF0553(I.I.Pinkel)</p>	<p>Small scale axial flow liquid hydrogen pump, 0.8 hub-to-tip ratio.</p> <p>During October, the Investigation Committee continued to work on their report of the September 14th explosion.</p> <p>The decision was made that no more testing will be done at the Pilot Plant Area ("G" Site). The single-stage axial-flow pump will be tested at another facility, probably "A" Site. Preliminary feasibility studies are now being made to determine the methods and costs.</p>

October 1964