TABLE I. - FLIGHT REENTRY RESEARCH AT HYPERBOLIC VELOCITIES

RESOURCE REQUIREMENTS - FUNDS

After project approval date launching will occur as follows:

37,000 feet per second
Spacecraft No. 1 - 20 months
Spacecraft No. 2 - 24 months

Obligations required in millions of dollars:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacecraft</td>
<td>0.88</td>
<td>2.97</td>
<td>1.04</td>
<td>4.89</td>
</tr>
<tr>
<td>Velocity Package</td>
<td>0.64</td>
<td>1.75</td>
<td>0.48</td>
<td>2.87</td>
</tr>
<tr>
<td>Launch Vehicles</td>
<td>2.40</td>
<td>4.00</td>
<td>0.10</td>
<td>6.40</td>
</tr>
<tr>
<td>Research and Development</td>
<td>0.06</td>
<td>1.38</td>
<td>0.08</td>
<td>1.52</td>
</tr>
<tr>
<td>Range</td>
<td>----</td>
<td>0.10</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>Total</td>
<td>3.98</td>
<td>10.20</td>
<td>2.00</td>
<td>16.18</td>
</tr>
</tbody>
</table>
Memorandum

TO:   Assistant Director for Flight Projects
FROM: Manager, Flight Reentry Programs Office
       Mail Stop 333

DATE: July 17, 1967

SUBJECT: Program 714, Project Fire - Technical closeout and summary

The mission purpose of Project Fire was to investigate the heating environment of vehicles entering the earth's atmosphere at velocities slightly greater than lunar return velocities. The primary objectives of the flight reentry experiments were to obtain onboard measurements that would define the hot-gas radiance and the total heating on a blunt-nose body of fairly large scale to provide data anchor points for comparison with results obtained from ground facilities and theoretical prediction methods. The mission and objectives have been obtained through two successful flight tests as planned.

Project Fire has been technically completed now that all the technical reports have been written and published with the exception of two which are in the NASA publishing processes. All of the Flight Reentry Programs Office Project Fire documents and records are now stored in the Federal Records Center, Region III, at Alexandria, Virginia. Only copies of the NASA technical reports and edited film are in the files of the Flight Reentry Programs Office.

Historical Dates.- Dates from the beginning to the end of the project that have some interest are as follows:

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideas and promotion of this type of reentry test</td>
<td>Summer 1960</td>
</tr>
<tr>
<td>Project Fire approval</td>
<td>December 19, 1961</td>
</tr>
<tr>
<td>Spacecraft contracts awarded</td>
<td></td>
</tr>
<tr>
<td>Velocity Package with Ling-Temco-Vought</td>
<td>March 2, 1962</td>
</tr>
<tr>
<td>Study (NASL-1807)</td>
<td></td>
</tr>
<tr>
<td>System (NASL-1946)</td>
<td>July 25, 1962</td>
</tr>
<tr>
<td>Rentry Package with Republic Aviation</td>
<td>June 14, 1962</td>
</tr>
<tr>
<td>System (NASL-1945)</td>
<td></td>
</tr>
<tr>
<td>(Pacing system in the project schedule)</td>
<td></td>
</tr>
<tr>
<td>Flight of No. 1 mission</td>
<td>April 14, 1964</td>
</tr>
<tr>
<td>(28 months after project approval)</td>
<td></td>
</tr>
<tr>
<td>Flight of No. 2 mission</td>
<td>May 22, 1965</td>
</tr>
<tr>
<td>Published final technical report</td>
<td>Summer 1967</td>
</tr>
</tbody>
</table>

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan
Resources Utilized.- The accumulated cost of Project Fire as of this date has totaled about 30.9 million dollars. Although the contracts have not been closed out and therefore settlement costs may cause some adjustment, up or down, the itemized costs are listed as follows:

Research and Development
- 714-01 Reentry Package ............... $8,749,974
- 714-02 Velocity Package ............... 5,474,502
- 714-03 Launch Vehicles and Systems
  Integration .................................. 11,615,928
- 714-04 Tracking and Data Acquisition ... 1,867,951
- 714-05 Range Operations ............... 291,197

SUBTOTAL ...................................... $27,999,552

In-house Support (cost obtained from job orders charged to Project Fire Tasks)
- Labor ........................................ $1,997,263
- Stock ....................................... 485,498
- Travel ....................................... 462,095

SUBTOTAL ...................................... $2,944,856

TOTAL ........................................ $30,944,408

The maximum Langley equivalent-to-full-time manpower used during the project was:

- Project Office 23
- Division support 60

TOTAL Langley 83

The peak in manpower occurred just prior to the first launch date because Reentry Package qualification tests and project field operations were concurrent.
Resultant Technical Reports.- Attached to this memorandum is the listing of the fifteen technical reports on the research data from these two successful flight tests. These fifteen reports are divided between the two flights as follows:

- 7 from Flight No. 1
- 5 from Flight No. 2
- 3 from combination of both Flight No. 1 and No. 2

15 Total NASA reports

Of this fifteen, eight are classified confidential Technical Memoranda and seven are unclassified Technical Notes. Only two of the reports were written by personnel other than those of the Flight Reentry Programs Office.

Retrospect.- On looking back to consider what the major problems were, only two really had major effects or were the causation for others. These were:

1. Internal company (Contractor) management inadequacies
2. Beyond the state-of-the-art radiometer instrument and especially the then unknown calibration techniques.

Moreover, the one technique that was predicted to be a major problem that of the principle and operation of the layered ejected calorimeter heat shield, proved to be no major problem and was not changed from the original concept.

A final comment is a distillation of the comments from the personnel who made major contributions to the project: "Even with all the headaches, it was fun! It is not often one gets to be part of a major job from beginning to end—and a successful one too."

David G. Stone

Attachment
List of technical reports

cc: (w/copy attachment)
HAWilson MS 213
RCDingeldein MS 333
HFWeber MS 333
IGRecant MS 159
ECKilgore MS 107
TNNBartron MS 335
ESLove MS 186
DGStone MS 333
NASA - Langley

Technical Reports of the Research Data
from
Project Fire


Technical Reports of the Research Data from Project Fire


NOTE:

In addition to the above NASA Reports the technical findings of Project Fire were summarized in a paper presented at Proceedings of Asset/Advanced Lifting Re-entry Technology Symposium, held December 14, 15, 16, 1965 at Miami Beach, Florida, sponsored by the Air Force Flight Dynamics Laboratory, Research & Technology Division, AFSC and published by AFFDL; Report AFFDL-TR-66-22, dated March 1966. The paper was titled "Radiative and Total Heating Rates Obtained From Fire Re-entries at 37 000 Ft/Sec," by R. C. Dingeldein, NASA, Langley Research Center.