SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

APRIL 1965

SITE	LOCATION	RESEARCH INSTALLATIONS (FOR)	DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FACILITY	NERVA OT1016 (H. M. Henneberry)	On March 31, the planned "B-3" test program on the Mark IX turbopump was cancelled. On April 13, the decision was made to move the "B-1" Block II test program to "B-3". At "B-3" Facility a turbopump test program will be run on an alternating schedule with the systems tests. The research hardware will consist of an Aero-Jet Mark III, Mod 4 turbopump, a KIWI B1B reactor with dummy fuel cells, and several servo-control systems. pleted. A flow rate of 31#/sec., at a pump speed of 10 000 rpm was attained on run #24. A flow rate of 28#/sec. at a pump speed of 8 500 rpm was attained on run #25. Total run duration for these tests was 35 seconds. On April 27, liquid hydrogen run #26 was completed. The turbopump system was bypassed for this run to obtain system dynamics data. A flow rate of 24#/sec. was obtained with a run duration of 24 seconds. In mid-April, a decision was made by Lewis Management to transfer the NERVA Program from "B-1" to "B-3" where testing will be run on an alternating basis between full scale pump tests and system dynamics tests. The essential elements of the research hardware will be removed from "B-1" along with required instrumentation for transfer to the "B-3" stand. Since no program presently exists for this facility, it will be maintained on a "standby" basis. This report will constitute a final status report until a research program is initiated for the B-1 Facility. Tasks for the next five months will include transfer of equipment from "B-1" to "B-3", upgrading of "B-3" Facility instrumentation, modification to the "B-1" steam system, and revisions to the "B-3" Facility piping and electrical system Checkout runs with LN_2 are scheduled for October.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

MAY 1965

SITE	LOCATION	RESEARCH INSTALLATION & DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.	

NERVA
OT1016
(H.M. Henneberry)

NERVA engine propellant feed system tests.

The new steam regulating system was checked out during the week of May 17. The new reactor nozzle arrived at Plum Brook on May 21 and is currently being mounted. Transfer of the systems test equipment from "B-1" to "B-3" is nearly complete.

Work is continuing on reactor carriage modifications, fabrication of the 54-inch nozzle adapter section, installation of servo-control valves, and hookup of new instrumentation equipment. The preliminary design of piping modifications for "B-3" systems tests has been completed. Liquid nitrogen checkout runs are scheduled for October.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

JUNE 1965

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.	NERVA OT1016 (H.M. Henneberry)		NERVA engine propellant feed system tests.

The 54" adapter section and no-flow diffuser have been installed. Modification of the reactor carriage was completed. The reactor will be installed in "B-3" by July 2.

The new thermocouple wires and instrumentation cabinets have been received and are being installed. Additional monitor instrumentation is being installed in the control room.

Three of the Annin "Y" pattern servo-valves have been installed and are ready for checkout.

Delivery of the Mark III, Mod. 4, turbo-pump is still scheduled for August 1, and checkout runs with liquid nitrogen are scheduled for October.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

JULY 1965

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.	NERVA OT 1016 (H. M. Henneberry)		NERVA engine propellant feed system tests.

The installation of the reactor and carriage has been completed. The piping to the nozzle is presently being installed. Pre-fabricated sections of the nozzle access platform have been delivered and are ready for installation.

A preliminary flow test was made on the altitude exhaust purge system with satisfactory results. Further testing will be performed when the steam system is returned to operation in August.

Installation of the new instrumentation cabinets is complete, and the new thermocouple wires have been pulled. Purchase Request for the addition to the forward instrument room still has to be processed.

Because the delivery of the Mark III, Modification 4 Turbopump has been extended to the latter part of August, Liquid Nitrogen checkout runs cannot be started until November.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

AUGUST 1965

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC	NERVA OT 1016 (H. M. Henneberry)		NERVA engine propellant feed system tests.

The following work was accomplished during August:

(1) The nozzle access platform installation was completed.

(2) Temporary installation of some of the reactor piping was completed so that the guides and supports could be fabricated.

(3) Some of the movie and TV camera supports were designed, fabricated and installed.

(4) The signal conditioning equipment installation and checkout was 80% completed.

(5) A checkout of the exhaust purge system with the steam ejectors was completed on August 26. The O_2 concentration in the 54" duct was reduced to 0.5%.

(6) An initial checkout of the servo valves was completed.

Significant event schedules are:

(1) Installation of data transducers is scheduled to start September 1.

(2) The bid opening for the forward instrument room addition has been re-scheduled to September 10.

The following problems were encountered:

(1) On the August 26 test the steam pressure control system failed to regulate. There seems to be some problem with contamination of hydraulic fluid and resulting interference with servomotor operation. This problem is currently being investigated.

SITE	SITE NAME RESEARCH INSTALLATION & DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.

(2) The actuator on the four-inch servo vent valve developed a large internal leak. After a brief period of satisfactory operation a second actuator developed the same problem. The manufacturer has been contacted. The other actuators on the smaller Annin servo valves have operated satisfactorily to date.

(3) Leaks developed between the nozzle and Mylar seal adapter ring. Apparently they are located where "Devcon" has been used to seal instrumentation tube penetrations. These penetrations will be resealed.

The pacing item for Research Operations is the delivery of the Mark III, Modification 4 turbopump from Aerojet which has slipped to the latter part of September. However, an on schedule (September 15) delivery of research piping may still allow checkout runs with liquid nitrogen the first part of November. These checkout runs could be delayed if difficulties are encountered in sealing the nozzle leaks.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

SEPTEMBER 1965

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.	

NERVA — NERVA engine propellant feed system tests.
OT 1016
(H. M. Henneberry)

The installation of the pressure transducers, movie camera and TV camera on the reactor-nozzle assembly constituted the major mechanical effort this month. This work is scheduled for completion the week of October 4. The leak between the nozzle and the mylar seal adapter ring was effectively sealed using Devcon F-2. However, another problem has been encountered on the nozzle. The nine carbon steel AN fittings which are welded to the nozzle inlet manifold for use as pressure taps must be ground off and replaced with stainless steel fittings. This repair will be done with the nozzle in place.

The actuator manufacturer (Boonshaft and Fuchs) maintains that the internal leakage in the servo-valve actuators was caused by the adverse tolerance build-up and has agreed to repair any units found to be defective. Meanwhile frequency response tests have started on the two-inch tank pressurization servo and the four-inch pump load servo.

All but twenty-four channels of the signal conditioning equipment have been installed and checked out. The remaining twenty-four channels will be completed when equipment is delivered. Installation of the SEL subsystem has begun. Hook-up and checkout of transducers will start October 4. The contract for the addition to the forward instrument room will be awarded on October 1. The contract has a completion time of 75 days.

The problems which were encountered in the steam pressure control system were traced to calibration discrepancies which have been corrected. Checkout operation will be resumed the first week in October.

Delivery of the turbo-pump and most of its associated piping is scheduled for the week of October 4. Delivery of the liquid Hydrogen level probe has slipped to October 11. The first liquid hydrogen run is still scheduled for mid-November.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

OCTOBER 1965

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.	NERVA OT 1016 (H.M. Henneberry)		NERVA engine propellant feed system tests.

The Aerojet Mark III Turbopump was delivered the week of October 4. All of the valves and piping for the propellant flow system have been received. The turbopump has been installed and is being instrumented. The installation of the propellant piping is scheduled to be completed by November 6. The liquid hydrogen liquid level probe has been installed and the liquid hydrogen run tank is presently being pressure checked and inerted.

The repaired Boonshaft and Fuchs actuator for the tank vent servo valve is scheduled to be delivered to Plum Brook by November 1. However, the identical actuator on the pump load servo developed the same internal leakage and has been shipped to the manufacturer for repairs. Boonshaft has promised return delivery of this unit by November 6. Checkout was completed on the tank pressurization servo and the checkout of the two-inch and four-inch pump discharge servo valves is proceeding satisfactorily.

Ten more balance panel channels are required to meet the instrument requirements for the first liquid nitrogen run. These were scheduled to be delivered October 18. They are currently being expedited. Installation of the SEL subsystem is complete and checkout will start November 1. Construction of the forward instrument room addition has begun.

Because of the steam system contracts the checkout of the steam system has been delayed, but it is scheduled to be resumed the first week of November.

The first liquid nitrogen checkout run is scheduled for November 17.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

NOVEMBER 1965

SITE	SITE NAME	RESEARCH INSTALLATION	&	DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.			

NERVA

OT1016(H.M.Henneberry) NERVA engine propellant feed system tests.

The first liquid nitrogen checkout run was made on November 17. Major parameters were as follows:

a. Tank pressure of 5 psig.

b. Maximum liquid nitrogen flow rate of 34 pps.

c. Turbopump rpm of zero (as predicted).

d. Duration of flow through the reactor of 59 sec.

Automatic shutdown was initiated manually when the liquid interface had reached the desired position in the test configuration.

Major problems encountered were as follows:

a. Noise on instrumentation channels.

b. Liquid level probe failed after the run.

c. Ignition flares on the burn-off were extinguished by the flow of purge gas.

d. The tank shut-off valve failed to close during the shutdown sequence (apparently frozen).

SITE	SITE NAME RESEARCH INSTALLATION & DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FACILITY (Continued)

Two types of errors showed up in the digital data tapes.

These were:

1. Random data word dropouts as evidenced by an error in the sync address of the next consecutive record following the dropout.

2. Two separate bursts, of approximately 2 seconds duration, of lateral, longitudinal and record length errors occurred during the data run. This happened without any other type of system error.

These two types of errors caused the automatic data retrieval program to halt upon recognizing the error conditions. No automatic or manual means was available for bypassing errors in the retrieval process.

The retrieval program has been provided with the capability of manual intervention in the event of error indications. No automatic bypass or error data is planned because of the difficulty of defining accurately the reason for the error indication. With the manual intervention capability, the programmer can decide what remedy to take upon defining the reason for the error indication. Therefore, given the same error indication, the capability now exists to retrieve the usable data.

The data acquisition group found that the first type of error, data work dropouts, was caused by random extra erroneous sync pulses being detected at the Central Recording System in data being received from the "B-3" Facility Subsystem. This was traced to the Facility Subsystem and cured by a design modification to the output data modulator input timing. The second type of error was the result of a bad section of magnetic tape. The tape appeared to have been folded over from the one edge. The tape handlers are being checked to see what may have caused this condition.

NOTE: Liquid Nitrogen Run No. 2 is scheduled for December 1, and Liquid Hydrogen Run No. 1 is scheduled for December 15.

SECTION II

PLUM BROOK ROCKET SYSTEMS DIVISION

TEST OPERATIONS REPORT

FOR THE MONTH OF

DECEMBER 1965

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC.	
		NERVA OT1016 (L. V. Humble) — NERVA engine propellant feed system tests. On December 7, Liquid Nitrogen Run No. 2 was made. The major parameters were as follows: (a) Tank pressure of 5 psig. (b) Maximum liquid nitrogen flow rate of 30 pps. (Continued on Page 26)

SITE	SITE NAME	RESEARCH INSTALLATION & DESCRIPTION
B-3	NUCLEAR ROCKET DYNAMICS AND CONTROLS FAC. (Continued)	

(c) Turbopump r.p.m. of zero.

(d) 65 second flow duration through the reactor.

Automatic shutdown was initiated manually when the liquid interface reached the desired position in the test configuration.

Major problems encountered were as follows:

(a) Central recording SEL Unit No. 2 did not operate properly. The run was recorded on SEL Unit No. 1.

(b) A bellows restraining mechanism failed, allowing the bellows to distort. In order to complete the run, the bellows was replaced with tubing.

On December 21, Liquid Hydrogen Run No. 1 was made. The major parameters were as follows:

(a) Tank pressure of 20 psig.

(b) Maximum liquid hydrogen flow rate of 13 pps.

(c) Turbopump r.p.m. of zero.

(d) 70 second flow duration through the reactor.

Automatic shutdown was initiated manually when the liquid interface reached the desired position in the test configuration. The only major problem encountered was in the central recording SEL system at "H" Building. The analog and digital indications of noise level did not agree. It was decided that the digital indication was correct. The system functioned properly in every other respect.

System chilldown tests with liquid hydrogen are scheduled for January 12 and 26.