Monthly Progress Report for August 1964
(1 August to 31 August 1964)

ION ROCKET SYSTEM RESEARCH AND DEVELOPMENT

Prepared for:
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Contract NAS3-5250

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Prepared by:

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300 North Halstead Street
Pasadena, California

OTS PRICE

XEROX $ 1.00
MICROFILM $ .50

1. GENERAL STATUS

During the report period the long duration run test data and hardware were analyzed. The permanent magnet engine was fabricated and tested. Several autocathode designs were tested and a liquid nitrogen cooled scanning neutral detector was fabricated. Since a quarterly report is being issued shortly after this monthly report, most details will be given in the quarterly report and only certain items will be covered here.

2. LONG-LIFE ENGINE SYSTEM

A 280 hour DE engine test, the last 200 hours of operation of which were continuous, was terminated on 7 August. Analysis of the data, including residual drains, will be reported in EOS Report 4920-Q-2 (NASA CR 54026). Analyses of the components, including weight changes, chemical analyses, and photo-micrographs of eroded portions of the electrode were also performed.

The 280 hour test was made with a copper accelerating electrode. No high accel drain currents were encountered and no tendency toward "runaway" was observed. However, because of its high sputtering ratio, copper is not considered to be an optimum electrode material. As reported in previous reports (EOS Report 4920-ML-5) molybdenum, a low sputtering ratio material, was found to exhibit high electron emission at moderate temperatures. This was hypothesized as being due to Schottky enhanced emission from a low work function composite surface (Cs-O-Mo).

A series of electrode material tests with operating engines is being scheduled to select an electrode material for the 750 hour engine. A material with a low sputtering ratio and low electron emission in the engine operating environment is being sought. The tests will include the determination of accel drain current due to electron emission as a function of electrode temperature and chamber pressure. The design of

the 750 hour engine will be completed at the end of the electrode material tests. The changes in the program schedule are presented in Section 8 of this report.

3. PERMANENT MAGNET STUDIES

During the report period the permanent magnet engine was fabricated and initial tests were conducted. A description of the engine and details of the tests will be presented in the quarterly report.

4. PLASMA DISTRIBUTION STUDIES

During the period, fabrication of the liquid nitrogen cooled neutral cesium detector, for scanning the neutral efflux in the beam, was completed. It will be used in the next period.

A multiple cathode, reverse feed modification of the DE engine was designed and placed in fabrication during the report period. This engine will be tested with a central anode to evaluate the effect of such operation on the plasma density distribution.

5. AUTOCATHODE IMPROVEMENT STUDIES

During the report period, several externally heated autocathode designs were tested with a DE engine. Results of the tests will be reported in the quarterly.

6. QUALITY ASSURANCE

17 shop travellers were submitted for processing during the month of August. Four standing assembly requests are active; one each for DER-1 engine, DER-2 engine, 4923 S/N1 zero-gravity feed system and 4923 S/N2 zero-gravity feed system.

Special processing instructions were issued for vacuum brazing of tantalum to molybdenum with palladium-cobalt filler material.

Failure reporting to date is summarized in the following tabulation:

Total number of failures reported	7
Corrective action taken	3
Corrective action not required	4
Outstanding	0

Failure reports Nos. 3, 4 and 5 were completed. They may be found on following pages.

7. PROGRAM FOR NEXT PERIOD

During the next period, electrode material tests will be pursued and design of the 750 hour engine will be started. The permanent magnet engine will be tested and evaluation of externally heated auto-cathode designs will be continued. The liquid nitrogen cooled, scanning neutral detector will be operated and plasma distribution studies resumed. It is anticipated that fabrication of the mulciple cathode, reverse feed engine will be nearly completed at the end of the next period and will be tested during the following period.

WA-4920 FAILURE REPORT

Date of Failure [illegible] May 1964 System Design Life [illegible]

Engine [illegible] Serial No. [illegible]

Feed System [illegible] Serial No. [illegible]

Control System [illegible] Serial No. [illegible]

Power Supply [illegible] Serial No. [illegible]

Description of Failure

I_s has increased to 23 ma (approximately 5 percent drain)

Test Conditions at the Time of Failure, Malfunction or Degradation

I_s = 450 ma

Run Time = [illegible] hours

Effect on System Performance

Excessive power [illegible] electrode [illegible]

Determination of Cause

[illegible] accelerating electrode [illegible] operation [illegible] in drain current.

Corrective Action

Not required until an optimum electrode material is selected.

Prepared by [signature] Date [illegible] May 1964
[illegible] August 1964
[illegible] August 1964

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WA 4920 FAILURE REPORT

No. 4

Date of Failure 6 June 1964 System Design Level DE

Engine DEK Serial No. 1

Feed System 4923 Serial No. 1

Control System GFE Serial No. 1

Power Supply GFE Serial No. 1

Description of Failure:

I- had increased to an excessive level.

Test Conditions at the Time of Failure, Malfunction, or Degradation:

I_B = 430 ma I- = 15 ma

Run Time = 17-1/2 hours

Effect on System Performance:

Shutdown due to excessive drain current (automatic control)

Determination of Cause:

See W.A. 4920 Failure Report No. 3

Corrective Action:

See W.A. 4920 Failure Report No. 3

Prepared by [signature] Date 6 June 1964
[signature] 7 August 1964
[signature] 12 August 1964

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WA 4920 FAILURE REPORT

No. [illegible]

Date of Failure: 18 June 1964 — System Design Level: DE

[illegible]: DER — Serial No.: 1

[illegible]: 4923 — Serial No.: 1

Control System: GFE — Serial No.: 1

Power Supply: GFE — Serial No.: 1

Description of Failure

I- had increased to an excessive level.

Test Condition at the Time of Failure, Malfunction, or Degradation

I_g = 430 ma I- = 22.5 ma

Run Time = 20-1/2 hours

Effect on System Performance

Excessive power consumed by electrode drains.

Determination of Cause

See W.A. 4920 Failure Reports Nos. 3 and 4.

Corrective Action

See W.A. 4920 Failure Reports Nos. 3 and 4.

Prepared by: Geo. C. Reid, R. C. Spencer, [illegible] Zufran — Date: 18 June 1964, 7 August 1964, 12 August 1964

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8. CONTRACTUAL AND FINANCIAL INFORMATION

Mileposts

Below is the list of mileposts and scheduled dates for the program. The schedules have been changed to reflect a change in the Statement of Work. An evaluation of electrode materials for the long-life engine will be performed prior to completion of the design of the 750 hour engine. The fabrication and testing of the deliverable system has been deleted from the Statement of Work.

Milepost	Scheduled Week of:	Comments
0 Start a. Fabrication of DE system b. Facility modification c. Determination of autocathode heat requirements d. Plasma distribution studies	24 Feb	24 Feb
1 Start analysis of DE engine magnetic field	22 Mar	22 Mar
2 a. Complete fabrication of 1st DE system and start initial testing b. Complete analysis of DE engine magnetic field and start design and fabrication of DE engine modification for PM field test	19 Apr	24 Apr
3 Complete facility modification and start long tests of DE engine (including 200 hour test)	10 May	15 May
4 Start design fabrication and testing of minimum power autocathodes	15 May	15 May
5 Start electrode material tests	30 Aug	30 Aug

Milepost (cont.)	Scheduled Week of:	Comments
6 Start design and fabrication of 750 hour system	30 Aug	30 Aug
7 Complete testing of DE engine with PM field and begin design of PM engine	15 Jun	6 Jun
8 Complete design of PM engine	10 Jul	15 Jul
9 Complete long tests including 200 hour test and analysis	9 Aug	23 Aug
10 Complete fabrication and begin testing of PM engine	15 Aug	23 Aug
1 Start investigation of elimination of separate cathode heater supply	23 Aug	21 Jun
1[illegible] Complete tests of PM engine	25 Oct	
13 Complete fabrication of 750 hour system and start performance mapping	15 Nov	
14 Complete autocathode improvement studies	29 Nov	
15 Complete performance mapping 750 hour system and start 750 hour test	6 Dec	
16 a. Complete 750 hour test and analysis	21 Feb	
b. Complete plasma distribution studies	21 Feb	
c. Start Final Report	21 Feb	
17 Complete Final Report	14 Mar	

Key Personnel

The key personnel on the program are:

R. C. Speiser	Program Supervisor
G. C. Reid	Long Life Engine
F. A. Barcatta	Long Life Feed System
C. Sohl	Applied Research
S. Zafran	Quality Assurance

These personnel supervise their respective tasks and are the major contributors to the program and to all reports generated under the program.

Manpower

During the period 1 August 1964 to 28 August 1964, 2,179.25 manhours were expended. The cumulative total manhours expended to 28 August 1964 constitute 40 percent of the total anticipated manhours for the program. The names of engineering and scientific personnel who worked on the project during the period are listed below.

Name	Hours
R. C. Speiser	152
R. Silver	20
F. A. Barcatta	23
S. Zafran	43
G. C. Reid	160
C. Sohl	160
R. Henderson	54
D. P. West	151
G. E. Trump	8
E. T. Currans	22
G. R. Troup	10
J. R. Frey	22

Manpower (cont.)

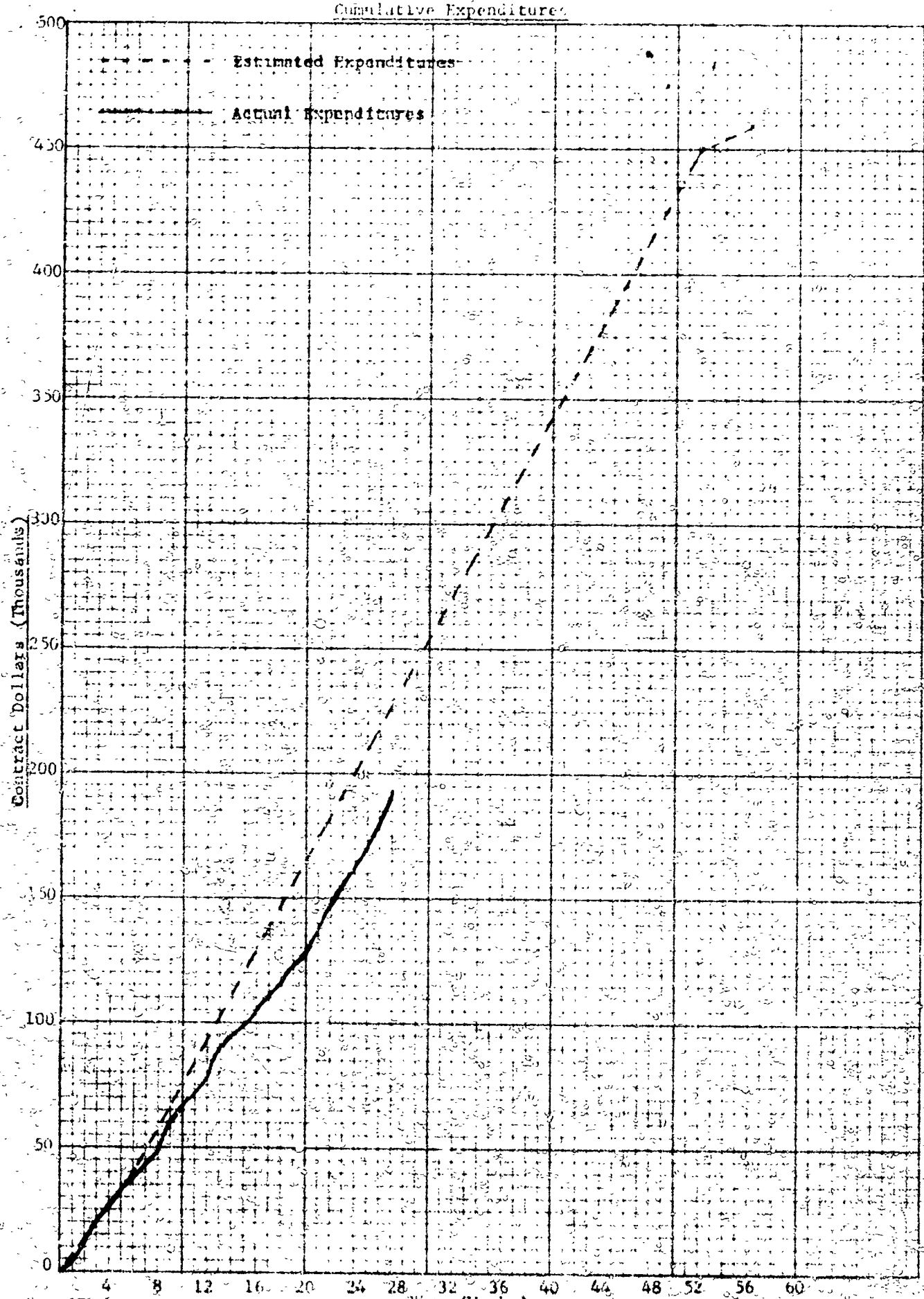
Name	Hours
C. L. Rahm	8
K. G. Wood	160
R. G. De Silvestri	12
V. V. Fosnight	64

Expenditures

The accompanying graph shows the comparison of estimated and actual expenditures versus time.

CESIUM ELECTRON BOMBARDMENT ION ENGINE

Cumulative Expenditures



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