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NTO-R-0142

**THREE DAY REPORT
FOR XECF EP-I
2 APRIL 1968**

MASTER

NERVA TEST OPERATIONS
Jackass Flats, Nevada

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THREE-DAY REPORT
FOR
EXPERIMENTAL PLAN I
XECF TEST SERIES

NTO-R-0142

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2 April 1968

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1.0 INTRODUCTION

This is the first of the THREE DAY REPORTS to be issued for the XECF test series. The purpose of this report is to present qualitatively the data, results and conclusions of EP-I. The final chronology and as-run test description are given herein for Run 1 of EP-I. Due to the time limitation, evaluation of data is incomplete, and any conclusions are preliminary.

Final results of this EP may be found in the forthcoming SPEAR memoranda.

2.0 SUMMARY

XECF Experimental Plan I was performed on April 2, 1968 at the ETS-1 Test Facility at the Nuclear Rocket Development Station, Jackass Flats, Nevada.

Run No. 1 of EP-1 was completed in accordance with Control Room Operating Procedure NTO-I-0337 as approved by the XECF Test Review Board. The remaining runs planned (i.e., No. 2, 3, and 4) for EP-1 were not initiated due primarily to the insufficient remaining N_2 inventory for facility inerting.

The cold flow test was performed with a 35 psia run tank pressure with the turbo-pump initially warm. The purpose of this test was to confirm bootstrapping from this initial run tank pressure. Although this test was successfully performed, the actual bootstrap was delayed longer than expected following the opening of PSV. The bootstrap delay and associated pump surging was apparently due to loss of PSL chill prior to opening of PSV and increase of ETC pressure during the run caused by a steam pressure transient resulting in a trip of the H_e (PCV-449) purge system. In addition partial prechill of the reflector occurred during PSL chilldown.

Chilldown and chill maintenance data for the integrated XECF/ETS-1 systems were obtained for the first time using LH_2 . Previous LN_2 facility and feed system cryoshock tests have been conducted; although the engine system downstream of the PDSV has not previously been chilled.

Malfunctions in the digital data systems resulted in significant data losses before and during the LH_2 flow phase. Equipment tape handling appears to have caused the problem in both DDS 1 and 2.

Although a number of anomalies were experienced, there were no problems or anomalies observed which would preclude the continuation of this test series.

3.0 TEST OBJECTIVES

The primary test objectives of the EP-I tests were:

1. Verify bootstrap startup sequences for XE-1
in order to define the startup procedures and sequences
to be used during XE testing.
2. Evaluate the performance of subsystems and components
during startup and chilldown when assembled as an
integrated system prior to being utilized in a nuclear
environment.
3. Compare XECF and ETS-1 cold flow data with that obtained
from the CFDTS and H-5 Facility in Sacramento - to provide
a basis for prediction of expected performance of a test
article in ETS-1 as a result of data obtained in the H-5
facility.
4. Checkout the interaction of the Test Stand Control System
(TSCS) with the Engine Control System (ECS) and Facility
Control System (FCS) - to demonstrate the compatibility
of the TSCS, ECS and FCS systems with the engine within
the range of variables attainable in this program.
5. Verify the adequacy of the NES and ETC for Engine Startup.
This includes verification of the secondary ejection
system, the ETC purge system, external shield fill and
drain system.

6. Cold flow acceptance test the UTS module used in the XECF for use as a spare for XE-1 & XE-2 Engines.
7. Verify the Purge Sequences for the X Engine.
8. Provide training for NTO personnel for future XE programs to familiarize the operators and test conductors with the engine system, the facility system and GSE equipment procedures.

4.0 PRETEST STATUS

4.1 FACILITY STATUS

The test configuration and status of the facility and NES system were essentially as planned for the XE tests, and as shown in the Simplified Flow Diagram, Figure 4.1.

The prime exceptions were that the neutronic systems, the LH_2 (V-5002) emergency cooldown system and the LN_2 (V-3601) cooldown system were not activated.

In order to perform the maximum number of runs, the facility LH_2 and GN_2 storage vessels were at or near their maximum capacities at the start of the run day operation.

4.1.1 LIQUID HYDROGEN SYSTEMS

The V-5001 run tank was at the 25% level and pressurized to 22 psig at the start of bootstrap run. Approximately 10,000 lbs of LH_2 was used from V-3801 to accomplish EP-I.

4.1.2 GAS SYSTEMS

For EP-I of XECF a 1.5 inch restricting orifice was installed in the H_e line upstream of PCV-471 and the H_2 line pressure upstream PCV-251 was maintained between 1000 and 1250 psig in order to avoid possible test article damage in the event of a valve failure. The initial inventory, arrangement of gas tank bottles and total EP-I gas usage is given in Table 4.1 below.

FIGURE 4.1

TABLE 4.1
GAS & LIQUID STORAGE & UTILIZATION
(CRT-46050 to 66600 Sec)

<u>FLUID</u>	<u>VESSEL</u>	<u>INITIAL INVENTORY</u> (lbs)	<u>AMOUNT USED</u> (lbs)
GN ₂	V-3201, 2,3	61,050	43,020
GN ₂	V-3901, 2,3,4	104,475	45,400
GH _e	V-3204, 5,6	8,582	4,212
GH ₂	V-3207, 8,9	5,955	1,100

4.2 CONTROL/SPECIAL INSTRUMENTATION STATUS

Incorporated but not operationally checked in the XECF EP-I were the TPCV pressure controller and the chilldown time delay coincidence circuit. The chilldown time delay circuit completes the TPCV pressure demand loop when a preset temperature is achieved at the reflector inlet. This circuit was bypassed for EP-I.

The Emergency ETC system, when armed, opens PCV-449 when the (PT-425) steam pressure rate limit is exceeded. The detector follows negative pressure transients to 5 psi/sec and trips when the actual pressure falls 10 psi below the tracked pressure. This system has previously been operated in the NEP-H_e- 1&2 tests and operated satisfactorily in preventing air back flow into the duct and ETC following Steam Generator Shutdown. This system was activated during EP-I as discussed in Section 6.

The engine emergency (loss of flow trip) sensors were installed prior to testing, although they were not activated for EP-I.

4.3 TEST ARTICLE STATUS

The XECF test configuration for the XECF test series is the same as that planned for the XE test series. The XECF nuclear system, however, consisted of the original NRX-A1 test assembly which has unfueled core.

The only significant test article anomaly occurring during EP-I was the failure of PDSV to close. Since Run No. 1 of EP-I was a warm pump start, the open PDSV created no problems. During post-test checks, PDSV did operate properly when the command voltage was increased from 28 VDC to 35 VDC, and subsequently operated when the voltage was decreased to 28 VDC. The reason for failure of PDSV to operate during EP-I, however, is not known.

5.0 PRE-RUN OPERATIONS

5.1 GAS SYSTEM HEADER PRESSURIZATION

The GH_2 and GN_2 headers pressurization were completed with no abnormalities. During the H_e header pressurization a leak was observed at BV-34 which had been recently opened. No further H_e leaks were observed following retorquing of this flange.

5.2 ETC SEAL SYSTEMS

The ETC seal systems were setup on R-I in accordance with NTO-I-320. Although the seal pressures were normal prior to the run, FT-434 appeared to be indicating an erroneous pressure differential. FT-434 had not been checked out prior to EP-I, however.

It should be noted that instrument boxes IB-I and IB-2 prior to EP-I were purged with GN_2 . Prior to EP-I the above boxes were sealed with a positive pressure applied inside the box to possibly reduce the GN_2 flow through FT-434.

The GN_2 Sealing System of the ETC appeared to be questionable during EP-I. Two substantial leaks were noted at Pt-631 and Pt-632, the S-4 bottom blade purge and S-I bottom seal blade purge, respectively. The above pressures decreased and increased 0.90 and 0.50 psi, respectively, when the Steam Generators went to Full Steam and were shutdown.

STEAM GENERATORS OUTLET
STEAM PRESSURE
PT-425

Figure 5.1

STEAM GENERATORS OUTLET
STEAM PRESSURE
PT-425

FIGURE 5.2

The above pressures were greater than atmosphere pressures during the run by a minimum of 1.0 psi.

5.3 SHIELD WATER FLOW RATES

Based on previous Test Data, the flow rates to the two Side Shields (S-I and S-2) and the bottom Shield (S-40) did not meet the required flow rates of 1474 and 604 GPM, respectively, which was expected.

Data indicated the S-2 Side Shield flow was 1150 GPM, the bottom shield (S-4) flow was 550 GPM. Due to a data acquisition problem the flow to the S-I side shield was not known. However, it has been approximated at 1190 GPM, based on the S-2 flow.

5.4 ENGINE/FACILITY PURGING AND INERTING

Engine and facility purging and inerting was successfully accomplished. Due to failure of PCV-621 to operate, however, FCV-50 was used for ETC inerting. PCV-621 failure to operate has been corrected by increasing the actuation pressure.

5.5 LH₂ FILL AND CHILLDOWN OPERATIONS

Fill and chill V-5001 was successfully accomplished. The V-5001 run tank was chilled to stable temperature of 35.5°R. The transfer of LH₂ from V-5001 back to V-3801 was also demonstrated for the first time; the new reflectometers, carbon resistance probes and RTT's in V-5001 all appeared to work well, although the reflectometer may need scale adjustments.

Figure 5.5 shows the V-3801 and V-5001 level, temperature and pressures between initial V-5001 fill and end of run.

The PSL was successfully chilled using PCV-579. It was discovered following the test that during PSL chill, LH₂ vent flow passed into the purge discharge line via open PDVV. The vent lines from PCV-579 and PDVV are not isolated before they enter a common header to flare stock (FS-5001). This resulted in a prechill of the engine during PSL chilldown, and subsequent steam generator startup and duct pull-down. Chill conditions were lost in the PSL prior to opening of PSV, however, due to early closure of PCV-579. These can be operationally prevented in future testing.

High H₂ concentrations were observed in the ETC during PSL chilldown operations but were corrected by an increased ETC N₂ purge. Subsequently, excessive H₂ concentrations were observed in the ETC during duct pull-down and ETC H₂ purge termination.

5.6 LOX SYSTEM CHILLDOWN OPERATIONS

Chilldown of the LOX line was successfully demonstrated using a revised technique which saved approximately 3000 gallons LOX over previous techniques.

Leakage which was initially observed at modified RSV-335 (plug removed) was corrected by re-torquing of the seal plate.

5.7 NES PRE-RUN OPERATIONS

The NES systems had been checked out and operated satisfactorily prior to EP-I. During EP-I, SG 2 and 3 were used when SG 1 was found to be inoperative due to a corroded limit switch on the propane supply valve.

SG 2 and 3 were started after PSL chilldown operations but prior to opening PSV, and ETC pressure of 7.8 psia established. As discussed in section 5.5, high H_2 concentrations were observed in the ETC during initial ETC pull-down.

The ETC Emergency Helium Purge system was activated following startup of the steam generators. Prior to activation of this system, however, steam line pressure oscillations of approximately 10 psi occurred which would have caused operation of the PCV-449 system. These pressure oscillations, shown in Figures 5.1 and 5.2, occurred when the shield fill and drain valves were opened and when the deluge system was activated.

As discussed in section 6.0, a steam pressure oscillation also occurred after activation of PCV-449 during the bootstrap run, which resulted in initiation of the ETC Emergency Helium Purge System.

6.0 RUN OPERATIONS

6.1 PLANNED RUN DESCRIPTION

The operating procedure planned for Run No. 1 of EP-I was summarized below:

DRY PUMP STARTUP TEST, RUN 1

Run 1 will be achieved by pressurizing the run tank to 35 psia. The propellant supply line (PSL) chilldown will be accomplished with the propellant line vent valve PCV-579. Flow through the line will be controlled by position of PCV-579 and will be at the maximum possible rate without overspeeding the turbine flow meter until LH₂ conditions are obtained at the PSV. Prior to initiation of flow, the reactor temperature as indicated by reactor core temperature measurements will be 500 to 560°R and the engine test compartment pressure will be approximately 8.0 psia. The pressure control loop will be closed at a nozzle tube exit temperature of 70°R and a chamber pressure of 60 psia demanded. The test will be initiated by opening the PSV and terminated when any test parameter limit is reached or when the test ceases to simulate engine startup, or when the chamber temperature reaches 200°R, whichever occurs first. The engine system will be returned to the initial reactor temperature range by flowing ambient gas.

FIGURE 6.1
SYSTEM PRESSURES

XECF EP1 4/02/68
THREE DAY REPORT

1	-*	PT110.A	-*	PSIA
2	-*	PT210..	-*	PSIA
3	-*	PT701..	-*	PSIA
4	-*	PT124.A	-*	PSIA
5	-*	PT148.A	-*	PSIA

UNIT 1
PLOT 2 THREE DAY REPORT

PRESSURE - PSIA

FIGURE 6.2
SYSTEM TEMPERATURES

XECF EP1 4/02/68
THREE DAY REPORT

1	TT139.A	RANKINE
2	TE302..	RANKINE
3	TT120..	RANKINE
4	TE720..	RANKINE
5	TE501..	RANKINE

FIGURE 6.5
LH₂ STORAGE AND RUN
TANK PARAMETERS

XECF EP1 4/02/68
V3801/V5001 LH2

1	-*	PT068..	-*	PSIA
2	-*	PT099..	-*	PSIA
3	-*	TT401..	-*	RANKINE
4	-*	TT044..	-*	RANKINE
5	-*	LT002..	-*	1/2 FULL
6	-*	LT499..	-*	1/2 FULL

6.2 TEST PARAMETER LIMITS

The applicable test parameter limits for EP-I are given in Table 6.1.

6.3 RUN DESCRIPTION

Figures 6.1, 6.2, 6.3 and 6.4 show selected facility and engine data plots for Run No. 1 of EP-I. Due to failure of digital data subsystem 1 between CRT 62822 and CRT 62851 the data plots are not well defined during the interval. The RPM data during this time interval was obtained from strip chart recordings. The upper ETC pressure hand plotted in Figure 6.3 was also obtained from strip chart recordings.

The run was initiated by opening PSV after PSL chilldown and PDVV closure. The nozzle torus temperature varied between 35 and 70⁰R before PDVV closure, rose to about 135⁰R after PDVV closure, and then dropped to about 70⁰R when PSV was opened. Although the dome end temperature was near ambient, the reflector temperature was 300⁰R before PSV was opened. The low temperatures existing before opening of PSV were due to PSL vent (PCV-579) flow which discharged into the pump discharge line via PDVV during ETC pull down. The PSL temperature rose to saturation resulting in a loss of hard chill conditions in the PSL when PCV-579 was closed prior to opening of PSV.

TABLE 6.1

XECF TEST PARAMETER LIMITS

<u>Parameter</u>	<u>Limit</u>	<u>Recommended Action</u>
Reflector Inlet Pressure (Pressure Vessel Limit)	500 psia (maximum) with LH ₂ 752 psia (maximum) with ambient gas feed	Reduce flow until pressure below limit
Reflector Inlet/Core Outlet Pressure Differential	175 psid (maximum) with ambient gas 200 psid (maximum) with LH ₂ feed	Reduce flow until pressure differential below limit
Core Pressure Differential	150 psid (maximum)	Reduce flow to reduce differential pressure limit
Nozzle Torus Inlet	1100 psig (maximum). Holds for any temperature between ambient and -420 ^o F	Reduce flow until pressure below limit
TPCV Pneumatic Supply	215 ⁺ 15 psia	Shutdown Test *
TPCV Pneumatic Vent	50 psia (maximum)	Shutdown Test
Turbopump Speed	22,500 rpm (maximum) at 7 psi NPSP	Shutdown Test
Turbopump Vibration Displacement	0.030 inch (maximum) at or near rotation resonate frequency (14,000 to 16,000 rpm)	Shutdown Test
TPCV Command Voltage	Loss of voltage	Shutdown Test
TPCV Feedback Voltage	Loss of voltage	Shutdown Test
TPCV Excitation Voltage	Loss of voltage	Shutdown Test
External Shield Pressure	22 psig (maximum)	Reduce Pressure
Steam Flow Rate to NES Duct	100 lb/sec (minimum)	Shutdown Test
Wind Velocity	10 mph at test initiation	Hold test starting
Dome Temperature	Initial ambient temperature minus 100 ^o R	OPEN TPCV

Although the reflector inlet temperature coincidence circuit (auto TPCV pressure loop closure at 70°R) was activated for run 1, it was manually bypassed and the TPCV pressure loop closed manually when the dome end temperature decreased to 405°R. The reflector inlet temperature was approximately 80°R when the TPCV pressure loop was closed. As shown in Figure 6.3, TPCV opened to 88 degrees in 12 seconds and remained at 88 degrees for 21.5 seconds. TPCV was manually closed when the chamber temperature reached its limit of 200°R.

PCV-449 was closed manually approximately one second before TPCV closure.

The pump speed (RPM), as shown in Figures 6.3 and 6.4, cycled six times before the pump discharge began to rise. The pump speed, chamber pressure and flow during the seventh and last cycle reached 5400 RPM, 38.5 psia, and 22 pps; respectively, before closure of TPCV. The decrease in pump speed oscillations after TPCV opening is attributed presently to the increase in ETC pressure caused by operation of the ETC Emergency Helium Purge System. As shown in Figure 6.3, a trip of the ETC Emergency Helium Purge System (PCV-449) occurred 12 seconds after TPCV started to open. PCV-449 was closed manually approximately one second before TPCV was closed.

An indication of loss of flow was observed in that detection/trip system, although it was not activated for EP-I. This is only significant in that this trip has been rescaled for the XECF test series and will be utilized in EP-II.

Following TPCV closure, gaseous helium (PCV-471) was used to warm up the engine. He was used instead of H_2 since the duct vault concrete temperature reached its limit of 710°R due to heating from the exhaust plume and unfavorable wind direction. Metal temperatures immediately inside the duct vault wall also rose and peaked at about 675°R . The GHe warm up prevented further structural heating and satisfactorily warmed up the engine.

7.0 DATA

The digital and analog data systems utilized, their sampling rates, and location of specific data are detailed in the as run XECF EP-I Data Log.

Of major significance was the loss of both digital data subsystems during EP-I. Although both subsystems were not lost concurrently, DDS #1 data was lost for 28 seconds during the bootstrap run, and DDS #2 had tape transfer problems which resulted in the loss of a less critical 14 seconds of data plus several other 1 second interval losses.

8.0 EP-I RE-ENTRY REPORT

A total of 2 re-entries were made during the EP-1 cold flow test. There were no exposure of re-entry Personnel to a hazardous environment. The first re-entry was established at 1035 hours. The purpose of the re-entry was to replace a faulty hydraulic pump, and to determine an electrical failure for Steam Generator, module number 1. The re-entry was terminated at 1155 hours when personnel entered the test cell bldg. The second re-entry was established 1423 hours. The purpose of re-entry was to determine the cause of a pressure leak in the LO₂ system. The leak was located in Line 6-LO-6 at the modified valve 50-RSV-335; the leak was corrected. A second leak was located at 50-LB-34 just upstream of 50-PCV-47; the leak was corrected. The re-entry was terminated at 1515 hours.

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10.0 CHRONOLOGY FOR XECF - EP-I - April 2, 1968

I. PRE-OPERATIONAL PHASE

A. Pre-Test Functions

32300 During pre-test check out of valves, PDV would not cycle close. Therefore, the R-Day Control Room Operating Procedure was changed by the TRB team, such that, PDV would not be required to be closed during any phase of the test. The marked up copy of the Control Room Operating Procedure was then released.

32470 Checked Control Room Net (Net #10).

32600 Checked the TDC and TRB Net (Net #5).

35474 Checking out Steam Generator Module #1.

36268 to 38420

Switched or Verified all valves in operate.

B. Calibration and Valve Exercise

38987 to 41262

Performed auto and manual calibration.

42038 to 44935

Valves exercised to the close or open position.

PCV-579, PRV-402, and PRV-200 had insufficient dome pressure to operate, He actuation system for valves activated at 45415 and above valves exercised at 45619 to 45662.

44690 to 44760

Fan indicator on TIE Console indicates Fan No. 1
in Pipe Chase did not start. Viewed Fan No. 1 on
T.V. fan operates with no problems except indication
on TIE Console

44944 to 45090

Exercised PCV-449 Emergency System.

45150 to 45526

Pressurized valve actuation system with He.

45774 to 46060

Set up and checked out Engine Valves

46084 to 46216

Checked our FSD Chain

46231 to 46310

Reported facility Fluid Inventory

GN₂ Vessels

PT-1 = 2500 PSIG

PT-4 = 2500 PSIG

PT-7 = 2500 PSIG

PT-2 = 0 PSIG

PT-666 = 1025 PSIG, GN₂ Auxiliary Header

GHe Vessels

PT-10 = 2600 PSIG

PT-13 = 2600 PSIG

PT-16 = 2600 PSIG

PT-5 = 190 PSIG

GH₂ Vessels

PT-441 = 2490 PSIG

PT-442 = 2490 PSIG

PT-443 = 2490 PSIG

PT-3 = 0 PSIG

V-3801 Level L-2 = 80%

V-3401 Level L-11 = 1.6 PSID

New GN₂ Vessels for Inerting

PT-652 = 3350 PSIG

PT-653 = 3300 PSIG

PT-654 = 3300 PSIG

PT-655 = 3400 PSIG

V-2801 Level L-2 = 4.4 PSID

V-3302 Level L-15 = 47 Ft.

46330 to 46394

Pressurized GN₂ Header

46580 Hold for Lunch

46590 Can't fix Steam Generator No. 1, decided to run with
Steam Generators No. 2 & 3.

48000 Resumed Operations

48010 Operator Net Check

48238 to 48636

Pressurized He Header

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48320 PCV-471 Leak Checked

48657 to 48945

Set up Auxiliary Systems

48950 to 49425

Eled in Oxygen

49069 to 49355

Bled in Propane Tank

49465 to 49681

Pressurized V-3801 to 32 PSIG

50240 Pressurized Propane and LOX Tank

II. OPERATIONAL PHASE

A. Inerted Duct Vault, Pipe Chase, TSER and Engine Test Compartment

49713 Inerted Duct Vault, Pipe Chase and TSER

50240 to 50302

Pressurized LOX Tank and Propane Tank

50647 to 50873

Inerted Engine Test Compartment

50740 PCV-621 does not OPEN, used FCV-50 remainder of test for GN₂ purge.

50895 LOX Leak at RSV-335 Body. Valve has plug (internals) removed with a blind flange installed in place of Bonnet. Leak at blind flange.

50900 LOX Tank and Propane Tank depressurized.

51100 Hold to fix LOX Leak.

51422 RSV-495 OPENED to Purge LOX header.

51460 Reentry Team entering area to:

(1) Fix LOX leak

(2) Fix He leak at LB-34 orifice.

51676 V-3801 Pressure locked up.

51770 H₂ header depressurized.

51800 Duct Vault, Pipe Chase, and TSER inerting stopped.

52036 PCV-447 CLOSED.

52050 UTS Purge Heater turned OFF.

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54230 (1) LOX leak at RSV-335 Body fixed.
(2) He leak fixed at LB-34 orifice.

54240 He leak check, no leaks reported.

55421 H_e header repressurized.

56130 Bled in Oxygen

56237 Bled in Propane

56430 Propane Tank pressurized to 295 PSIG.

56801 LOX Tank pressurized to 310 PSIG.

Reinerted Duct Vault, Pipe Chase, TSER and ETC

57125 PT-656 reported at 0 PSIG.

57130 RSV-900 and RSV-899 OPENED.

57144 OPENED RSV-887, 890, 893, and 896 as required to inert
Duct Vault and Pipe Chase while PT-656 was kept
below 700 PSIG. O₂ concentration required to be
below 5%.

57168 RSV-927 OPENED.

57260 Verified PCV-621, PCV-447 and RSV-882 CLOSED.

57277 UTS purge heater turned ON.

57288 PCV-447 Opened to establish 1 lb/sec GN₂ and 397
PSIG at PT-643 to inert Engine Test Compartment.

57300 Engine Test Compartment Oxygen Concentration 1%.

57310 PRV-869 used to establish 410 PSIG at PT-191.

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57416 FS-5001 O₂ concentration indicating 20%. Bad
vacumm pump on sensor.

57525 RSV-287 CLOSED.

B. FILLED V-5001

57971 RSV-142 OPENED, 50 PSIG at PT-100.

57980 RSV-83 OPENED.

57986 RSV-255 OPENED.

57995 RSV-283 and RSV-186 OPENED.

58007 RSV-261 CLOSED

58032 RSV-128 OPENED, LH₂ transfer to V-5001 started.

58420 Deluge system activated at top of Stand, RESET.

58800 Possible LH₂ leak below run tank observed on T.V.

59030 RSV-515 CLOSE light OUT on Console.

59177 RSV-390 CLOSED

59193 PCV-180 CLOSED to check possible leak at bottom
of Run Tank, V-5001 pressure increased to 18
PSIG, no effect on vapors. Vapors assumed to be
liquid air since the area is foam insulated instead
of vacumm jacketed.

59420 PCV-180 OPENED to vent V-5001.

59587 RSV-390 OPENED.

59603 RSV-128 OPENED to complete V-5001 FILL.

59630 RSV-129 OPENED

59651 RSV-192 OPENED

60406 RSV's - 128/129 CLOSED when V-5001 level indicated 90%.

60413 V-5001 level maintained between 90% and 100% using
RSV-129.

XECF - EP-I

Started back flow V-5001 to V-3801

60419 V-3801 level at 61%.
60426 PRV-426 used to establish 500 PSIG at PT-598.
60457 V-5001 Bulk temperature at 36°R.
60775 RSV-390 CLOSED.
60782 V-3801 Vented manually.
60852 V-5001 pressurized to 22.2 PSIG using PCV-165 manually.
60976 RSV-219 OPENED, Started to back flow to V-3801.
61079 PCV-165 switched to auto when V-5001 level at 70%
(pressure error zeroed). PCV-165 oscillated when
switched to Auto; apparently the error was not
completely zeroed.
61636 RSV-129 CLOSED when V-5001 level at 25%.

C. SET UP STEAM GENERATORS AND ESTABLISHED DUCT COOLANT FLOW

61654 RSV-296 OPENED to bleed in duct.
61698 RSV-297 OPENED.
61732 RSV-439 Verified OPEN.
61737 RSV-433 OPENED.
61760 Water O.K. lights on Steam Generator panels verified.
61764 Reset all Steam Generators.
61772 Steam Generator ready switches depressed.
61782 Water injection control valve pot set at 10
on SG-2 and SG-3.

D. DRY PUMP TEST WITH 35 PSIA IN RUN TANK (V-5001)

61803 RSV-142 CLOSED, He flow into PSL stopped.
61812 PCV-579 OPENED to vent PT-485 (PSL) to Zero.
61841 PDVV OPENED.
61849 RSV-455 OPENED, Started Chillydown of PSL.
61871 FCV-50 used to establish 2 pps GN₂ flow.

XECF - EP-I

61906 PCV-579 used to chill down PSL until T-533 $\leq 40^{\circ}\text{R}$.

61937 RSV-481 OPENED

62114 RSV-132 OPENED, main PSL valve.

RSV-455 CLOSED, Bypass around RSV-132

62130 RSV-738 OPENED, Duct H_2O Drain Valves

62134 RSV-739 OPENED, Duct H_2O Drain Valves

62140 RSV-858 OPENED, Drain Snout cooling water shutoff valves

62147 RSV-859 OPENED, Drain Snout cooling water shutoff valves

62152 FCV-30 OPENED

62163 FCV-31 OPENED until F-31 indicated 2.7 PSID (4300 gpm).

62263 RSV-298 OPENED, water valve to FT-32

62400 INCREASED FCV-50 until 55 PSIG at PT-474

62433 Manual Steam Generator Purge on

62437 All recorders on HIGH

62449 Started Steam Generator 2 to Idle Steam

62454 Started Steam Generator 3 to Idle Steam

62467 Verified Idle Steam Conditions

62477 Steam Generator 2 to FULL STEAM

62489 Steam Generator 3 to FULL STEAM

62502 FCV-50 CLOSED

62514 Adjusted FCV-423-2 and -3 until T-534 indicated $1260 \pm 50^{\circ}\text{R}$, 45 second timer initiated.

62617 Engine Test Compartment shield water flow started.

RSV-303 OPENED

RSV-304 OPENED

RSV-305 OPENED

RSV-306 OPENED

62646 FCV-31 OPENED to 100%

62658 Verified; RPM trip active

EN-801 Bypass active; EN-800 Active

XECF - EP-1

62669 1950 PSIG at PT-904 inlet to PCV-449.
62717 PCV-449 Auto Demand set at 445 Pot divisions
(30 pps).
62729 PCV-449 rate trip activated
62733 Drum Control Selected
62736 PCV-449 armed
62740 PCV-449 in Operate
62743 Reactor Started
62747 Pressure control pot set to 80 divisions.
62751 Pressure control selected
62763 PDVV CLOSED
62773 Pressure Loop CLOSED
62777 PCV-579 CLOSED
62781 Started Engine
62785 RSV-446 CLOSED, Engine Purge System
62802 PSV OPENED, Boot Strap started.
62833 TPCV OPENED
62849.6 PCV-449 Tripped
62849.8 PCV-449 OPENED
62867 PCV-449 CLOSED
62868 TPCV CLOSED
Chamber temperature at limit of 200°F.
62874 RSV-132 CLOSED, main PSL Shut Off Valve.
62881 PDVV OPENED
62883 RSV-142 OPENED, He purge to PSL started.
62892 CSV OPENED
CVV CLOSED
62897 Pt-3=1200 PSIG CH₂ Pressure

XECF - EP-I

62902 T-840 Concrete temperature at Duct Vault reached
maximum allowable temperature of 250°F.

62904 RSV-201 OPENED.

62924 RSV-201 CLOSED, decided to warmup with He instead
of H₂ because of concrete temperature.

62997.9 PCV-471 OPENED (approximately 1%) for warmup.

63280 RSV-142 CLOSED.

63290 Switched PCV-449 to SAFE.

63294 Reset PCV-449.

63298 Bypassed rate trip.

63302 Adjusted FCV-423-2 and -3 control pot to 10 divisions.
Started 60 second timer.

63365 ETC Shield Water flow stopped.

RSV-303 CLOSED

RSV-304 CLOSED

RSV-305 CLOSED

RSV-306 CLOSED

63445 Steam Generators to IDLE condition, one at a time.

63466 FCV-50 used to establish minimum ETC purge.

63477 CLOSED:

FCV-30	RSV-738	RSV-858
FCV-31	RSV-739	RSV-859

63549 PCV-471 CLOSED

63572 Recorders to LOW.

63580 CSV CLOSED

CVV OPENED

XECF - EP-I

63592 Stopped all Steam Generators
Manual Purge Shutoff 5 minutes
after last module shutdown

63607 RSV-433 CLOSED

63615 CLOSED: RSV-298
RSV-297
RSV-296

63630 FCV-50 Pressure Increased

63644 After completion of manual purge, verified P-405,
P-407 and P-408 were at pre-start values for all
Generators.

63665 FCV-50 decreased

63780 Hold to discuss above test

64021 RSV-129 OPENED

64090 RSV-130 OPENED when T-44 indicated gas conditions
RSV-129 and RSV-83 CLOSED

64103 GH₂ bottles secured

64108 PSV CLOSED

64118 RSV-455 OPENED

64123 PCV-579 OPENED

64247 Turned UTS Purge heater OFF

64248 CLOSED FCV-50 and PCV-447.

III. POST-OPERATIONAL PHASE

A. Securing LOX and Propane Tanks

64880 to 65457

Venting LOX and Propane tanks

65289 Purged Propane Manifold

65890 PCV-579 CLOSED after T-589 exceeded 200°R.

65910 V-5001 vented with PCV-165/180 in Manual.

65998 RSV-390 OPENED.

66005 RSV-455 CLOSED and PCV-579 OPENED.

66014 RSV-142 OPENED.

66945 RSV-482 CLOSED.

66173 Vented P-17 to 100 PSIG using PRV-485.

Cycled CVV as required.

66520 PSV CLOSED.

66524 TBV CLOSED.

66585 FCV-50 CLOSED.

67560 to 67658

GN₂ System Vented

GH₂ System Vented and Purged

GHe System Vented

67100 to 67250

GN₂ to Engine Test Compartment sealing system
turned OFF.

B. REPORTED FACILITY STATUS

67745 to 68275

Verified position of all valves.

Reported Facility Status (Cont'd)

67905 to 68275

Reported Facility Fluid Inventory

GH₂ Vessels

PT-1 = 625 PSIG

PT-4 = 625 PSIG

PT-7 = 625 PSIG

PT-2 = 600 PSIG

GH_e Vessels

PT-10 = 1125 PSIG

PT-13 = 1125 PSIG

PT-16 = 1125 PSIG

PT-5 = 75 PSIG

GH₂ Vessels

PT-441 = 995 PSIG

PT-442 = 2500 PSIG

PT-443 = 2500 PSIG

PT-3 = 0 PSIG

V-3801 Level, L-2 = 72%

68485 to 68850

Performed system post auto calibration.

TO: Distribution

DATE: 8 April 1968

FROM: W. D. Wayne

NTO-M-21096

PLG:WDW:eo

SUBJECT: Transmittal of XECF-EP-I Three Day Report

DISTRIBUTION: (See attached sheet)

Transmitted herewith for your records and information is the XECF-EP-I Three Day Report, NTO-R-0142. This test was successfully conducted on 2 April 1968.

W. D. Wayne, Manager
NERVA Test Operations

Attachment - 1

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