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19 September 1957

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MEMORANDUM

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To: C. H. Trent

MASTER

From: S. G. Rumbold

Subject: Weekly Summary of Progress on Rover Project

Copies to: L. Green, B. B. Fowler, L. Shenfil, S. G. Rumbold, 296 File.

Reference: Monthly Summary of Technical Progress on Rover Project dated 12 September 1957

1. A brief statement of work accomplished during the past week from 12 September is given here. Wherever possible, progress is reported in terms of the information provided in the reference memorandum and in terms of contractual objectives.

2. Item 1 - Preliminary Power Plant Studies

a. Final review and revision of the comparison study of nuclear versus chemical is about 70% complete.

b. Data for graphical presentation of gross weight, propellant weight, and component weights for ammonia nuclear rockets is complete and is being plotted. Hydrogen version is in preparation.

c. A second revision of the ammonia reference system was made. The gross weight is estimated to be 1,540,000 lbs instead of the reported 1,440,000 lbs.

d. ~~Determination~~ Trajectory calculations being conducted on the IBM 704 are about 80 to 90% complete.

3. Item 2 - Systems Analysis Studies

a. Equations defining turbopump system for the topping cycle were scaled and added to the reactor - thrust chamber analogue.

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TECHNICAL DOCUMENT CENTER
Nuclear Rocket Operations

DOC. NO. 11-1931

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C. H. Trent

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19 September 1957

b. Fabrication for expansion of the network analyzer to handle larger problems was continued.

4. Item 3 - Component Studies

a. Turbopump

50% 100%
(1) Initial analysis of hydrodynamic hydrogen lubricated bearings is complete.

(2) One layout of a turbopump for a bleed cycle was completed and a second revised design started.

(3) A memo report of the refined bleed cycle analysis was started. *complete*

b. Propellant

(1) No significant work

c. Controls

(1) Vendors on specific control components were contacted.

95%
A proposal for evaluating the Maxson weight flow meter in hydrogen was received. Aeroproducts has proposed development of an actuator at their expense. Air Research was requested to bid on supplying a pneumatic actuator. Manning, Maxwell and Moore were contacted. Evaluation of components continued.

d. Tanks and Structures

new program
(1) Determination of the effect of tank pressure on tank configuration is essentially complete. *90%*

e. Thrust Chamber

program
(1) The IBM 704 is being altered to accommodate the reduction in turbopump outlet pressure from 2400 to 1800 psi.

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f. Reactor

(1) The first cut of determining stress in the reactor base plate using electrical analogue is complete.

(2) The startup analogue was altered to add another section.

*check to mission
of section - ready to run
standing
80%*

5. Facilities

a. Flux map is being computed from the revised equations.

b. Synthesis of test programs for engine components is about 60% complete.

- now in computing

85-90%

6. Low Temperature Materials Investigation

70% { a. Preliminary ^{*screening*} ~~scaling~~ of plastic bonded stainless steel laminates is essentially complete. Test results are being evaluated.

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C. H. Trent

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19 September 1957

7. Miscellaneous

a. We are planning a total of 6 topical reports. These are:

- (1) Comparison Study
- (2) Brochure
- (3) Iron Horse
- (4) PCR
- (5) Facilities
- (6) Dynamic Analysis and Scaling of Large Tanks

8. Obviously, the proposal has taken a large share of the time of key personnel. We will be tight on some items, but as of now, we expect to be in decent shape for the final quarterly.

S. G. Rumbold, Project Engineer
Rover Projects

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14 November, 1957
SGR:jam

MEMORANDUM

TO: C. H. Trent
FROM: S. G. Rumbold
SUBJECT: Weekly Summary of Progress on Rover Project (Title: U)
REFERENCE: Weekly Summary dated 31 October 1957, Control No. 1633.1

1. A brief summary of the status of the various reports being prepared is recorded here. Obviously, some of the people are looking at technical topics which are a continuation of the contract work, but since these are not being reported to Mr. Hilden, I am not reviewing them here.

2. The final quarterly report is complete and was sent to Technical Publications Tuesday.

3. The summary final report has been outlined and work has just been started. 10%

4. The topical reports are in various stages of work. These may be summarized as,

a. Comparison - Text and figures are assembled and some additions and refinements are planned before publication. With George Henry leaving for two weeks because of his father's death, Hal McQueen is assuming responsibility to clean this up. 30%

b. Iron Horse - The Iron Horse missile configuration has been determined, the specific cycle selected and general preliminary design completed. This is about 30% complete.

c. Tanks - The topical report on P. Sandorff's analysis on the Dynamic Similitude is essentially complete. The text is on reproducible 80%

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4
mats and will be issued in the next week or two.

d. Facilities - The preparation of text for the topical report on facilities and test procedures is 75% complete.

e. Brochure - A draft of the text is complete and sketches for the various figures were prepared by Technical Publications. I am holding up further action until our fiscal status permits going ahead with the required illustrations. This will be an expensive report and one which we may have to review critically as to whether or not we can afford it.

S. G. Rumbold, Project Engineer
Rover Projects

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STATUS OF EXPERIMENTAL PROGRAM
AS OF 14 NOVEMBER 1957

Final Summary Report

Reduction of experimental data required for the final report is approximately 50% complete, assuming that data reduction constitutes half the report effort, therefore, the final report is approximately 25% complete. ✓

Detailed Topical Reports

Preparation of ~~separate~~ topical reports on heat removal studies, flow separation ~~studies~~ and heat transfer to cryogenic fluids has not yet been started; however, the data reduction, which is basic to the first two of these reports, is approximately 50% complete as stated above. It is estimated, therefore, that the topical reports themselves, which will draw upon material previously reported, ^{in quarterly reports} can also be considered approximately 50% complete.

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File Ref: _____

Report of Telephone Discussion

Route to: C. H. Trent

L. Shenfil

S. G. Rumbold

L. Green

A. J. Medved

Organization WADC

Date Thursday
7 November 1957

Party Talked to Jack Hilden

Time 10:45 AM

Subject: Program Status

Approx. Length
of Conversation 10 Min.

Resume of Conversation: Overall status - work completed. Now in progress of
reducing data and writing reports. Inquired status of contract extension & P.R.

Wieser apparently has approval and is preparing letter on extension
and report date change as requested in Sept. 23 letter. Hilden stated that letter
contained too many different items - which had to go through so many hands that it
delayed action.

On P.R., he thought it was ready to go on Oct. 17, but that it was the
wrong one being sent. Now it is in hands of an officer at the field (he believes)
and he expects it right away (any day). He said he'd call when he gets it.

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B. B. Fowler
Signature

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31 October 1957

SGR:jam

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MEMORANDUM

TO: C. H. Trent
FROM: S. G. Rumbold
SUBJECT: Weekly Summary of Progress on Rover Project
REFERENCE: Weekly Summary dated 24 October 1957, Control No. 1633.1

1. A brief statement of work accomplished in the past week through 30 October is recorded here. Progress is reported in terms of the Contract Work Statement and the objectives defined therein.

2. Item 1 - Preliminary Power Plant Studies

Work performed to date on the Iron Horse Missile is being refined and will be used as the basis of a topical report.

3. Item 2 - Systems Analysis Studies

Analog computer tests were made on the reference engine with a step disturbance of 0.1 dollar activity, 2 control rod actuator time constants (.02 and .2 seconds) ^{were} simulated. The results agree with behavior predicted from frequency response tests.

4. Item 3 - Component Studies

a. Turbo Pump

Various arrangements of turbo pump components for the topping and bleed cycles were examined. Layouts were initiated to evaluate those chosen.

b. Propellant

No work.

c. Controls

Vendor control on specific control elements was continued. Detailed analysis of a gas poison control sub-system for the reactor is approximately 30% complete.

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d. Tanks and Structures

Work planned for the control is complete. u

e. Thrust Chamber

The results of the computer work is being used in our analysis to relate pressure drop to coolant weight flow rate, diameter of tubes, coolant pressure, average coolant bulk pressure, nozzle expansion ratio, chamber to throat area ratio. This analysis will be applicable to the nozzle throat section as well as the ^{gent}divergent throat cone. The various analysis are intended to be used in the final selection of the propellant flow system.

f. Reactor

The reactor for the Iron Horse Missile is being redesigned. Heat transfer evaluation and structural configuration of this item are 70% complete. Continued studies on the auxiliary heater and center island gas control system are being carried out. PCR work for the year is complete and the topical report is being passed.

g. Miscellaneous

Hydraulic analysis on various flow diagrams was made to check pressure drops and to review the assumptions made in component analysis. This will assist in determining the applicability of each component to the engine arrangement.

5. Facilities

The topical report is the major item of work. The rough draft is about 50% complete.

S. G. Rumbold, Project Engineer
Rover Projects

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STATUS OF EXPERIMENTAL WORK AS OF 31 OCTOBER 1957

*Mrs. Rumbold
from Mary Seeger*

All experimental work will be terminated at the end of the day and preparation of the final summary report and individual topical reports will then be initiated. u

Heat Removal Experiments

The heat removal experiments using electrically heated porous graphite sources have been completed for the three grades of porous material considered. The power levels employed in each case were 0, $12\frac{1}{2}$ kilowatts and 40 kilowatts total dissipation. In the final test the power level was raised in an effort to reach 100 kilowatts total dissipation. Although the power supply is adequate for this purpose, it was found that hot spots at the end of the cylindrical specimen section prevented the test from reaching power dissipation levels of more than about 75 kilowatts. The data from all the tests conducted are in process of reduction.

Flow Separation Studies

The studies of flow separation in the transparent walled nozzle using Schlieren observation are being completed today. Following the initial check-out of the apparatus the systematic cold flow test program included runs with various nozzle entrance pressures reaching up to about 300 psi, a value corresponding to the maximum flow rate of 1 lb. per second, achievable with the nitrogen flow systems currently installed. In the systematic test series, pressure distributions along the nonporous wall were recorded by photographic viewing of ^a/manometer bank. Three grades of material for the porous wall were tested; namely, Micrometallic Corporation, Porous Stainless Steel with nominal pore sizes of 10, 20 and 30 microns. Injection pressure behind the porous wall were 0, 25, 50 and 100 psi. The Schlieren pictures and the pressure distribution pictures are being processed and data reduction will be initiated tomorrow.

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Heat Transfer to Cryogenic

wall

The flow system including the pyrex ~~flow~~ test section has been installed and flow tested with water. Owing to a few leaks in the test section ceiling system, tests were liquid nitrogen were not possible during the current contract period. Today an attempt will be made to checkout the thermocouple system by tests using boiling water. U

In summary, it is estimated that the system will require only a brief shake-down period before being ready for tests employing liquid nitrogen to gain experience with operation of the apparatus under cryogenic conditions.

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24 October 1957
SGR:bd

MEMORANDUM

To: C. H. Trent
From: S. G. Rumbold
Subject: Weekly Summary of Progress on Rover Project
Reference: Weekly Summary dated 17 October, 1957, Control No. 1633.1

1. A brief statement of work accomplished in the past week through 23 October is recorded here. Progress is reported in terms of the Contract Work Statement and the objectives defined therein.
2. Item 1 - Preliminary Power Plant Studies
 - a. Graphical presentation of gross weight, propellant weight, and component weights for chemical rockets is complete.
 - b. Two additional trajectory calculations were made for two thicknesses of thermal insulation on the propellant tank (.1 and .2 inches) The trajectories are optimum for the specific program resulting in circular or near circular orbits at an altitude of slightly over 200 miles. Atmospheric heating resulted in no loss in propellant. Boiloff was not sufficient to fill volume of consumed propellant.
3. Item 2 - Systems Analysis Studies

The electronic analog engine simulator was put into operation. Flow rate and chamber pressure feedback were investigated for step changes.
4. Item 3 - Component Studies
 - a. Turbopump

Revised chemical boost pump designs for comparison study.

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24 October 1957

b. Propellant

No work

c. Controls

Investigated engine shutdown requirements on turbine bypass valve. The required size is 12 inches for the Reference Vehicle.

It appears the existing hydraulic Moog Valve Company Hydraulic Servo can be adopted for pneumatic service based on their test data.

d. Tanks and Structures

Evaluation of effect of L/D of 3 was determined from trajectory calculations. We would like to repeat for L/D of 4 and 5 but because of cost, can't be done.

Evaluation of minimum tank pressure using payload stresses as a criterion is complete. Pressure (⁷³73 psi for payloads under 100,000 lbs) is too low for practical use.

e. Thrust Chamber

Results of the IBM 704 computer program for the regeneratively cooled vector control nozzles were received and analysis started.

Acceptable designs were obtained with Molybdenum alloy and pure Molybdenum. Inconel X appears likely but limited. 347SS appears very marginal.

f. Reactor

Various reactor concepts for use in an "Iron Horse" Vehicle were studied. Requirements of the auxillary heater for the topping cycle studied with regard to hydraulic requirements to transfer the needed heat. PCR heat transfer analysis for propellant through annulus between core and reflector is essentially complete.

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24 October 1957

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5. Facilities

Topical report is the major item of work. It is outlined and rough draft about 25% complete.

6. Topical Reports

Brochure - text complete - figures in preparation

Iron Horse - started

S. G. Rumbold, Project Engineer
Rover Projects

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1. Heat Removal Studies

The systematic heat removal experiments on Grades 20, 30, and 40 porous material have been completed. This constitutes the entire scope of work planned for the current report period, but the tests of the coarsest (Grade 20) material will be repeated next Monday in an effort to resolve some *suspicious* results. The experimental program is thus approaching 100% completion.

2. Nozzle Flow Studies

The preliminary checkout tests of the transparent wall nozzle and Schlieren system have been completed. The systematic experiments using the nozzle with porous boundary samples employing 10-micron and 30-micron nominal ^{pore}~~porous~~ size material, and employing complete pressure distribution measurements, are being performed today. This leaves only the measurements employing the boundary specimen using 20-micron nominal ^{pore}~~porous~~ size material to be done next week. The experimental program is thus approaching 100% completion.

3. Heat Transfer to Cryogenic Fluids

An apparently satisfactory heater strip has been fabricated by bonding a strip of stainless steel shim stock to the instrumented heater block. The test section has been assembled using the temporary Pyrex windows and is being incorporated into the flow system. The system is scheduled for leak testing and instrumentation checkout tomorrow.

The program is thus estimated to be approximately 90% complete, requiring only the aforementioned system checks and leak tests followed by installation of the insulated ^{wrap}(lagging) material, and it is anticipated that this work will be completed by October 31.

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17 October 1957
SGR:bd

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MEMORANDUM

To: C. H. Trent
From: S. G. Rumbold
Subject: Weekly Summary of Progress on Rover Project
Reference: Weekly Summary dated 10 October, 1957, Control No. 1633.1

1. A brief statement of work accomplished in the past week through 17 October is recorded here. Progress is reported in terms of the Contract Work Statement and the objectives defined therein.

2. Item 1 - Preliminary Power Plant Studies

a. Topical report on comparison study of nuclear vs chemical rockets is complete. Text is being revised after first review.

b. Graphical presentation of gross weight, propellant weight, and component weights for the chemical rockets is not complete. It appears boost-pump weights for the first stage are in error by a factor of two. These are being checked. This should be complete Monday.

c. The two trajectory calculations (one without tank insulation, one with 0.2 feet of insulation) show that the 1500~~0~~lb propellant loss can be reduced to a negligible quantity in case 2. We would like to run a third calculation using correct total propellant consumption to obtain proper range, but with fiscal situation, I doubt if we can afford it.

3. Item 2 - Systems Analysis Studies

a. More modifications of analog are being made. Since we are not supporting this work, it is done as time permits on Avionics overhead.

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17 October 1957

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We will not report this work again. It can be said that we have an engine analog for use in future work.

b. A hand calculation of one qualitative approach to the shutdown problem was made. It appears that a flight shutdown can be made without using vernier rockets to trim impulse.

4. Item 3 - Component Studies

Most of our effort has been on the quarterly report.

a. Turbopump

Revised layout drawing of a turbopump (900 psi) for use in topping cycle is now complete.

b. Propellant

No work

c. Controls

A circuit diagram for one overall control system was made

d. Tanks and Structures

Parametric studies are complete drawings comparing the nuclear (hydrogen and ammonia) and chemical rockets at 10 points over the spectrum of missions are complete.

e. Thrust Chamber

The IBM data for the main nozzle cooling was reviewed. Molybdenum alloy (0.5% Ti), Inconel X, and pure Molybdenum appear superior. They permit design of a low pressure drop nozzle. Steel is satisfactory but requires a high pressure drop. Aluminum does not appear to be adequate.

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f. Reactor

Two new reactor designs were conceived. One is an "Iron Horse" concept, the other a "folded-core". The latter results in a minimum pressure drop.

Detail design of auxiliary nuclear heaters for the topping cycle were studied.

5. Item 4 - Facilities

Quarterly report draft was prepared. Topical report was started.

S. G. Rumbold, Project Engineer
Rover Projects

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Heat Removal Studies (Grade 20)

40% 70
The coarsest-grain specimen, has been tested at zero, 12, and 40 kw power dissipation levels. The next finer specimen (Grade 30) has been tested at the zero and 12-kw levels, at the 40 kw test will be performed this afternoon. This will leave the test phase approximately 60% complete, since only one more grade of material (Grade 40) is scheduled for testing.

Nozzle Separation Studies

50% 70
The glass-walled nozzle has been installed and preliminary Schlieren photographs made in cold-flow tests under varying at different chamber pressure levels up to 300 psi indicate that separation is promoted by injection. Systematic testing including pressure-distribution measurements will begin tomorrow, and should not require more than 5 working days provided that all instrumentation works satisfactorily.

Heat Transfer to Cryogenic Fluids

Deposition of ~~the~~ a heater strip element by electrochemical methods was abandoned, and a 2-mil stainless steel strip is now

being bonded to the ceramic base by ^u
a ~~self~~ soldering method which is
"guaranteed" to produce good bonds between
metals and ceramics at high temperatures.

The flow test installation has been
completed about as far as possible without
the test section itself, which will be
available for installation next week,
following baking of the solder joint and
facing of the strip ends.

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10 October 1957
SGR:am

MEMORANDUM

To: C. H. Trent
From: S. G. Rumbold
Subject: Weekly Summary of Progress on Rover Project
Reference: Weekly Summary dated 3 October, 1957, Control No. 1633.1

1. A brief statement of work accomplished in the past week through 9 October is recorded here. Progress is reported in terms of the Contract Work Statement and the objectives defined therein.

2. Item 1 - Preliminary Power Plant Studies

a. The first complete draft of the final review of the comparison study of nuclear vs chemical rockets is essentially complete. Following various editorial and minor technical revisions this will be released as a topical report.

b. Graphical presentation of gross weight, propellant weight and component weights for chemical rockets is being held up for revision of tank weights. All other data are available. We expect to be able to include these graphs along with the nuclear graphs in the final quarterly.

c. Two trajectory calculations were completed on the IBM 704 Computer. Review of these to be made before other work would be done. We hope additional trajectories will not be needed in the scope of this work.

3. Item 2 - Systems Analysis Studies

a. As a result of the shake-down test conducted last week on the working analog of the topping cycle engine, modifications are being made. The circuit diagram is complete and installation is expected to be made by today or tomorrow.

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4. Item 3 - Component Studies

a. Turbopump

Stress analysis of turbine blades and impeller vane was made and these data are being used to review possible design changes in the designs generated to date.

b. Propellant

No significant work.

c. Controls

Current diagram A revised cost estimate (reduced) was received from Air Research.

d. Tanks and Structures

Tank configurations for the nuclear ammonia rockets have been determined. Parametric studies of balloon type tanks is essentially complete. If the equations can be expressed mathematically so that the digital computer will converge instead of diverge, this work will be complete.

e. Thrust Chamber

Thrust control nozzle heat transfer problems were run on the IBM 704 Computer.

f. Reactor

The results of the computer runs are being evaluated.

5. Item 4 - Facilities

Various charts and graphical presentations were prepared for inclusion in the quarterly report.

6. Item 5 - Experimental Investigations

a. Low Temperature Materials Investigations

No additional results were obtained.

b. High Temperature Heat Transfer Investigation

Two power tests were made; one at 12 1/2 KW total power dissipation and the second of shorter duration at 40 KW. Fluctuations in temperature

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C. H. Trent

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10 October 1957

in the porous sections were extreme in case 2. The specimen surface somewhat chewed up. This could have happened on disassembly. Another section was installed and a cold run made. Now the next specimen of finer porosity will be run and probably a third type can be tested. This item is essentially 25% complete.

c. Low Temperature Heat Transfer Investigation

Installation of the flow system for water and liquid nitrogen check-out tests is progressing steadily and is now about 90% complete. The delivery of heating strip is being awaited. The plating vendor is still having trouble in making the plated strip adhere to the base. He is now trying gold frit.

d. Nozzle Flow Separation Investigation

The tube section was installed and the Schliern mirrors aligned. First pictures were taken and cold tests started.

S. G. Rumbold, Project Engineer
Rover Projects

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10/10/57

Hilden

1. Is there any provision for severable equipment (facilities). of the scope of \$350,000?

Not as rosy as last week. Discuss with Weiner

2. Status of PCR report classification

Letter to contract officer 2 weeks ago. Will check

3. Re letter 1 Oct. re rpt. distribution Item a - Std list M3679 Non proprietary only? What about NAA

Left out statement All gov agencies prop's non-gov. non-prop.

4. PR status

PR in center - F&D Wiener RFP out 23 August

Organization
sent

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Experimental Status — 10/3/57

HEAT REMOVAL FROM EXTENDED-SURFACE SOURCE

Operating difficulties required disassembly of the test furnace, rework of some parts, and recalibration of the radiation pyrometers. The systematic test program has not progressed since last week's report, and unless the testing can be expedited during the four weeks remaining, the scope of the program will have to be reduced to include testing of only two grades of specimen coarseness.

2 power tests
1) 12 1/2 kW test
sec
total dissipate
40 kW
five Tim
power sections
extreme in
case r
specimen
checked
in disassembly?
run another
old

25%
complete now next
first
probably
3rd

NOZZLE FLOW SEPARATION

Persistent fabrication difficulties have finally been overcome, and the transparent-walled test section is being picked up today. Installation will be started tomorrow, and cold-flow tests started next week.

Installed
Schlieren
aligned
51st pictures
cold flow
started

HEAT TRANSFER TO CRYOGENIC FLUIDS

Installation of the flow system for water and liquid nitrogen checkout tests is progressing steadily, and is now about 80 percent complete. The transparent-walled test section is complete except for the heater-strip and thermocouple segment. This ceramic segment was received sometime ago in Aerojet's laboratory; the fine, flush-mounted thermocouples were installed, and the nickel base for the heater plating was vacuum-deposited. However, the plating vendor is encountering difficulty in making the plated strip adhere to the base, and is trying revised plating techniques to avoid this problem.

90%

Heating strip
gold frit
almost complete

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3 October 1957
SGR:am

MEMORANDUM

To: C. H. Trent
From: S. G. Rumbold
Subject: Weekly Summary of Progress on Rover Project
Reference: Weekly Summary dated 26 September 1957, Control No. 1633.1

1. A brief statement of work accomplished in the past week through 2 October is recorded here. Progress is reported in terms of the Contract Work Statement and the objectives defined therein.

2. Item 1 - Preliminary Power Plant Studies

essentially
a. The final review of the comparison study of nuclear vs chemical rockets is 90% complete.

b. Graphical presentation of gross weight, propellant weight and component weights for the ammonia and hydrogen nuclear rockets is complete. The data for the second stage of the chemical rockets is complete. Work is continuing on the first stage.

c. Revised comparison chart of nuclear and chemical vehicles are on hand and replacement slides and 8 x 10 prints will be transmitted to WADC shortly.

*2 made
hold for
review*
d. Trajectory calculations being conducted on the IBM 704 Computer are not complete. Difficulties have been encountered on the check-out runs. We hope to wind these up this week if all goes well.

3. Item 2 - Systems Analysis Studies

a. Some servos in the topping system analog were replaced.

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C. H. Trent

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3 October 1957

a

Shake-down tests are in progress and we expect to complete these this week.

These will serve as a demonstration that a working analog is on hand for more extensive use in next year's program. We do not expect to get anything more than very preliminary results from these tests.

4. Item 3 - Component Studies

a. Turbopump

The revised design of turbopump for a bleed cycle is complete.

A first draft of the bleed cycle analysis is on hand.

b. Propellant

No significant work.

c. Controls

(1) Evaluation of components continuing. A proposal for a transducer was received from Ultradyne.

(2) Pneumatic actuators were discussed with a representative of Lockheed, Marietta, Georgia.

(3) An overall engine system diagram was made showing one control scheme using poison gas reactor control.

d. Tanks and Structures

(1) Tank design for chemical systems were made.

e. Thrust Chamber

(1) The main nozzle heat transfer problem was run on the IBM 704 Computer.

f. Reactor

(1) The temperature reactivity determinations on the IBM 704 Computer are complete.

5. Item 4 - Facilities

a. Radiation flux maps were made for the reference flight vehicle;

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Mod.
as result
of shake down
tests.

turbine
blades
impeller
vane
1/4

Quarterly
Review
cost est.
reduce
air removal

control
system

evaluating
results
of data

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C. H. Trent

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3 October 1957

one for fast neutrons, and the other for gamma radiation. u

6. Item 5 - Low Temperature Materials Evaluation

a. No additional results were obtained.

S. G. Rumbold, Project Engineer
Rover Projects

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26 September 1957
SGR:am

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MEMORANDUM

To: C. H. Trent
From: S. G. Rumbold
Subject: Weekly Summary of Progress on Rover Project
Reference: Weekly Summary dated 19 September 1957, Control No. 1633.1

1. A brief statement of work accomplished in the past week through 25 September is recorded here. Progress is reported in terms of the Contract Work Statement and the objectives defined therein.

2. Item 1 - Preliminary Power Plant Studies

a. The final review of the comparison study of nuclear vs chemical rockets is 80% complete. The report is expected to be complete early next week but various revisions to put it into shape suitable for publication as a topical report will continue well into October.

b. Graphical presentation of gross weight, propellant weight, and component weights for the ammonia nuclear rockets is complete. The data for the hydrogen nuclear rockets is at hand and the graphs are being plotted. We hope to wind this up this week. Data for flourine ammonia chemical rockets are being assembled for plotting. This overall item can be considered 75% complete.

c. The revision of the ammonia reference system is complete and the various charts and slides will be revised.

d. Trajectory calculations being conducted on the IBM 704 Computer are still in progress. Some problems were encountered in using equations

80-90%

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involving a rotating earth in these calculations. We expect to wind these up early next week.

3. Item 2 - Systems Analysis Studies

a. Shake-down tests of the analog system for the type of topping cycle using the reactor - thrust chamber - turbopump system were made.

b. Fabrication for expansion of network analyzer continued.

4. Item 3 - Component Studies

a. Turbopump

(1) Initial analysis of hydrostatic hydrogen-lubricated bearings is complete.

(2) The revised design of a turbopump for a bleed cycle is 90% complete.

(3) The report of the refined bleed cycle analysis is being held up to permit re-examination of booster pump requirements.

b. Propellant

(1) No significant work.

c. Controls

(1) Evaluation of components continued and additional vendors were contacted, including Westinghouse Electronic Tube Division and Hydraulic Research. A proposal for supplying a pneumatic actuator was received from Air Research.

(2) The Nautilus control system was discussed with Manning, Maxwell and Moore representatives.

(3) Outline drawings of one overall control scheme was made as well as 18 subsystem outline drawings.

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d. Tanks and Structures

e. Thrust Chamber

(1) The altered program for the IBM 704 computations were transmitted to the computer people for computation.

f. Reactor

(1) Temperatures reactivity determinations on the IBM 704 Computer are ready to run and should be completed next week. This will finish work on that item.

(2) The steady state analysis of reactor behavior was expanded to include new data from LASL.

5. Item 4 - Facilities

a. Radiation flux map field computations are complete. These data are yet to be plotted to form the map. This item should be considered 95% complete.

b. Synthesis of test programs for engine components is about 75% complete.

6. Item 5 - Low Temperature Materials Evaluation

a. Tensile shear evaluation testing at liquid nitrogen temperatures is complete. Armstrong A-6 adhesive with E catalyst gave the best results.

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Rover Projects

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STATUS OF EXPERIMENTAL WORK - WORK ORDER 1310

ITEM I, PHASE D2 - TASK AEC : HIGH TEMPERATURE HEAT REMOVAL

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The zero power permeability ~~of the~~ calibrations of the coarse-grained graphite specimens have been completed. Recalibration of the ^{four} ~~floor~~ radiation pyrometers was required prior to initiation of the powered tests. Completion of the heat removal experiments is still scheduled for the last of October. The systematic testing is approximately 15% complete as of this date.

ITEM I, PHASE D2 - TASK AED: LOW TEMPERATURE HEAT TRANSFER

Installation of the equipment (test section, pipe and valves, tankage, and instrumentation) is now about 50% complete. The components of the transparent-walled test section itself have been received from the vendor and are being assembled in Aerojet shops.

ITEM I, PHASE D2 - TASK AEE: NOZZLE FLOW STUDIES

The glass-walled nozzle section has been inspected by project personnel in the vendor's shop. Difficulties with window fabrications apparently have been overcome and the nozzle is to be delivered on September 30. Meanwhile, provisions ^{for} ~~of~~ cold-flow tests are complete, awaiting the nozzle installation, and testing should be initiated next week.

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STATUS OF EXPERIMENTAL WORK - W.O. 1310

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Item I, Phase D2, Task AEC: High Temperature Heat Removal

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Last week's report was erroneous. Two tests (zero-power and 10 kw total dissipation) have been performed on the lowest-permeability (finest-grain) porous sample. At specimen surface temperatures of 3200°F, achieved accidentally, the hot-side platinum voltage-drop taps to the specimen failed. Also, unreliable gas temperature readings were obtained during the test. After replacing the pt wires with Iridium wires for ΔV measurement, and re-calibrating the hot-side gas thermocouple, tests using the coarsest-grain specimen have been initiated.

Owing to a shortage of time as well as of funds during the current contract year, heat-transfer tests are planned only for the three coarsest-grained porous graphite samples, with the possible addition of a fourth sample depending upon the rate of process and associated costs. Completion of the heat removal experiments, is now scheduled for the last of October, with data analysis extending into the report period. The systematic testing is therefore only about 10% complete as of this date.

Item I, Phase D2, Task AED: Low-Temperature Heat Transfer

As a result of a reduced level of effort dictated by ~~final~~^{fund} limitations, completion of the installation of the equipment (test section, piping and valves, tankage, and instrumentation) is now scheduled for the first week of October. As of this date, installation is about 40% complete. During the remainder of the contract period, shakedown tests using water will be conducted.

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Item I, Phase D2, Task AEE: Nozzle Flow Studies

Vendor difficulties in fabrication of the glass nozzle windows have continued to delay delivery of the work test section, which is now promised by Sept. 26. Since cold-flow tests may be performed by by ^{the} passing nitrogen flow around the heat-removal section, installation of the nozzle and alignment of the Schlieren system can be completed within one day, once the nozzle arrives. With cold-flow operation, a large number of test conditions (stagnation pressure & injection flow rate) may be performed in one day, and it is estimated that the entire series of planned cold-flow tests can be completed during one working week, once operation is initiated.

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