INDEXING NASA PROGRAMS FOR TECHNOLOGY TRANSFER
METHODS DEVELOPMENT AND FEASIBILITY
FINAL REPORT

By William H. Clingman

Distribution of this report is provided in the interest of
information exchange. Responsibility for the contents
resides in the author or organization that prepared it.

Prepared by
W. H. CLINGMAN & CO.
MANAGEMENT and TECHNOLOGY CONSULTANTS
1600 LTV Tower
Dallas, Texas

for
TECHNOLOGY UTILIZATION OFFICE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Under Contract No. NASw-2368
29 May 1972
ACKNOWLEDGEMENT

The author wishes to acknowledge the guidance and assistance provided throughout the project by Royal G. Bivins, Jr. of the NASA Technology Utilization Office.
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>3</td>
</tr>
<tr>
<td>INDEXING METHODOLOGY</td>
<td>5</td>
</tr>
<tr>
<td>INDEXING NASA PROGRAMS</td>
<td>7</td>
</tr>
<tr>
<td>GENERATION OF A COMPLETE INDEX</td>
<td>15</td>
</tr>
</tbody>
</table>

TABLES

<table>
<thead>
<tr>
<th>Table #</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CHECKLIST FOR GENERATING TECHNICAL DESCRIPTORS</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>SPECIFICITY OF TYPICAL PAD TECHNICAL PLANS</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>SURVEY RESPONDENTS</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>PAD TECHNICAL PLAN -- EXCERPT</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>KEY WORDS AND INDEX TERMS FOR EXCERPT</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>FINAL SET OF INDEX TERMS FOR EXCERPT</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>NASA PADS</td>
<td>16</td>
</tr>
</tbody>
</table>

APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>INDEXING WORKSHEETS</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>REVISED SAMPLE INDEX, SUPPORTING R&amp;T, COMMUNICATIONS</td>
<td>43</td>
</tr>
<tr>
<td>C</td>
<td>REVISED SAMPLE INDEX, POWER &amp; ELECTRIC PROPULSION SRT</td>
<td>63</td>
</tr>
</tbody>
</table>
A major part of the NASA Technology Utilization Program involves the identification of technology which can contribute to solving a nonaerospace problem. Regional Dissemination Centers are engaged in this type of activity for industrial clients. Application Teams also often seek out personnel at NASA centers that are cognizant of technologies relevant to a specific nonaerospace need. Previous studies have identified several problems in searching the literature for nonaerospace users. As a result it was desired to have an index to all NASA ongoing programs, where the index was designed for technology transfer. That is, the focus in the index would be on the technologies being developed rather than on the aerospace problems being solved.

In a previous study an indexing methodology was developed which assigned descriptors to projects based on a limited description of technical plan. The objective of the present project was to evaluate the application of this methodology to indexing ongoing NASA programs. These programs are comprehended by the NASA Program Approval Documents (PADS). Each PAD contains a technical plan for the area it covers. It was proposed that these could be used to generate an index to the complete NASA program.

To test this hypothesis two PADS were selected by the NASA Technology Utilization Office for trial indexing. These covered communications and power and electric propulsion. A sample index was prepared for each PAD. The index associated with each descriptor had a list of NASA technical managers and their organizations. The implication of the index was that the area of responsibility for each manager would involve technology relevant to the descriptor.

This was tested by sending to each manager a list of the descriptors associated with his area. The manager was asked to delete inaccurate descriptors and add others that had been omitted. When the manager deleted a broad term obviously related to his work, this deletion was not retained. Of the additions recommended by the managers, only those in the NASA Thesaurus or with a thesaurus equivalent were included.
In all 33 individuals were contacted and responses were obtained from 25. There were 783 descriptors that had been chosen relevant to the work of these 25 technical managers. The latter recommended 114 deletions and 188 additions. Of these, 103 deletions and 100 additions were retained. Thus 87% of the original 783 descriptors had been retained as being accurate. Also 87% of the descriptors in the final list had been present in the original index. This is a measure of the completeness of the indexing. These results confirmed the feasibility of the proposed approach for indexing NASA programs for technology transfer.

In addition to a set of PADS, information has been collected on the individual or organization responsible for each part of the technical plans. The next step in preparing a complete index would be to outline each of the technical plans, listing events in accordance with the indexing methodology. Each item on the list would then be assigned a responsible individual or organization using the information that has been collected. Key words would be chosen. These would then be expanded into the final list of descriptors using the NASA Thesaurus. The final step would be the organization and production of the index itself.

This project has demonstrated the feasibility of indexing ongoing NASA programs using PADS as the source of information. The same indexing methodology, however, could be applied to other documents containing a brief description of technical plan. The nature of the methodology is such that the index generated would be particularly suited to technology transfer. Physical principles and novel relationships involved in the developing technology would be covered. The results of this project show that over 85% of the concepts in the technology should be covered by the indexing. Also over 85% of the descriptors chosen would be accurate. This completeness and accuracy for the indexing is considered quite satisfactory for application in technology transfer.
One of the primary aims of the NASA Technology Utilization Program is to facilitate the transfer of NASA developed technology to nonaerospace users. To achieve such transfer requires that there be a link between the nonaerospace user and the NASA data bank and/or the ongoing NASA programs developing the technology. The latter case is particularly important when an active approach is being taken to technology transfer. In this case it is often necessary to locate technical personnel with knowledge useful in an application engineering program. The people engaged in an ongoing program are often in the best position to clearly see the work which must be done to apply their technology to a specific nonaerospace problem.

It is unlikely that a nonaerospace problem would be covered directly in an index to the NASA data bank. In addition there are no current indexes to ongoing in-house programs. The present program was a first step toward providing an index to all NASA programs for use in technology transfer. The material needed to generate a complete index has been gathered. Sample indexes to two NASA programs were prepared and these were used to demonstrate the feasibility of the indexing methodology. The application of this methodology to generate a complete index is discussed in the final section of this report.

The present indexing of NASA technology is done primarily for the aerospace user. Thus, the focus of this indexing is on the aerospace problem solved rather than on the technology which contributed to the solution. A study has shown that when the Regional Dissemination Centers search the NASA data bank for nonaerospace users (Application Teams) less than 40% of the relevant documents in the data bank are found.\textsuperscript{1} In this study it was shown that


simultaneous but independent searches are highly nonuniform in their results, retrieving different documents from the collection. This pattern of nonuniform retrieval and low recall is probably peculiar to the nonaerospace user.

Fundamental difficulties were found in searching for the nonaerospace user. Specific words must be selected from the aerospace vocabulary in order to conduct the literature search. The user's problem, however, cannot really
be described with precision using these words. Thus, any one of a large number of specific terms may have been used to index a document containing relevant technology. Determining a priori which one was used is a fundamental problem. For example, it was found that on the average 70% of the relevant documents not retrieved by a given RDC strategy were indexed at most under only one of the terms used in the literature search by the RDC. It was evident from the results of this study that the literature search specialist cannot determine how relevant documents were indexed from a knowledge of the nonaerospace problem alone.

In a second study\textsuperscript{2} the feasibility was established of providing an index which focuses on the technology rather than the aerospace problem. Specifically the feasibility of indexing NASA work units was established from this standpoint. In selecting index terms information was used on the objective and approach to be taken in the work unit R&D projects. It was shown that such an index could be prepared which would accurately cover with aerospace terms the technology resulting from these research projects. In the present project the applicability of this same indexing methodology to NASA Program Approval Documents (PADS) has been established. Starting with the written technical plans in these PADS the above methodology could be applied to generate a complete index to the ongoing NASA program. This special index could then lead the Application Teams to the individuals and organizations carrying out work relevant to the nonaerospace user.

\textsuperscript{2}Indexing Research and Technology Resumes For Technology Transfer" by William H. Clingman; prepared for Technical Information Services Company under NASA Contract No. NASw-1812; November 21, 1969.
INDEXING METHODOLOGY

The indexing methodology that has been used consists of three steps. First, the indexer reorganizes the available information so as to chronologically list all events of the proposed research program as described in the technical plan. In preparing the list of events, cause and effect relationships are considered in arriving at the proper order. In listing any particular event the indexer asks whether the events already listed are sufficient to enable the event being listed to take place. It is not intended that specialized technical knowledge on the part of the indexer be applied to such a consideration. What is intended is that general logical relationships be considered as a guide in extracting from the written material as much information as possible. For example, if the event being listed by the indexer is the assembly of a piece of hardware, then one could conclude that the parts being assembled must already be available. If one or more of these parts has not been discussed in an already listed event, then the indexer could scan the written material to determine whether such information is available.

Second, using the checklist of questions given in Table 1 the indexer selects key words from the list of chronological events. Key words are also selected using the original written material. The terms used should include those related to the physical principles and novel relationships in the technology being developed or applied.

Third, the NASA Thesaurus is used to convert the key words into a final set of descriptors. In general there will be several descriptors corresponding to each key word. The indexer uses the hierarchical relationships in the Thesaurus to identify descriptors which pertain to the R&D program but were not thought of in listing the key words. The Thesaurus is thus used to suggest new terms to the indexer so that the indexing of each part of the technical program can be as complete as possible even though the available information is limited.

This methodology was applied in a previous study to indexing Research and Technology Resumes. In that program the indexing accuracy was 95% and completeness was 88%. That is, 95% of the descriptors chosen based only on a brief statement of technical plan did apply to technology which resulted from the project. Also, 88% of the terms chosen by NASA to index all reports resulting from the project were covered by the descriptors which were generated from the brief statement of technical plan. From these results it was concluded that the application of this same methodology to ongoing NASA programs should be evaluated.
TABLE 1

CHECKLIST FOR GENERATING TECHNICAL DESCRIPTORS

Background

What new technology, if any, had led to this program?
What is the aerospace need giving rise to this program?

Experimental Methods

What type of experimental procedures will be used?
If analysis is to be done will novel mathematical techniques or computer programming be used?
What special characteristics will be required of the experimental equipment?
What procedures will be used to test or control the quality of products or processes developed in the program?

Novel Materials

What kind of novel materials, if any, will be involved in the program?
What will be their composition or form?
How will they be made?
What will be their desired novel properties?
How will they be applied?

Novel Equipment

What kind of novel equipment, if any, will be involved in the program?
What will it do and how will it work?
What novel materials or components will be used in this equipment?
How will it be assembled?
What will be its applications?

End Results

What will be the end result of the R & D program?
If a new product or process is to be developed, what will it do?
What problems must be solved to accomplish the end result?
What will completion of the R & D program make possible?
What are the anticipated applications of the work to be done?
Three things are considered necessary to develop an index to NASA programs. First is a written description of the technical work in progress. This description needs to be in sufficient detail to allow the development of descriptors, yet not so detailed that the indexing job is overwhelming. Second, there must exist a means of analyzing the technical description to obtain accurate and complete descriptors. The indexing methodology discussed in the previous section was evaluated for this purpose. Third, there needs to be a way of associating different parts of the written description with the individuals and/or organizational entities within the NASA Field Centers that are carrying out the work. For each PAD information has been obtained from NASA Headquarters on the responsible organization or individual for each part of the technical plan in that PAD.

The technical plans which have been written as a part of the NASA Program Approval Documents were analyzed as a solution to the first requirement. In particular it was desired to determine whether these plans were presented in sufficient detail to obtain technical descriptors of the work from them. The specificity of a statement in a technical plan can be roughly measured in terms of the number of professional man-years of technical work described per page of single-spaced typewritten material. In the previous study this measure of specificity ranged from 5 to 72. In the statements involving a high number of man-years per page high accuracy and completeness could still be achieved. For example, in Resume 127-52-01-02-23 the specificity of the statement of technical plans was 72 man-years per page. This resume concerned the development of an integrated advanced life support system. The statement of technical plan was in fact only 4 sentences long. Even so 93% of the terms used by NASA in indexing all reports from the project were covered by 17 descriptors generated solely from the statement of technical plan.

The specificity of the statements of technical plans for a sampling of PADS is shown in Table 2. There is a wide range of specificities. Many of these, however, fall within the range that was examined in the previous program on indexing Resumes. A single PAD covers a very large program compared to a single Resume. The written technical statement of plan in the PAD is a proportionately greater size. The hypothesis was thus made that the above indexing methodology could be applied to PADS with an accuracy and completeness comparable to that achieved in the previous study.

This hypothesis was tested in the present program. Two PADS were selected by the NASA Technology Utilization Office for trial indexing, Communications Supporting Research and Technology and Space Electric Power Systems. A sample
### TABLE 2

**SPECIFICITY OF TYPICAL PAD TECHNICAL PLANS**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Man Years</th>
<th>Pages</th>
<th>Man - Years Per Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>78-730-128)</td>
<td>Chemical Propulsion</td>
<td>330</td>
<td>6</td>
<td>55</td>
</tr>
<tr>
<td>78-730-731)</td>
<td>Earth Observations Supporting R&amp;T</td>
<td>173</td>
<td>1-1/2</td>
<td>115</td>
</tr>
<tr>
<td>61-820-; 61-880-</td>
<td>Communications Supporting R&amp;T</td>
<td>164</td>
<td>1-1/4</td>
<td>131</td>
</tr>
<tr>
<td>601</td>
<td>TIROS/TOS Improvements</td>
<td>42</td>
<td>1-1/3</td>
<td>32</td>
</tr>
<tr>
<td>604</td>
<td>Nimbus</td>
<td>401</td>
<td>7</td>
<td>57</td>
</tr>
<tr>
<td>607</td>
<td>Meteorological Soundings</td>
<td>53</td>
<td>3-1/2</td>
<td>15</td>
</tr>
<tr>
<td>608</td>
<td>Synchronous Meteorological Satellites</td>
<td>14+</td>
<td>2/3</td>
<td></td>
</tr>
<tr>
<td>610</td>
<td>Cooperative Applications Satellites</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>680</td>
<td>Applications Technology Satellites</td>
<td>191</td>
<td>3-1/3</td>
<td>57</td>
</tr>
<tr>
<td>640</td>
<td>Earth Resources Survey/Aircraft</td>
<td>176</td>
<td>1-1/2</td>
<td>117</td>
</tr>
<tr>
<td>641</td>
<td>Earth Resources Technology Satellites</td>
<td>60+</td>
<td>1-1/3</td>
<td></td>
</tr>
<tr>
<td>855</td>
<td>Geodetic Satellites</td>
<td>18</td>
<td>6-1/2</td>
<td>3</td>
</tr>
<tr>
<td>51-500-312</td>
<td>Tracking and Data Acquisition</td>
<td>7885</td>
<td>8</td>
<td>980</td>
</tr>
</tbody>
</table>
index for each of these PADS was prepared using the above methodology. Each of these indexes has been prepared and submitted to the NASA Technology Utilization Office as a separate document and should be considered as a part of this final report.

Included with each sample index are the worksheets that were used to prepare them. These worksheets are also in Appendix A of this report. The first worksheet is a listing of events and areas of technical activity taken from the written objective and technical plan in the PAD. Most of the listed events are taken directly from the PAD. Some are implied by the technical plan. Where possible the chronological order of events was considered in order to derive areas of technical activity implied by but not specifically mentioned in the technical plan.

Next to specific events or entire areas of technical activity on this first worksheet are code letters in parentheses. These code letters are the same as used in the sample index and correspond to the individual who is cognizant of this specific technical activity in the program. In some cases these individuals are individual investigators and in other cases they are project managers. In all cases the individual is reported to have sufficient knowledge of the technologies involved in his part of the program to direct an application team to the specific individuals that can contribute to a problem solution.

The next step in preparing the index was to derive a set of key words and key phrases from the list of events. The NASA Thesaurus was then used to select descriptors corresponding to each key word or phrase. The key words and descriptors are listed on the second worksheet for each program. Also listed next to each key word is the code letter for the cognizant individual.

The sample index for each program was then prepared. In the index the descriptors are listed in alphabetical order. Under each descriptor is given a list of individuals and their NASA Center. Each individual is reported to be cognizant of activities involving technology related to the descriptor. The individuals were listed using their code letter and a key was given at the beginning of the index. This format would allow efficient updating of the total index as individual responsibilities and organizations change.

The next step was to evaluate the accuracy and completeness of the sample indexes. Each of the technical managers included in the indexes was contacted either by mail or personal interview. The interviews were held with Messrs. D. Fielder and W. E. Rice at the Manned Spacecraft Center and with N. McAvoy at Goddard Space Flight Center. In all 33 individuals were contacted and responses were obtained from 25. A list of those responding is given in Table 3.

Each manager was asked to verify the accuracy of the descriptors chosen for
## Table 3

**Survey Respondents**

<table>
<thead>
<tr>
<th>Name</th>
<th>Center</th>
<th>Terms</th>
<th>Respondent Deletions</th>
<th>Final Deletions</th>
<th>Respondent Additions</th>
<th>Final Additions</th>
</tr>
</thead>
<tbody>
<tr>
<td>G. W. Brooks</td>
<td>Langley</td>
<td>33</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>G. R. Seikel</td>
<td>Lewis</td>
<td>29</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>D. Silverman</td>
<td>Hdq.</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>J. Miller</td>
<td>Goddard</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>39</td>
<td>22</td>
</tr>
<tr>
<td>T. Lynch</td>
<td>Goddard</td>
<td>48</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>W. E. Rice</td>
<td>MSC</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D. Fielder</td>
<td>MSC</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>G. Oer</td>
<td>Goddard</td>
<td>59</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>H. Hoffman</td>
<td>Goddard</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>W. R. Cherry</td>
<td>Goddard</td>
<td>77</td>
<td>16</td>
<td>14</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>N. McAvoy (Int)</td>
<td>Goddard</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>G. Clark</td>
<td>Goddard</td>
<td>17</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>C. H. Nelson</td>
<td>Langley</td>
<td>36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>R. V. Powell</td>
<td>JPL</td>
<td>58</td>
<td>27</td>
<td>25</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>D. T. Berntowicz</td>
<td>Lewis</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>W. Krabill</td>
<td>Wallops Station</td>
<td>58</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>R. Alexovich</td>
<td>Lewis</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>H. J. Schwartz</td>
<td>Lewis</td>
<td>50</td>
<td>20</td>
<td>19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>R. Breitwieser</td>
<td>Lewis</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>G. Andrus</td>
<td>Hdq.</td>
<td>20</td>
<td>2</td>
<td>1</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>E. A. Richley</td>
<td>Lewis</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>S. J. Kaufman</td>
<td>Lewis</td>
<td>45</td>
<td>25</td>
<td>25</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td>D. R. Packe</td>
<td>Lewis</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>J. Foster</td>
<td>Ames</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>A. Briglio</td>
<td>JPL</td>
<td>137</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>2</td>
</tr>
</tbody>
</table>

Total: 783  114  103  188  100
his part of the corresponding PAD. These descriptors had been chosen based only on the information contained in the PAD. The individual was also asked to list additional descriptors that had been omitted. Based on the responses obtained, additions and deletions were made to the original index. Revised indexes were prepared and submitted as a separate document to the NASA Technology Utilization Office. These revised indexes are in Appendices B and C of this final report.

In Table 4 is shown an example of an excerpt from the PAD #61-880-164, Supporting R&T, Communications. Mr. H. Hoffman at Goddard Space Flight Center has responsibility for this part of the work. In Table 5 are shown the key words that were chosen based solely on the excerpt in Table 4. Also in Table 5 are shown the index terms derived from the key words using the NASA Thesaurus. After Mr. Hoffman reviewed these terms he added the two additional ones shown in Table 6. This example illustrates the indexing and evaluation process.

Every addition and deletion recommended by the technical managers was not included in the revised index. Deletions not included were those in which the term was a broad one that was obviously applicable to the work. Many of the recommended deletions were terms related to the application of the technology. These were all included in the revised indexes. Of the recommended deletions, 35% were application related. Of the recommended additions, only those in the NASA Thesaurus or with a thesaurus equivalent were included. Table 3 shows the number of additions and deletions for each respondent in the survey. The format of the revised indexes shows where the additions and deletions were made. Additions are shown to the right of the left column. Deletions are shown as missing lines from the left column.

In all there were 783 descriptors that had been chosen relevant to the work of the 25 technical managers who had responded. The managers recommended 114 eliminations and 188 additions. Of these, 103 eliminations and 100 additions were retained. Thus in the revised index 87% of the original 783 descriptors have been retained as being accurate. Also 87% of the descriptors in the revised index were present in the original. This is a measure of the completeness of the indexing.

These results are consistent with those obtained in our previous study of indexing Research and Technology Resumes. The results demonstrate the applicability to PADS of the previously developed indexing techniques. The results also confirm the feasibility of the proposed approach for indexing NASA programs for technology transfer.
Applications Technology efforts will include studies of the feasibility and characteristics of stabilized spacecraft; sensor and instrumentation development and spacecraft technology activities.


<table>
<thead>
<tr>
<th>KEY WORDS</th>
<th>INDEX TERMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STABILIZED SPACECRAFT FEASIBILITY</td>
<td>STABILIZED PLATFORMS</td>
</tr>
<tr>
<td>STABILIZED SPACECRAFT CHARACTERISTICS</td>
<td>SPACECRAFT STABILITY</td>
</tr>
<tr>
<td>SENSOR DEVELOPMENT</td>
<td>STABILITY DERIVATIVES</td>
</tr>
<tr>
<td>INSTRUMENTATION DEVELOPMENT</td>
<td>DYNAMIC CHARACTERISTICS</td>
</tr>
<tr>
<td></td>
<td>SPACECRAFT STABILITY</td>
</tr>
<tr>
<td></td>
<td>SENSORS</td>
</tr>
<tr>
<td></td>
<td>GUIDANCE SENSORS</td>
</tr>
<tr>
<td></td>
<td>SPACECRAFT INSTRUMENTS</td>
</tr>
<tr>
<td></td>
<td>INSTRUMENT PACKAGES</td>
</tr>
<tr>
<td></td>
<td>SPACECRAFT INSTRUMENTS</td>
</tr>
</tbody>
</table>
**TABLE 6**

**FINAL SET OF INDEX TERMS FOR EXCERPT**

**ORIGINAL:**
- STABILIZED PLATFORMS
- SPACECRAFT STABILITY
- STABILITY DERIVATIVES
- DYNAMIC CHARACTERISTICS
- SENSORS
- GUIDANCE SENSORS
- SPACECRAFT INSTRUMENTS
- INSTRUMENT PACKAGES

**Added by Technical Manager:**
- ATTITUDE INDICATORS
- ATTITUDE CONTROL
GENERATION OF A COMPLETE INDEX

Based on the results of the trial indexing discussed above it is proposed that a complete index to ongoing NASA programs could be developed using the information presented in the Technical Plan section of all PADS. A complete collection of PADS has been assembled. A list of the PADS and the length of their written technical plan is shown in Table 7. There is a total of 246 pages devoted to the technical plans. It is proposed that a complete index to ongoing programs could be produced by indexing this material using the methodology discussed above. The cost would be higher than indexing a report of the same size because of the detailed nature of the indexing. The cost should be approximately comparable to that of indexing in depth an equivalent amount of Tech Brief Material.

In addition to a complete set of PADS information has also been collected on the individual or organization responsible for each part of the technical plan. For OART and T&D it is the form of RTOP collections. For the other areas the information is in the form of lists which were obtained from the program offices at NASA Headquarters.

The first step in preparing a complete index would be to outline each of the technical plans, listing events in accordance with the indexing methodology. Each item on the list would then be assigned a responsible individual or organization using the information that has been collected. Key words would be chosen. Using the Thesaurus these would then be expanded into the final list of descriptors as discussed above. The final step would of course be the organization and production of the index itself.

This project has demonstrated the feasibility of indexing ongoing NASA programs using PADS as the source of information. The same indexing methodology, however, could be applied to other documents containing a brief description of technical plan. The nature of the methodology is such that the index generated would be particularly suited to technology transfer. Physical principles and novel relationships involved in the developing technology would be covered. The results of this project show that over 85% of the concepts in the technology should be covered by the indexing. Also over 85% of the descriptors chosen would be accurate. This completeness and accuracy for the indexing is considered quite satisfactory for application in technology transfer.
### TABLE 7

**NASA PADS**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Pages of Technical Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-703-320</td>
<td>Special Support, Technology Applications</td>
<td>5-1/2</td>
</tr>
<tr>
<td>51-500-150</td>
<td>Tracking &amp; Data Acquisition, Supporting R&amp;T</td>
<td>4</td>
</tr>
<tr>
<td>51-500-311</td>
<td>T&amp;DA, Network Operations &amp; Equipment</td>
<td>3-1/2</td>
</tr>
<tr>
<td>51-500-312</td>
<td>T&amp;DA, Network Operations &amp; Equipment</td>
<td>3-1/2</td>
</tr>
<tr>
<td>61-880-160</td>
<td>Supporting R&amp;T, Earth Observations</td>
<td>2-1/3</td>
</tr>
<tr>
<td>61-880-164</td>
<td>Supporting R&amp;T, Communications</td>
<td>2-1/4</td>
</tr>
<tr>
<td>61-880-601</td>
<td>TIROS/TOS Improvements</td>
<td>2-1/3</td>
</tr>
<tr>
<td>61-880-604</td>
<td>Nimbus</td>
<td>7-1/2</td>
</tr>
<tr>
<td>61-880-607</td>
<td>Meteorological Soundings</td>
<td>4</td>
</tr>
<tr>
<td>61-880-608</td>
<td>Synchronous Meteorological Satellite</td>
<td>1-1/2</td>
</tr>
<tr>
<td>61-880-610</td>
<td>Cooperative Applications Satellite</td>
<td>1</td>
</tr>
<tr>
<td>61-880-611</td>
<td>Global Atmospheric Research</td>
<td>1-1/3</td>
</tr>
<tr>
<td>61-880-630</td>
<td>Applications Technology Satellites</td>
<td>3-1/3</td>
</tr>
<tr>
<td>61-880-640</td>
<td>Earth Resources Survey/Aircraft</td>
<td>1-5/6</td>
</tr>
<tr>
<td>61-880-641</td>
<td>Earth Resources Technology Satellite</td>
<td>1</td>
</tr>
<tr>
<td>61-880-855</td>
<td>Geodetic Satellites</td>
<td>3</td>
</tr>
<tr>
<td>70-700-130</td>
<td>OART Supporting Studies</td>
<td>1/2</td>
</tr>
<tr>
<td>70-705-789</td>
<td>OART Advanced Mission Studies</td>
<td>6</td>
</tr>
<tr>
<td>71-710-120</td>
<td>Power &amp; Electric Propulsion SRT</td>
<td>5-1/2</td>
</tr>
<tr>
<td>71-710-704</td>
<td>SERT II</td>
<td>1-1/2</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Amount</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>72-720-718</td>
<td>NERVA</td>
<td>5-2/3</td>
</tr>
<tr>
<td>72-720-321</td>
<td>Nuclear Rocket Development</td>
<td>1/3</td>
</tr>
<tr>
<td>72-720-121</td>
<td>SRT - Nuclear Rocket Systems</td>
<td>3-3/4</td>
</tr>
<tr>
<td>72-720-122</td>
<td>SRT - Nuclear Rocket Propulsion</td>
<td>3-3/4</td>
</tr>
<tr>
<td>74-740-124</td>
<td>Supporting R&amp;T</td>
<td>5-1/2</td>
</tr>
<tr>
<td>74-740-709</td>
<td>Small Space Vehicle Flight Experiments</td>
<td>1</td>
</tr>
<tr>
<td>74-740-711</td>
<td>Scout-Launched Reentry Flight Experiments</td>
<td>1</td>
</tr>
<tr>
<td>74-740-713</td>
<td>Scout-Launched Meteoroid Flight Experiments</td>
<td>1-1/4</td>
</tr>
<tr>
<td>74-740-727</td>
<td>Lifting-Body Flight Research Program</td>
<td>1</td>
</tr>
<tr>
<td>74-740-131</td>
<td>Aerospace Safety Research</td>
<td>1</td>
</tr>
<tr>
<td>75-750-125</td>
<td>Supporting R&amp;T, RAMC</td>
<td>5</td>
</tr>
<tr>
<td>75-750-730</td>
<td>Supporting R&amp;T, RAMC</td>
<td>5</td>
</tr>
<tr>
<td>76-760-126</td>
<td>Advanced R&amp;T</td>
<td>3</td>
</tr>
<tr>
<td>76-760-736</td>
<td>General Aviation Aircraft Technology</td>
<td>1-1/2</td>
</tr>
<tr>
<td>76-760-721</td>
<td>V/STOL Aircraft Technology</td>
<td>2-1/2</td>
</tr>
<tr>
<td>76-760-737</td>
<td>Subsonic Aircraft Technology</td>
<td>4</td>
</tr>
<tr>
<td>76-760-720</td>
<td>Subsonic Aircraft Technology Supporting R&amp;T</td>
<td>3-1/2</td>
</tr>
<tr>
<td>76-760-722</td>
<td>Hypersonic Aircraft Technology</td>
<td>1-1/2</td>
</tr>
<tr>
<td>93-980-981</td>
<td>Advanced Studies - OMSF</td>
<td>16</td>
</tr>
<tr>
<td>79-780-129</td>
<td>Basic Research - OART</td>
<td>10</td>
</tr>
<tr>
<td>78-730-128</td>
<td>Chemicals Propulsion R&amp;T</td>
<td>3-1/2</td>
</tr>
<tr>
<td>78-730-731</td>
<td>Chemical Propulsion Experimental Engineering</td>
<td>4-1/2</td>
</tr>
<tr>
<td>77-770-127</td>
<td>Human Factors Systems SRT</td>
<td>5</td>
</tr>
<tr>
<td>77-770-708</td>
<td>Small Biotechnology Flight Projects</td>
<td>1-1/2</td>
</tr>
<tr>
<td>Code</td>
<td>Project/Component</td>
<td>Volume</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>77-770-735</td>
<td>Orbiting Frog Oolith</td>
<td>2/3</td>
</tr>
<tr>
<td>96-920-976</td>
<td>Space Shuttle</td>
<td>8</td>
</tr>
<tr>
<td>96-960-978</td>
<td>Skylab, Experimental Development</td>
<td>1-5/6</td>
</tr>
<tr>
<td>96-960-964</td>
<td>Skylab, Saturn Workshop I</td>
<td>1-1/3</td>
</tr>
<tr>
<td>96-960-965</td>
<td>Skylab, Apollo Telescope Mount</td>
<td>1-1/3</td>
</tr>
<tr>
<td>96-960-972</td>
<td>Skylab, Saturn IB Vehicle</td>
<td>1</td>
</tr>
<tr>
<td>96-960-973</td>
<td>Skylab, Saturn V Vehicle</td>
<td>1</td>
</tr>
<tr>
<td>96-960-961</td>
<td>Skylab, Spacecraft Modifications</td>
<td>1-1/3</td>
</tr>
<tr>
<td>96-960-996</td>
<td>Skylab, Program Support</td>
<td>5/6</td>
</tr>
<tr>
<td>96-960-991</td>
<td>Skylab, Payload Integration</td>
<td>5/6</td>
</tr>
<tr>
<td>96-940-995</td>
<td>Skylab, Mission Operations</td>
<td>5/6</td>
</tr>
<tr>
<td>96-975-975</td>
<td>Space Station</td>
<td>5</td>
</tr>
<tr>
<td>92-910-914</td>
<td>Apollo Spacecraft</td>
<td>6</td>
</tr>
<tr>
<td>92-910-933</td>
<td>Apollo, Saturn V Vehicle</td>
<td>5-1/3</td>
</tr>
<tr>
<td>92-910-921</td>
<td>Apollo, Mission Control Systems</td>
<td>2</td>
</tr>
<tr>
<td>92-910-924</td>
<td>Apollo Space Operations</td>
<td>2</td>
</tr>
<tr>
<td>92-910-950</td>
<td>Apollo, Launch Operations</td>
<td>1-1/3</td>
</tr>
<tr>
<td>92-910-955</td>
<td>Apollo, Launch Instrumentation</td>
<td>1</td>
</tr>
<tr>
<td>92-910-980</td>
<td>Apollo, Systems Engineering</td>
<td>1-1/2</td>
</tr>
<tr>
<td>92-980-908</td>
<td>Apollo, Advanced Development</td>
<td>1-1/6</td>
</tr>
<tr>
<td>92-910-392</td>
<td>Apollo, Contract Administration</td>
<td>--</td>
</tr>
<tr>
<td>84-810-195</td>
<td>Apollo, Lunar Science</td>
<td>1-1/6</td>
</tr>
<tr>
<td>84-810-385</td>
<td>Apollo, Lunar Data Analysis</td>
<td>1-1/6</td>
</tr>
<tr>
<td>89-830-180</td>
<td>Launch Vehicle Procurement, SRT</td>
<td>2-1/2</td>
</tr>
<tr>
<td>Code</td>
<td>Project Description</td>
<td>Quantity</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>89-830-490</td>
<td>Scout</td>
<td>3-1/2</td>
</tr>
<tr>
<td>89-830-491</td>
<td>Centaur</td>
<td>3-1/2</td>
</tr>
<tr>
<td>89-830-492</td>
<td>Delta</td>
<td>6</td>
</tr>
<tr>
<td>89-830-496</td>
<td>Titan III C</td>
<td>2</td>
</tr>
<tr>
<td>84-840-185</td>
<td>Planetary Exploration, SRT</td>
<td>1/2</td>
</tr>
<tr>
<td>84-840-186</td>
<td>Planetary Astronomy</td>
<td>1</td>
</tr>
<tr>
<td>84-840-196</td>
<td>Planetary Exploration, Data Analysis</td>
<td>1-1/6</td>
</tr>
<tr>
<td>84-840-811</td>
<td>Pioneer</td>
<td>1-1/6</td>
</tr>
<tr>
<td>84-840-815</td>
<td>Viking</td>
<td>2</td>
</tr>
<tr>
<td>84-840-816</td>
<td>Mariner Mars '69</td>
<td>2</td>
</tr>
<tr>
<td>84-840-819</td>
<td>Mariner Mars '71</td>
<td>2</td>
</tr>
<tr>
<td>84-840-820</td>
<td>Mariner Venus Mercury '73</td>
<td>1</td>
</tr>
<tr>
<td>84-840-823</td>
<td>Helios</td>
<td>1-1/6</td>
</tr>
<tr>
<td>85-850-188</td>
<td>Physics &amp; Astronomy, SRT</td>
<td>2</td>
</tr>
<tr>
<td>85-850-352</td>
<td>Physics &amp; Astronomy, Airborne Research</td>
<td>1/2</td>
</tr>
<tr>
<td>85-850-385</td>
<td>Physics &amp; Astronomy, Data Analysis</td>
<td>1-1/2</td>
</tr>
<tr>
<td>85-850-821</td>
<td>Orbiting Solar Observatories</td>
<td>2-3/4</td>
</tr>
<tr>
<td>85-850-831</td>
<td>Orbiting Astronomical Observatories</td>
<td>6</td>
</tr>
<tr>
<td>85-850-832</td>
<td>High Energy Astronomy Observatories</td>
<td>2-1/2</td>
</tr>
<tr>
<td>85-850-850</td>
<td>Explorers</td>
<td>10</td>
</tr>
<tr>
<td>85-850-879</td>
<td>Sounding Rockets</td>
<td>1</td>
</tr>
<tr>
<td>87-870-189</td>
<td>Bioscience, SRT</td>
<td>2</td>
</tr>
<tr>
<td>87-870-191</td>
<td>Planetary Quarantine</td>
<td>1-1/2</td>
</tr>
<tr>
<td>87-870-883</td>
<td>Biosatellite A, B, D</td>
<td>1</td>
</tr>
</tbody>
</table>

*Includes all technical material*
APPENDIX A

INDEXING WORKSHEETS
Chronological List of Events

Advanced Systems
   Advanced Signal processing - S
      (A) System Approach - technique studies,
          (A) Communication systems analysis,
              demand assignment communication systems
              signal processing
      (B) Hardware Development
          Communications satellite repeater studies
          digital implementation of analog demodulators
          millimeter wave communications
   (P) Future information network

(0) Biomedical Telecommunications by Satellite - Applicability
    Definition of Needs - Interchange of data -
        between medical schools, diagnostic centers,
        laboratories and hospitals

System Studies

Hardware Tests

User Communications For Planned Systems
   (M) Determination of Needs
       Provide Continuing Updated Projections
   (C) Educational Communications Satellite System Study

Evaluation

(D,Q)Navigation/Traffic Control
   Information Transmission from satellite to ships, aircraft
      mobile platforms
   System Analysis - data transmission
      voice transmission
      position determination techniques
   Hardware Development - data transmission
      voice transmission
      position determination equipment

Evaluation
Collision Related Studies
System Analysis
Search -- rescue -- collision prevention

Hardware Development
Search -- rescue -- collision prevention

(E) Evaluation
Data collection and retrieval from fixed and moving platforms (balloons and buoys)

Traffic Control
System Analysis - feasibility -- concept studies
over-ocean traffic control ships
land traffic control aircraft --
aircraft collision avoidance

Hardware Development
position fix and collect sensor data from automated, fixed, and mobile platforms

Evaluation

Communications
Communication Technique Evaluation
(G) Laser communications
(N) Cost Factors for communication satellites
(N) Effect of parameters on communication services
(N) Efficient use of spectrum
(F) Tracking Data Relay Satellite systems
(F) Signal Design
(E) Network Communications
(A) Antenna beam shaping
(N) Data Processing
(N) Data Management

Hardware Development
(F) Parametric Amplifiers
(F) VHF phased array receivers
(A) Antennas
(A) Multiple beam scannable high gain satellite antennas
(B) Multiple narrow beam shaped pattern antenna
(S) Cathode tubes
(S) High Efficiency Klystron tubes
(S) High power tubes
(S) RF Components
(T) High Power Communications Satellite Subsystems

Testing
(A) Antenna beam shaping
Interference measurement
Radio interference
Improved Communication Satellite

Geodesy

(Z) Improved gravity field estimates
   Combine surface gravity and satellite perturbation
   Derive field from optical, doppler, a surface gravity data
   Models from these data
   Validate and test fields

(Z) Standard geometric and gravimetric reference system
   Development of requirements

Altimeters
   Test bed for evaluation
   Altimeters
   Altimeter Data
   Transmission Techniques

Applications Technology

(H) Stabilized Spacecraft
   feasibility study
   characteristics study

   Sensor and Instrumentation Development

(A) Synchronous Orbit Thruster Motor
   Optimum attitude/period control
   Thruster selection

(A) Rendezvous with applications spacecraft
   Automated & Manned
   feasibility and characteristics
<table>
<thead>
<tr>
<th>Code</th>
<th>Key Word</th>
<th>Index Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A,B,P</td>
<td>Advanced Signal Processing</td>
<td>Signal Processing; Telemetry; Signal Encoding; Signal Analyzers; Signal Detection</td>
</tr>
<tr>
<td>A</td>
<td>Communication System Analysis</td>
<td>Telecommunication; Satellite Television; Multichannel Communication; Space Communication; Radio Relay Systems; Satellite Networks</td>
</tr>
<tr>
<td>A</td>
<td>Communication Techniques</td>
<td>Communication Equipment; Telemetry; Pulse Communication; Modulation; Signal Transmission Information Theory; Digital Systems Point to Point Communications; Communication Theory</td>
</tr>
<tr>
<td>A</td>
<td>Demand Assignment</td>
<td>Allocations; Data Links; Networks</td>
</tr>
<tr>
<td>B</td>
<td>Communication Devices &amp; Circuits</td>
<td>Communication Equipment; Radio Equipment; Satellite Television; Radio Relay Systems; Repeaters; Relay; Communication Satellites</td>
</tr>
<tr>
<td>B</td>
<td>Communication Satellite Repeater Studies</td>
<td>Demodulators; Digital Systems; Detectors</td>
</tr>
<tr>
<td>B</td>
<td>Digital Implementation of Analog Demodulators</td>
<td>Digital Techniques; Heterodyning</td>
</tr>
<tr>
<td>B</td>
<td>Millimeter Wave Communications</td>
<td>Millimeter waves; Microwave Transmission; Communication Equipment</td>
</tr>
<tr>
<td>P</td>
<td>Information Network</td>
<td>Data Link; Networks; Network Synthesis</td>
</tr>
<tr>
<td>O</td>
<td>Biomedical Telecommunication</td>
<td>Communicating; Data Transmission</td>
</tr>
<tr>
<td>O</td>
<td>Satellite Telecommunication</td>
<td>Biotelemetry; Bioengineering; Biology; Medical Science; Telecommunication Spacecraft Communication</td>
</tr>
<tr>
<td>O</td>
<td>Biomedical Communication Analysis</td>
<td>Communicating; Point to Point Communications; Data Link; Data Retrieval</td>
</tr>
<tr>
<td>O</td>
<td>Biomedical Data Interchange</td>
<td>Medical Phenomena; Medical Personnel Diagnosis; Diseases; Clinical Medicine; Examination</td>
</tr>
<tr>
<td>O</td>
<td>Medical School Data Interchange</td>
<td>Medical Science; Medical Equipment</td>
</tr>
<tr>
<td>O</td>
<td>Diagnostic Center Data Interchange</td>
<td>Hospitals</td>
</tr>
<tr>
<td>O</td>
<td>Medical Laboratory Interchange</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Hospital Data Interchange</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Biomedical Telecommunication Systems</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Topic</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Telecommunication Hardware</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Telecommunication Testing</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>User Communication Needs</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Educational Communications Satellite</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Educational Communications System</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Projections of User Needs</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>System Studies</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Navigation</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Sea Traffic Control</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Collision Avoidance</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Air Traffic Control</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Information Transmission</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Satellite to Ship Transmission</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Satellite to Aircraft Transmission</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Transmission to Mobile Platforms</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Data Transmission Analysis</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Voice Transmission Systems</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Position Determination</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Data Transmission Circuits</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Voice Transmission Hardware</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Position Determination Equipment</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Information Transmission Testing</td>
<td></td>
</tr>
<tr>
<td>D, Q</td>
<td>Ship Collision Avoidance</td>
<td></td>
</tr>
</tbody>
</table>

- Video Communication; Facsimile Communication
- Telecommunication; Television Systems Tests; Test Equipment
- Information; Information Retrieval Data Retrieval; Documents
- Educational Television; Communications Satellites Training Devices
- Human Factors Engineering
- Forecasting; Planning Systems Analysis Telecommunication
- Collision Avoidance; Collisions Aircraft Guidance; Air Navigation Air Traffic Control; Air Traffic; Aircraft Communication; Tracking (Position)
- Transmission; Information Data Transmission; Satellite Transmission Satellite Transmission Surface Navigation Satellite Transmission Aircraft Communication Satellite Transmission Platforms; Flying Platforms Data Transmission; Data Processing Information Theory; Transmission Efficiency Voice Communication; Verbal Communication Voice Data Processing; Signal Encoding Position (Location); Positioning Navigation; Position Indicators Data Links; Transmission Circuits Radiotelephones; Broadcasting
- Voice Communication; Verbal Communication Voice Data Processing; Signal Encoding Position (Location); Positioning Navigation; Position Indicators Data Links; Transmission Circuits Radiotelephones; Broadcasting
- Position Indicators; Aircraft Instruments Navigation Instruments Transmission Efficiency; Transmission Loss Signal Transmission; Attenuation Coefficients Collision Avoidance; Collisions Traffic Control; Surface Navigation
Tracking Data Relay Satellite Systems

Signal Design

Network Communications

Antenna Beam Shaping

Data Processing

Data Management

Parametric Amplifiers

VHF Phased Array Receivers

Antennas

Multiple Beam Antennas

Scannable Antennas

High Gain Satellite Antennas

Multiple Narrow Beam Antenna

Shaped Pattern Antenna

Cathode Tubes

High Efficiency Klystron

High Power Tubes

RF Components

High Power Subsystems

Communications Satellite Subsystems

Antenna Beam Shaping

Interference Measurement

Radio Interference

Gravity Field Estimates

Surface Gravity

Satellite Perturbation

Tracking Stations; Tracking Networks

Satellite Tracking; Relay Satellites

STADAN (Satellite Tracking Network)

Signal Analysis; Signal Generators

Signal Distortion; Signal Reception

Satellite Networks; Communication Satellites Networks

Antennas; Directional Antennas

Antenna Arrays

Antenna Radiation Patterns

Data Processing; Signal Processing

Data Systems

Parametric Amplifiers

Microwave Amplifiers

Very High Frequencies; Phased Arrays

Antenna Arrays; Receivers

Antennas

Multiple Beam Interval Scanners

Directional Antennas; Steerable Antennas

Inertialless Steerable Antennas

High Gain; Spacecraft Communication

Multiple Beam Interval Scanners

Directional Antennas

Antenna Radiation Patterns

Antenna Arrays

Klystrons; Microwave Tubes

Microwave Tubes; Vacuum Tubes

Power Gain; Vacuum Tube Oscillators

Radio Frequencies; Components

Electronic Equipment; Solid State Devices

Power; Power Limiters

Power Supply Circuits

Communication Satellites

Communication Equipment

Antennas; Directional Antennas

Antenna Arrays

Antenna Radiation Patterns

Interference

Electromagnetic Interference

Radio Frequency Interference

Gravitational Field

Gravimetry; Gravitational Effects

Gravitational Constant

Satellite Perturbation

Gravitational Fields; Satellite Orbits
<p>| Z | Optical Data | Optical Tracking |
|   |              | Optics; Optical Measurement |
|   |              | Optical Properties; Optical Measuring Instruments |
| Z | Doppler Data | Doppler Effect; |
|   |              | Doppler Navigation |
| Z | Gravity Measurement | Gravimetry; Gravimeters |
|   | Gravity Calculations | Gravitation Theory; Gravitational Constant |
|   | Gravity Field Models | Gravitational Fields; |
| Z | Standard Geometric Reference System | Geodetic Coordinates |
|   |                      | Reference Systems; Inertial Reference Systems |
| Z | Standard Gravimetric Reference System | Gravitational Field; |
|   |                      | Coordinates; Inertial Reference Systems |
| Z | Altimeters | Altimeters |
| Z | Altimeter Test Bed | Flight Instruments; Tests |
|   | Altimeter Data | Altitude Tests; Test Equipment |
|   | Altimeter Transmission Techniques | Altitude |
|   |                      | Position (Location) |
| H | Stabilized Spacecraft Feasibility | Stabilized Platforms |
|   | Stabilized Spacecraft Characteristics | Spacecraft Stability |
| H | Sensor Development | Sensors; Guidance Sensors |
|   | Instrumentation Development | Spacecraft Instruments |
| A | Synchronous Orbit | Synchronous Satellites |
|   | Thruster Motor | Syncom Satellites; Satellite Orbits |
| A | Optimum Attitude Control | Rocket Engines; Thrust |
|   | Optimum Period Control | Thrust Vector Control |
| A | Thruster Selection | Attitude Control; Rocket Engine Control |
|   | Spacecraft Rendezvous | Satellite Attitude Control |
|   |                      | Orbits; Satellite Orbits |
|   |                      | Spacecraft Guidance |
|   |                      | Rocket Engines; Spacecraft Propulsion |
|   |                      | Propulsion System Performance |
|   |                      | Space Rendezvous |
|   |                      | Rendezvous Spacecraft |</p>
<table>
<thead>
<tr>
<th>Applications Spacecraft</th>
<th>Applications Technology Satellites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Rendezvous</td>
<td>Flight Mechanics; Orbital Rendezvous</td>
</tr>
<tr>
<td>Rendezvous Trajectories; Unmanned Spacecraft</td>
<td></td>
</tr>
<tr>
<td>Manned Rendezvous</td>
<td>Rendezvous Guidance</td>
</tr>
<tr>
<td>Rendezvous Guidance</td>
<td>Manned Spacecraft</td>
</tr>
<tr>
<td>Rendezvous Trajectories; Space Rendezvous; Rendezvous Trajectories</td>
<td>Command Guidance</td>
</tr>
<tr>
<td>Rendezvous Characteristics</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis of Alternative Power Systems

(M) Power versus mission
Future mission analysis -- space power requirements
Assessment of solar, chemical and nuclear systems -- electric propulsion analysis
Small solar powered, electric thruster systems for spacecraft position control and unmanned planetary applications

(B) Primary propulsion systems (solar and nuclear) for planetary and interplanetary missions

(M) Improvements in existing electric power systems
New space environments -- improve reliability -- reduce weight
-- increase efficiency -- lengthen useful life

(M) New System Concepts
New space environments -- improve reliability -- reduce weight
-- increase efficiency -- lengthen useful life

(G,M) Development of Nuclear Electric
(M) Research to provide fundamental information needed for advanced systems
(F) Thermionic emission of surfaces -- theoretical and experimental -- plasma properties
High strength, high temperature metallic structural materials
Electrical Insulator Materials
Research on new components and design techniques
Erosion and cavitation damage models for liquid turbines
(M) Liquid metal MHD components -- vapor liquid separators, supersonic two-phase nozzles,
Analysis and modeling of advanced systems

Technology Development
High temperature, high strength refractory alloys -- corrosion resistant

(N) Insulator and thermoelectric materials -- for light-weight, high performance systems

(G) Evaluate major component designs
Evaluate failure modes of selected components, subsystems, and systems
Instruments for temperature, pressure flow, and electrical measurements
(Q) Spacecraft power system integration peculiar to nuclear systems

System Assembly
(G) AEC supplied heat source
NASA spacecraft
(E) Brayton, Rankine, thermionic, and/or thermoelectric conversion

(H) SNAP-8
long life (10,000/m), 30-50 kwe, reactor space power system
manned and unmanned applications
(G) System design -- reactor + a dynamic power conversion system
performance and life development of components for power
conversion
broad boarded power conversion systems -- test data
compact, flight-representative system -- non-nuclear and then
nuclear ground test
NASA Space Power Facility

(A) Nuclear Electric Safety
Design of specific space power system
Investigate basic phenomena -- aerodynamic re-entry heating
Develop technology base for assessment of safety of nuclear space
power systems
To provide inputs to system designers
Safety analysis of specific systems
Advanced research in aerodynamics and re-entry dynamics
Structural design and hardware tests using radioactive material
Special testing

(R,0) Development of Solar Power
Research
(H) Improve resistance to degradation in space radiation
environment up to 10 years life
Better metal-silicon contacts to take advantage of new
light weight structures
(I) New solar cells with improved efficiency
(I) New solar cells with reduced costs

(M) Technology Development
Storing compactly large solar cell arrays for launch
Automatic deployment of large, lightweight arrays -- reliability

(M,K,I) Large Flexible Arrays
Structural & Flight dynamic interactions with
guidance and control
other spacecraft systems
Solar array orientation drive equipment
low power -- reliable

(M,B) Extend capability to new environmental extremes
Venus-Mercury flybys
Solar probes
Mars landers
Jupiter flybys and orbiters
Development of Chemical Power

Research

- non-aqueous electrolytes (organic, molten salt, solid)
- high energy density anodes and cathodes
- basic electrochemistry of alkaline batteries
- fuel cell catalysts, electrodes, and electrolyte control
- batteries for high and low temperature extremes
- Environmental effects on electrochemical reactions
  - Zero gravity -- charge particle nuclear radiation
  - RF electromagnetic radiation

Technology Development

- High energy-density batteries - sealed, heat sterilizable
  - Use on capsules which enter or land on planetary surfaces
  - engineer and fabricate
- Rechargeable batteries -- long life
  - use on synchronous and low altitude earth orbits
  - applications and space science spacecraft
  - Manned earth and orbital vehicles
- One year fuel cell power systems
  - extension of life from a few weeks
  - Q shuttle power source
  - Emergency power systems on manned space stations
  - Electric Power for lunar shelters and lunar excursion vehicles

Development of Rechargeable Fuel Cells

- Regeneration of fuel cell reactants
- Extend usefulness to long duration missions
- would complement solar cell and nuclear power systems

Development of Power Conditioning and Distribution Systems

Research

- Improvements in analytical theory of power processing circuits
- Improvements in synthesis and dynamic analysis of power processing circuits
- Identification, measurement, and control of stresses limiting life
  - Thermal, electrostatic, and other stresses
  - Failure analysis
  - Semiconductor-magnetic element interactions

Technology

- Identification of new processing and distribution concepts
  - Improved efficiency, weight, and reliability

Development and demonstration

- Solid state systems
- Space shuttle circuits and devices
- Station/Base and advanced aircraft
Development of light weight processors
Solar electric propulsion
Direct broadcast applications

Power systems technology -- isotope, thermoelectric
10 years life minimum

Long Range Objectives
Spacecraft missions of 10 years or longer without manual repair or resupply

50-100 kW single unit power processor operating temperature range extended to 200-300°C from 50-85°C.

Aircraft electrical system improvement
maintenance, weight, reliability, and complexity

Development of Electric Engines

Resistojet -- NH₃ or H₂ and biowastes (e.g. CO₂)
reaction control system applications -- manned space stations

technology ready status in 3-5 years

Ion engines with electric vectoring capability -- applications North-South station keeping and maneuvering

Electron Bombardment ion propulsion system -- spacecraft prime propulsion

Ground operation of complete closed loop system -- modular configuration
Solar power matching networks -- failure logic and switching networks

Electric Thruster Technology

Advanced thruster research -- physical phenomena -- mechanization -- efficient acceleration of propellants to propulsion velocities

High efficiency electron bombardment ion thrusters in the low specific impulse range (1,000-3,000 sec.) to reduce power requirements

Electrostatic thrust vectoring of electron bombardment ion engines
High thrust, high density plasma accelerators for prime propulsion applications

Advanced Thruster Technology -- to improve candidate thruster systems for:
Position control of manned space stations-resistojet
Position control of applications satellites -- electric vectoring
Prime propulsion for small, automated spacecraft
<table>
<thead>
<tr>
<th>Code</th>
<th>Key Word</th>
<th>Index Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Mission Analysis</td>
<td>Mission Planning</td>
</tr>
<tr>
<td>M</td>
<td>Space Power Requirements</td>
<td>Missions; Electric Power Plants</td>
</tr>
<tr>
<td>M</td>
<td>Space Missions</td>
<td>Space Missions</td>
</tr>
<tr>
<td>M,B</td>
<td>Solar Power Systems Analysis</td>
<td>Solar Generators; Systems Analysis; Direct Power Generators; Direct Power Generators; Fuel Cells; Electric Batteries; Systems Analysis</td>
</tr>
<tr>
<td>M</td>
<td>Chemical Power Systems Analysis</td>
<td>Nuclear Electric Power Generation Systems Analysis</td>
</tr>
<tr>
<td>M,B</td>
<td>Nuclear Systems Analysis</td>
<td>Nuclear Electric Power Generation Systems Analysis</td>
</tr>
<tr>
<td>M</td>
<td>Electric Propulsion Analysis</td>
<td>Electric Propulsion</td>
</tr>
<tr>
<td>M</td>
<td>Electric Thruster Systems</td>
<td>Electric Rocket Engines</td>
</tr>
<tr>
<td>M</td>
<td>Spacecraft Position Control</td>
<td>Spacecraft Position Indicators</td>
</tr>
<tr>
<td>M</td>
<td>Unmanned Planetary Applications</td>
<td>Spacecraft Maneuvers; Positioning</td>
</tr>
<tr>
<td>M</td>
<td></td>
<td>Interplanetary Flight; Interplanetary Spacecraft</td>
</tr>
<tr>
<td>M,B</td>
<td>Primary Propulsion Systems</td>
<td>Space Exploration; Planetary Environments</td>
</tr>
<tr>
<td>M,B</td>
<td>Planetary and Interplanetary Space Flight</td>
<td>Propulsion System Configurations; Propulsion</td>
</tr>
<tr>
<td>M</td>
<td>Electric Power System Improvements</td>
<td>Interplanetary Flight; Trajectory Analysis</td>
</tr>
<tr>
<td>M</td>
<td>New Space Environments</td>
<td>Interplanetary Spacecraft</td>
</tr>
<tr>
<td>M</td>
<td>Improved Reliability</td>
<td>Electric Generators; Electric Power; Energy Conversion Efficiency; Weight Analysis</td>
</tr>
<tr>
<td>M,N</td>
<td>Weight Reduction</td>
<td>Planetary Environments; Extraterrestrial Environments</td>
</tr>
<tr>
<td>M,N</td>
<td>Increased Efficiency</td>
<td>Reliability; Reliability Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Weight; Weight Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy Conversion Efficiency; Power Efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thermodynamic Efficiency</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Lengthened Useful Life</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>New Power System Concepts</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Nuclear Electric</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Surface Thermionic Emission</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Plasma Properties</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>High Strength Metallic Structural Materials</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>High Temperature Metals</td>
<td></td>
</tr>
<tr>
<td>G,M,F,N</td>
<td>Electrical Insulator Materials</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>New Nuclear System Components</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Erosion Damage Models</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Cavitation Damage Models</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Liquid Metal Turbines</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Liquid Metal MHD Components</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Vapor Liquid Separators</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Supersonic Two-Phase Nozzles</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Advanced System Modeling</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Corrosion Resistant Alloys</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Thermoelectric Materials</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Failure Mode Analysis</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Measuring Instruments</td>
<td></td>
</tr>
<tr>
<td>G,M</td>
<td>Temperature Measurement</td>
<td></td>
</tr>
</tbody>
</table>

Life (Durability); Service Life
Spacecraft Power Supplies; Electric Power
Auxiliary Power Sources; Direct Power Generators
Nuclear Electric Power Generation
Nuclear Electric Propulsion
Thermionic Emission; Thermionic Cathodes
Plasma Dynamics; Plasma Physics
Structural Members; Construction Materials
High Strength Alloys; High Strength Steels
High Temperature; Metals; Alloys
Heat Resistant Alloys
Electrical Insulation
Electric Generators; Nuclear Power Plants
Nuclear Electric Power Generation
Erosion; Metal Surfaces; Pitting Deterioration
Cavitation Corrosion; Erosion
Liquid Metals; Turbines
Liquid Metal Cooled Reactors
Magnetohydrodynamic Generators
Liquid Metals; Magnetohydrodynamic Flow
Liquid Vapor Equilibrium Separators
Supersonic Flow; Supersonic Nozzles
Two Phase Flow
Dynamic Models; System Analysis
Mathematical Models
Corrosion Resistance; Alloys
Thermoelectric Materials
Failure; System Failures
Reliability Engineering
Measuring Instruments
Temperature Measuring Instruments
| G,M       | Pressure Measurement | Pressure Measurements |
| G,M       | Flow Measurement     | Flow Measurement      |
| G,M       | Electrical Measurements | Electrical Measurement |
| Q         | Spacecraft/Power System Integration | Spacecraft Power Supplies Systems Engineering |
| G         | Isotope and Reactor Heat Source | Nuclear Reactors; Isotopes Radioactive Materials Systems Engineering; Assembly |
| G,M       | System Assembly      |                                |
| E         | Nuclear Electric Brayton Cycle | Nuclear Electric Power Generation Brayton Cycle |
| H         | Nuclear Electric Rankine Cycle | Nuclear Electric Power Generation Rankine Cycle |
| H         | Nuclear-Thermionic Conversion | Nuclear Electric Power Generation Thermionic Power Generation |
| N         | Nuclear Thermoelectric Conversion | Nuclear Electric Power Generation Thermoelectric Power Generation SNAP-8; SNAP |
| H         | SNAP-8               |                                |
| H,G       | Dynamic Power Conversion System | Electric Generators; Energy Conversion |
| H,G       | Power Conversion Component Life | Life (Durability); Service Life |
| H         | Breadboarded Systems | Breadboard Models |
| H         | Test Data            | Tests; Test Equipment      |
| H         | Flight Representative System | Flight Tests; Performance Tests |
| H         | Ground Tests         | Ground Tests; Test Facilities Performance Tests |
| H         | Nuclear Ground Tests | Nuclear Electric Power Generation Ground Tests; Test Facilities Nuclear Reactions Systems Engineering; Electric Generators |
| H         | Compact Power System |                                |
| H         | NASA Space Power Facility | Space Power Unit Reactors; Test Facility Spacecraft Power Supplies |
| A         | Nuclear Electric Safety | Reactor Safety |
| A         | Aerodynamic Re-entry Heating | Aerodynamic Heating Re-entry Effects |
| A         | Safety Assessment    | Safety Factors; Safety; Hazards |

-36-
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Safety In Nuclear Power Design</td>
</tr>
<tr>
<td>A</td>
<td>Safety Analysis of Specific Systems</td>
</tr>
<tr>
<td>A</td>
<td>Re-entry Dynamics</td>
</tr>
<tr>
<td>A</td>
<td>Aerodynamics</td>
</tr>
<tr>
<td>A</td>
<td>Hardware Tests Using Radioactive Material</td>
</tr>
<tr>
<td>A</td>
<td>Structural Design Tests</td>
</tr>
<tr>
<td>A</td>
<td>Special Testing</td>
</tr>
<tr>
<td>R,0</td>
<td>Solar Power Systems</td>
</tr>
<tr>
<td>R,0,M</td>
<td>Radiation Degradation of Solar Cells</td>
</tr>
<tr>
<td>R,0,M</td>
<td>Space Radiation Environment</td>
</tr>
<tr>
<td>R,0</td>
<td>Metal-silicon Contacts</td>
</tr>
<tr>
<td>R,0</td>
<td>Lightweight Solar Cell Array Structures</td>
</tr>
<tr>
<td>R,0,I</td>
<td>Improved Efficiency Solar Cells</td>
</tr>
<tr>
<td>R,0,I</td>
<td>Lower Cost Solar Cells</td>
</tr>
<tr>
<td>R,0,M</td>
<td>Stowing Solar Cell Arrays Compactly</td>
</tr>
<tr>
<td>R,0,M</td>
<td>Launching Large Solar Cell Arrays</td>
</tr>
<tr>
<td>R,0,M</td>
<td>Reliable and Automatic Deployment of Arrays</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Large Flexible Arrays</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Structural Interactions</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Flight Dynamic Interactions</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Spacecraft Guidance and Control</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Effect on Spacecraft Systems</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Reactor Safety</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Nuclear Electric Power Generation System Analysis</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Accident Prevention</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Re-entry; Re-entry Effects</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Re-entry Trajectories</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Aerodynamics</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Radioactive Materials; Radiation Hazards</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>radioactive Contaminants; Radioactivity</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Structural Design; Spacecraft Design Performance Tests</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Space Electric Rocket Tests</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Generators; Photoelectric Generators</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Auxiliary Power Units; Solar Cells</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Cells; Radiation Effects</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Radiation Tolerance; Radiation Dosage</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Extraterrestrial Radiation</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Extraterrestrial Environments</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>silicon Junctions; Semiconductor Junctions</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Electric Contacts</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Generators; Solar Collectors</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Cells; Arrays; Low Weight</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Energy Conversion Efficiency</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Power Efficiency; Solar Cells</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Low Cost; Solar Cells</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Packaging; Space Storage</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Generators</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Launching; Solar Cells</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Generators; Prelaunch Tests</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Reliability Engineering</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Generators; Space Erectable Structures</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Cells; Flexible Bodies</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Solar Generators</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Structural Design</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Dynamic Characteristics</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Dynamic Response</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Spacecraft Guidance</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Spacecraft Control</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Systems Engineering</td>
</tr>
<tr>
<td>R,0,0,0,M,K,I</td>
<td>Spacecraft Design; Solar Generators</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Solar Array Orientation</td>
</tr>
<tr>
<td>R,0,M,K,I</td>
<td>Reliable Drive Equipment</td>
</tr>
<tr>
<td>R,0,M,B</td>
<td>New Environmental Extremes</td>
</tr>
<tr>
<td>R,0,M,B</td>
<td>Venus-Mercury Flybys</td>
</tr>
<tr>
<td>R,0,M,B</td>
<td>Solar Probes</td>
</tr>
<tr>
<td>R,0,M,B</td>
<td>Mars Landers</td>
</tr>
<tr>
<td>R,0,M,B</td>
<td>Jupiter Flybys And Orbiters</td>
</tr>
<tr>
<td>R,J</td>
<td>Chemical Power Systems</td>
</tr>
<tr>
<td>R,J</td>
<td>Non-aqueous Electrolytes</td>
</tr>
<tr>
<td>R,J</td>
<td>Organic Electrolytes</td>
</tr>
<tr>
<td>R,J</td>
<td>Molten Salt Electrolytes</td>
</tr>
<tr>
<td>R,J</td>
<td>Solid Electrolytes</td>
</tr>
<tr>
<td>R,P,J</td>
<td>High Energy Density Electrodes</td>
</tr>
<tr>
<td>R,P,J</td>
<td>Alkaline Battery Electrochemistry</td>
</tr>
<tr>
<td>P,M,K,J,R</td>
<td>Lone Life rechargeable Batteries</td>
</tr>
<tr>
<td>P,M,K,J,R</td>
<td>Synchronous Orbits</td>
</tr>
<tr>
<td>P,M,K,J,R</td>
<td>Low altitude earth orbits</td>
</tr>
<tr>
<td>P,M,K,J,R</td>
<td>Applications Spacecraft</td>
</tr>
<tr>
<td>P,M,K,J,R</td>
<td>Space Science Spacecraft</td>
</tr>
<tr>
<td>P,M,K,J,R</td>
<td>Manned Earth Orbital Vehicles</td>
</tr>
<tr>
<td>J,R</td>
<td>Long life fuel cell systems</td>
</tr>
<tr>
<td>J,Q,R</td>
<td>Shuttle power source</td>
</tr>
</tbody>
</table>

-38-
J,R  Space station emergency power  Space Stations; Emergencies
J,R  Lunar shelter electric power  Auxiliary Power Sources
J,R  Lunar excursion vehicle power  Lunar Shelters
J,R  Rechargeable Fuel Cells  Auxiliary Power Sources
J,R  Fuel Cell Reactant Regeneration  Lunar Surface Vehicles
J,R  Long Duration Missions  Auxiliary Power Sources
J,R  Fuel Cell Catalysts  Fuel Cells; Storage Batteries
J,R  Fuel Cell Electrodes  Regenerative Fuel Cells
J,R  Fuel Cell Electrolyte Control  Fuel Cell Catalysts
J,R,P  High Temperature Batteries  Fuel Cell Catalysts
J,R,P  Low Temperature Batteries  Fuel Cells; Electrodes
J,R  Environmental Effects  Electrochemistry
J,R  Electrochemical Reactions  Fuel Cells; Electrodes
J,R  Zero Gravity  Electrochemistry
J,R  Charge Particle Nuclear Radiation  Electrolytic Cells
J,R  RF Electromagnetic Radiation  High Temperature; Electric Batteries
R,P,M,J  High Energy Density Batteries  Life (Durability)
R,P,M,J  Planetary Batteries  Electrolytes
R,P,M,J  Battery Fabrication  Electrochemical Cells
J,R  Fuel Cell Auxiliary Power  High Temperature Batteries

-39-
S,R,O,M Power Conditioning and Distribution
S,R,O,M Power Processing Circuit Theory
S,R,O,M Circuit Synthesis and Analysis
S,R,O,M Failure Analysis
S,R,O,M Thermal Stresses
S,R,O,M Electrostatic Stresses
S,R,O,M Semiconductor-Magnet Element Interactions
S,R,O,M Improved Efficiency
S,R,O,M Improved Weight
S,R,O,M Improved Reliability
S,R,O,M Space Shuttle Circuits and Devices
S,R,O,M Station/Base and Advanced Aircraft
R,M,O,S Lightweight Processors
R,M,O,S Solar Electric Propulsion
R,M,O,S Direct Broadcast Applications
R,M,O,S Isotope Thermoelectric Power Systems
R,M,O,S Self-sustaining Systems
R,M,O,S Multikilowatt Processor
R,M,O,S High Temperature Operation
R,M,O,S Improved Maintainability

Power Supply Circuits; Power Supplies
Power Transmission
Power Supply Circuits
Circuits
Circuit Reliability; Failure
Thermal Stresses
Electrostatics; Stresses
Stress Analysis
Semiconductor Devices
Energy Conversion Efficiency
Power Efficiency
Low Weight
Reliability
Solid State Devices
Space Shuttle; Space Stations
Circuits
Aircraft; Space Stations
Low Weight; Electric Generators
Solar Generators; Electric Propulsion
Radio Transmission; Broadcasting
Radio Communication
Thermoelectric Power Generation
Radioisotope Batteries
Radioactive Isotopes
Life (Durability)
Electric Generators; Auxiliary Power Sources
Self Repairing Devices
Life (Durability)
Electric Generators
Spacecraft Power Supplies
High Temperature
High Temperature Tests
Maintainability
Aircraft Electrical System
Reduced Weight
Reduced Complexity
Electric Thruster Technology
Thruster mechanization
Efficient Propellant Acceleration
Electron Bombardment Ion Thrusters
High Efficiency Ion Thrusters
Low Specific Impulse Range
Electrostatic Thrust Vectoring
High Thrust Plasma Accelerators
High Density Plasma Accelerators
Prime Propulsion Applications
Position Control of Manned Space Stations
Position Control of Application Satellites
Small Spacecraft Prime Propulsion
Electric Thruster Applications
Resistojet
Bio-Fuel Cells
Ammonia Fuel Cells
Hydrogen Fuel Cells

Auxiliary Power Sources
Aircraft
Low Weight
Reliability
Rocket Engines; Electric Rocket Engines
Thrust Vector Control
Rockets; Spacecraft Components
Thrust
Propellant Mass Ratio
Propulsive Efficiency
Ion Propulsion; Ion Engines
Electron Beams; Electron-Ion Recombination
Propulsive Efficiency
Specific Impulse
Thrust Vector Control
Electrostatic Propulsion
Thrust; High Thrust
Plasma Accelerators; Plasma Propulsion
Plasma Density
Plasma Accelerators
Electric Propulsion; Spacecraft Propulsion
Propulsion System Configurations
Manned Spacecraft; Space Stations
Positioning; Position Errors
Applications Technology Satellites
Positioning; Position Errors
Spacecraft; Unmanned Spacecraft
Propulsion System Configurations
Spacecraft Propulsion
Electric Rocket Engines
Electric Propulsion
Resistojet Engines; Plasma Engines
Electric Rocket Engines
Biochemical Fuel Cells
Fuel Cells
Ammonia; Fuel Cells
Hydrogen Oxygen Fuel Cells
Reaction Control of Spacecraft
Ion Engines For Vectoring
Ion Engines In Applications
- Satellites
North-South Station Keeping
- and Maneuvering
Electron Bombardment Ion
- Propulsion System
Spacecraft Prime Propulsion
Ground Testing
Power System Modular
- Configuration
Solar Power Matching Networks
Failure Logic and Switching
- Networks
Reaction Control; Thrust Control
Altitude Control; Spacecraft Control
Direction Control; Thrust Vector
Control
Ion Engines
Ion Engines
Applications Technology Satellites
Station Keeping; Spacecraft Control
Spacecraft Maneuvers
Ion Propulsion; Ion Engines; Electron
Beams
Electron-Ion Recombination
Electric Propulsion; Spacecraft
Propulsion
Propulsion System Configurations
Ground Tests
Space Electric Rocket Tests
Spacecraft Power Supplies
Modules
Solar Generators; Power Supplies
Power Supply Circuits
Switching Circuits
System Failures; Fail-Safe Systems
APPENDIX B

REVISED SAMPLE - INDEX

SUPPORTING R&T, COMMUNICATIONS
### INDEXING KEY

**PAD:** 61-880-164  
**Program:** Space Applications  
**Office:** OSSA  
**Project:** Communications

**Center:** JPL

<table>
<thead>
<tr>
<th>Code</th>
<th>Individual</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>R. Powell</td>
<td>Research and Advanced Development Program Office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--Electronics</td>
</tr>
</tbody>
</table>

**Center:** Goddard Space Flight Center

<table>
<thead>
<tr>
<th>Code</th>
<th>Individual</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>T. Lynch</td>
<td>Communications and Navigation Division</td>
</tr>
<tr>
<td>J</td>
<td>J. Eckerman</td>
<td>Communications and Navigation Division -- Communications Technology Section</td>
</tr>
<tr>
<td>C</td>
<td>J. Miller</td>
<td>Communications and Navigation Division</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--Communications Technology Section</td>
</tr>
<tr>
<td>D</td>
<td>G. Oer</td>
<td>Communications and Navigation Division</td>
</tr>
<tr>
<td>E</td>
<td>C. Cote</td>
<td>Navigation Division -- Navigation &amp; Data Collections Branch</td>
</tr>
<tr>
<td></td>
<td>G. Clark</td>
<td>Manned Flight Planning and Analysis Division -- Advanced Plans and Techniques Branch</td>
</tr>
<tr>
<td>G</td>
<td>N. McAvoy</td>
<td>Advanced Development Division -- Quantum Optics Section</td>
</tr>
<tr>
<td>H</td>
<td>H. Hoffman</td>
<td>Earth Observation Systems and Systems Engineering Division -- Stabilization and Control Branch</td>
</tr>
<tr>
<td>Code</td>
<td>Individual</td>
<td>Organization</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>--------------</td>
</tr>
<tr>
<td>I</td>
<td>E. Hymowitz</td>
<td>Earth Observation Systems and Systems Engineering Division - SATS Study Manager</td>
</tr>
<tr>
<td>K</td>
<td>S. Stevens</td>
<td>International Projects Office ATS F&amp;G Project</td>
</tr>
<tr>
<td>L</td>
<td>H. Gerwin</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center: Headquarters</td>
</tr>
<tr>
<td></td>
<td>Code</td>
<td>Individual</td>
</tr>
<tr>
<td>M</td>
<td>D. Silverman</td>
<td>Communications Programs - Systems Programs Chief</td>
</tr>
<tr>
<td>N</td>
<td>G. Andrus</td>
<td>Communications Satellite Programs Chief</td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td>Geodetic Satellites Program Manager</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center: MSC</td>
</tr>
<tr>
<td></td>
<td>Code</td>
<td>Individual</td>
</tr>
<tr>
<td>O</td>
<td>D. Fielder</td>
<td>E&amp;D Program Planning Office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center: Ames Research Center</td>
</tr>
<tr>
<td></td>
<td>Code</td>
<td>Individual</td>
</tr>
<tr>
<td>P</td>
<td>J. Foster</td>
<td>Guidance and Navigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center: WS</td>
</tr>
<tr>
<td></td>
<td>Code</td>
<td>Individual</td>
</tr>
<tr>
<td>Q</td>
<td>W. Krabill</td>
<td>Directorate of Applied Science</td>
</tr>
<tr>
<td>R</td>
<td>L. Ross</td>
<td>Directorate of Operations - Project Management Section</td>
</tr>
<tr>
<td>Code</td>
<td>Individual</td>
<td>Organization</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>S</td>
<td>R. Alexovich</td>
<td>Spacecraft Technology Division - Special Projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Office</td>
</tr>
<tr>
<td>T</td>
<td>R. Lovell</td>
<td>Spacecraft Technology Division - Spacecraft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Systems Section</td>
</tr>
<tr>
<td>U</td>
<td>E. Davison</td>
<td>Spacecraft Technology Division - Flight Projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Branch</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Center: Langley Research Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>V</td>
</tr>
</tbody>
</table>
KEY WORD INDEX

AIR NAVIGATION
D - Goddard
Q - WS

AIR TRAFFIC
D - Goddard
Q - WS

AIR TRAFFIC CONTROL
D - Goddard
N - Headquarters
Q - WS

AIRCRAFT COMMUNICATION
D - Goddard
Q - WS

AIRCRAFT GUIDANCE
D - Goddard
Q - WS

AIRCRAFT INSTRUMENTS
D - Goddard
Q - WS

AIRPORT SURFACE DETECTION EQUIPMENT
Q - WS

ALL WEATHER AIR NAVIGATION
D - Goddard
Q - WS

ALTIMETERS
Z - Headquarters

ALTITUDE
Z - Headquarters

ALTITUDE TESTS
Z - Headquarters
ANTENNA ARRAYS
   F - Goddard
   B - Goddard
   A - JPL

ANTENNA RADIATION PATTERNS
   B - Goddard
   A - JPL

ANTENNAS
   A - JPL    S - Lewis    N - Headquarters

APPLICATIONS TECHNOLOGY SATELLITES

ATTENUATION COEFFICIENTS
   D - Goddard
   Q - WS

ATTITUDE CONTROL
   H - Goddard

ATTITUDE INDICATORS
   H - Goddard

BALLOON FLIGHT
   E - Goddard

BALLOON SOUNDING
   E - Goddard

BALLOONS
   E - Goddard

BANDWIDTH
   N - Headquarters

BIOENGINEERING
   O - MSC

BIOLOGY
   O - MSC

BIOTELEMETRY
   O - MSC

BROADCASTING
   D - Goddard    N - Headquarters
   Q - WS        C - Goddard

BUOYS
   E - Goddard

-48-
CHANNEL CAPACITY
  N - Headquarters

CLINICAL MEDICINE
  O - MSC

CODING
  N - Headquarters

COLLISION AVOIDANCE
  D - Goddard
  Q - WS

COLLISIONS
  D - Goddard
  Q - WS

COMMAND GUIDANCE
  A - JPL

COMMUNICATING
  O - MSC  M - Headquarters
  P - Ames
  N - Headquarters

COMMUNICATION EQUIPMENT
  B - Goddard
  N - Headquarters
  T - Lewis
  A - JPL

COMMUNICATION SATELLITE
  B - Goddard
  T - Lewis

COMMUNICATION THEORY
  A - JPL  C - Goddard
  N - Headquarters

COMMUNICATIONS SATELLITES
  C - Goddard
  N - Headquarters
  F - Goddard

COMPONENTS
  S - Lewis
  Q - WS

COMSAT PROGRAM
  N - Headquarters
COORDINATES
  Z - Headquarters

COST ESTIMATES
  N - Headquarters

DATA ACQUISITION
  D - Goddard
  Q - WS
  E - Goddard

DATA LINK
  O - MSC
  D - Goddard
  Q - WS
  A - JPL
  P - Ames

DATA PROCESSING
  D - Goddard
  Q - WS
  N - Headquarters

DATA REDUCTION
  E - Goddard
  B - Goddard

DATA RETRIEVAL
  M - Headquarters
  O - MSC

DATA SAMPLING
  E - Goddard

DATA SYSTEMS
  N - Headquarters

DATA TRANSMISSION
  P - Ames
  D - Goddard
  Q - WS
  N - Headquarters
  Z - Headquarters

DEMODULATORS
  B - Goddard

DETECTORS
  B - Goddard
DIAGNOSIS
  O - MSC

DIGITAL SYSTEMS
  C - Goddard
  B - Goddard

DIGITAL TECHNIQUES
  B - Goddard

DIRECTIONAL ANTENNAS
  A - JPL
  B - Goddard

DISEASES
  O - MSC

DISTANCE MEASURING EQUIPMENT
  D - Goddard
  Q - WS

DOCUMENTS
  M - Headquarters

DOPPLER EFFECT
  Z - Headquarters

DOPPLER NAVIGATION
  Z - Headquarters

DYNAMIC CHARACTERISTICS
  H - Goddard

EDUCATIONAL TELEVISION
  C - Goddard
  N - Headquarters

ELECTROMAGNETIC INTERFERENCE
  A - JPL

ELECTRONIC EQUIPMENT
  S - Lewis

EXAMINATION
  FADING
  O - MSC
  N - Headquarters
  C - Goddard

FACSIMILE COMMUNICATION
  O - MSC
  M - Headquarters

FLIGHT INSTRUMENTS
  Z - Headquarters

-51-
HIGH GAIN
  A - JPL

HOSPITALS
  O - MSC

HUMAN FACTORS ENGINEERING
  C - Goddard

INDICATING INSTRUMENTS
  D - Goddard
  Q - WS

INERTIAL PLATFORMS
  D - Goddard
  Q - WS

INERTIAL REFERENCE SYSTEMS
  Z - Headquarters

INFORMATION
  M - Headquarters
  D - Goddard
  Q - WS

INFORMATION RETRIEVAL
  M - Headquarters

INFORMATION THEORY
  A - JPL
  D - Goddard
  Q - WS
  N - Headquarters

INSTRUMENT PACKAGES
  H - Goddard

INSTRUMENT LANDING SYSTEMS
  Q - WS

INTERFERENCE
  A - JPL

IONOSPHERIC DISTURBANCES
  C - Goddard

KLYSTROMS
  S - Lewis

LASERS
  G - Goddard

LOW NOISE
  C - Goddard
MEDICAL EQUIPMENT
   0 - MSC

MEDICAL PERSONNEL
   0 - MSC

MEDICAL PHENOMENA
   0 - MSC

MEDICAL SCIENCE
   0 - MSC

MICROWAVE AMPLIFIERS
   F - Goddard

MICROWAVE TRANSMISSION
   B - Goddard

MICROWAVE TUBES
   S - Lewis

MILLIMETER WAVES
   B - Goddard

MODULATION
   A - JPL

MULTICHANNEL COMMUNICATION
   A - JPL

MULTIPLE BEAM INTERVAL SCANNERS
   B - Goddard

NAVIGATION
   D - Goddard
   Q - WS

NAVIGATION AIDS
   D - Goddard
   Q - WS
   E - Goddard

MICROWAVES
   A - JPL
   C - Goddard

MIXING CIRCUITS
   C - Goddard
NAVIGATION INSTRUMENTS
   D - Goddard
   Q - WS

NAVIGATION SATELLITES
   D - Goddard
   Q - WS

NETWORK SYNTHESIS
   P - Ames

NETWORKS
   A - JPL
   P - Ames
   F - Goddard

OBSERVATION
   E - Goddard

OPTICAL COMMUNICATION
   G - Goddard

OPTICAL MEASUREMENT
   Z - Headquarters

OPTICAL MEASURING INSTRUMENTS
   Z - Headquarters

OPTICAL PROPERTIES
   Z - Headquarters

OPTICAL TRACKING
   Z - Headquarters

OPTICS
   Z - Headquarters

PARAMETRIC AMPLIFIERS
   F - Goddard
   C - Goddard

PHASED ARRAYS
   F - Goddard

PHASE LOCKED SYSTEMS
   A - JPL
PLANNING
  M - Headquarters

PLATFORMS
  D - Goddard
  E - Goddard

POINT TO POINT COMMUNICATIONS
  O - MSC

POSITION INDICATORS
  D - Goddard
  Q - WS

POSITION (LOCATION)
  Z - Headquarters
  D - Goddard
  Q - WS

POSITIONING
  D - Goddard
  Q - WS

POWER
  T - Lewis
  N - Headquarters

POWER GAIN
  S - Lewis
  A - JPL

POWER LIMITERS
  T - Lewis

POWER SUPPLY CIRCUITS
  T - Lewis

POWER TRANSMISSION
  N - Headquarters

PROPAGATION
  N - Headquarters
  C - Goddard

QUEUING THEORY
  D - Goddard

PULSE COMMUNICATION
  A - JPL

RADIO EQUIPMENT
  B - Goddard

RADIO FREQUENCIES
  S - Lewis
RADIO FREQUENCY INTERFERENCE
A - JPL     N - Headquarters      F - Goddard

RADIO RELAY SYSTEMS
B - Goddard
A - JPL

RADIO TELEPHONES
D - Goddard
Q - WS

RECEIVERS
F - Goddard
N - Headquarters
C - Goddard

RECONNAISSANCE
D - Goddard
Q - WS

REFERENCE SYSTEMS
Z - Headquarters

RELAY
B - Goddard

RELAY SATELLITES
F - Goddard

REPEATERS
B - Goddard

RESCUE OPERATIONS
D - Goddard
Q - WS
<table>
<thead>
<tr>
<th>Term</th>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATELLITE NAVIGATION SYSTEMS</td>
<td>D - Goddard</td>
</tr>
<tr>
<td></td>
<td>Q - WS</td>
</tr>
<tr>
<td>SATELLITE NETWORKS</td>
<td>A - JPL</td>
</tr>
<tr>
<td></td>
<td>F - Goddard</td>
</tr>
<tr>
<td></td>
<td>Z - Headquarters</td>
</tr>
<tr>
<td>SATELLITE PERTURBATION</td>
<td>Z - Headquarters</td>
</tr>
<tr>
<td>SATELLITE TELEVISION</td>
<td>B - Goddard</td>
</tr>
<tr>
<td>SATELLITE TRACKING</td>
<td>F - Goddard</td>
</tr>
<tr>
<td>SATELLITE TRANSMISSION</td>
<td>D - Goddard</td>
</tr>
<tr>
<td></td>
<td>Q - WS</td>
</tr>
<tr>
<td>SEARCH RADAR</td>
<td>D - Goddard</td>
</tr>
<tr>
<td></td>
<td>Q - WS</td>
</tr>
<tr>
<td>SEARCHING</td>
<td>D - Goddard</td>
</tr>
<tr>
<td></td>
<td>Q - WS</td>
</tr>
<tr>
<td>SENSORS</td>
<td>H - Goddard</td>
</tr>
<tr>
<td></td>
<td>D - Goddard</td>
</tr>
<tr>
<td></td>
<td>Q - WS</td>
</tr>
<tr>
<td>SHIPS</td>
<td>D - Goddard</td>
</tr>
<tr>
<td></td>
<td>Q - WS</td>
</tr>
<tr>
<td>SIGNAL ANALYZERS</td>
<td>A - JPL</td>
</tr>
<tr>
<td></td>
<td>S - Lewis</td>
</tr>
<tr>
<td></td>
<td>P - Ames</td>
</tr>
<tr>
<td></td>
<td>F - Goddard</td>
</tr>
<tr>
<td>SCATTERING</td>
<td>C - Goddard</td>
</tr>
<tr>
<td>SCINTILLATION</td>
<td>C - Goddard</td>
</tr>
</tbody>
</table>
SIGNAL DETECTION
A - JPL
S - Lewis
P - Ames

SIGNAL DISTORTION
F - Goddard

SIGNAL ENCODING
A - JPL
S - Lewis
P - Ames
D - Goddard
Q - WS

SIGNAL GENERATORS
F - Goddard

SIGNAL PROCESSING
A - JPL
S - Lewis
P - Ames
N - Headquarters

SIGNAL RECEPTION
F - Goddard

SIGNAL TRANSMISSION
D - Goddard
Q - WS
A - JPL

SOLID STATE DEVICES
S - Lewis

SPACE COMMUNICATION
A - JPL
N - Headquarters

SOLAR CELLS
N - Headquarters

SPACECRAFT COMMUNICATION
A - JPL
O - MSC
SPACE INSTRUMENTS
   H - Goddard

SPACECRAFT RECOVERY
   Q - WS

SPACECRAFT STABILITY
   H - Goddard

STABILITY DERIVATIVES
   H - Goddard

STABILIZED PLATFORMS
   E - Goddard
   D - Goddard
   Q - WS
   H - Goddard

STADAN (SATELLITE TRACKING NETWORK)
   F - Goddard

STEARABLE ANTENNAS
   A - JPL

SURFACE NAVIGATION
   D - Goddard
   Q - WS

STATIONS
   C - Goddard

STATIONARY ORBITS
   N - Headquarters

SURVEILLANCE
   Q - WS
   D - Goddard

SYSTEM ANALYSIS
   D - Goddard
   Q - WS

SYSTEMS
   D - Goddard
   Q - WS

SYSTEMS ANALYSIS
   M - Headquarters
   C - Goddard

SYSTEMS ENGINEERING
   M - Headquarters

-60-
TELECOMMUNICATION
M - Headquarters
D - Goddard
Q - WS
N - Headquarters
A - JPL
O - MSC

TELEMETRY
A - JPL
S - Lewis
P - Ames

TELEVISION SYSTEMS
O - MSC
C - Goddard

TEST EQUIPMENT
O - MSC
Z - Headquarters

TESTS
O - MSC
C - Goddard
Z - Headquarters

TELEVISION TRANSMISSION
M - Headquarters

TESTS
O - MSC
C - Goddard
Z - Headquarters

THRESHOLDS
C - Goddard
D - Goddard

TRACKING NETWORKS
F - Goddard
N - Headquarters

TRACKING (POSITION)
D - Goddard
Q - WS

TRACKING STATIONS
F - Goddard

TRAINING DEVICES
C - Goddard

TRAFFIC CONTROL
D - Goddard
N - Headquarters
Q - WS
C - Goddard

TRANSMISSION
D - Goddard
Q - WS
TRANSMISSION CIRCUITS
  D - Goddard
  Q - WS

TRANSMISSION EFFICIENCY
  D - Goddard
  Q - WS

TRANSMISSION LOSS
  D - Goddard
  Q - WS

UNMANNED SPACECRAFT
  A - JPL

VERBAL COMMUNICATION
  D - Goddard
  Q - WS

VIDEO COMMUNICATION
  Q - MSC

VOICE COMMUNICATION
  D - Goddard
  Q - WS

VOICE DATA PROCESSING
  D - Goddard
  Q - WS

TRAVELLING WAVE TUBES
  S - Lewis
  N - Headquarters

TRANSPONDERS
  N - Headquarters

TRANSMITTERS
  N - Headquarters

TROPOSPHERIC SCATTERING
  C - Goddard

ULTRAHIGH FREQUENCIES
  C - Goddard
APPENDIX C

REVISED SAMPLE INDEX

POWER & ELECTRIC PROPULSION SRT
<table>
<thead>
<tr>
<th>Center:</th>
<th>Ames</th>
<th>Center:</th>
<th>Lewis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Individual</td>
<td>Code</td>
<td>Individual</td>
</tr>
<tr>
<td>A</td>
<td>G. Goodwin</td>
<td>C</td>
<td>E. A. Richley</td>
</tr>
<tr>
<td>B</td>
<td>J. V. Foster</td>
<td>D</td>
<td>G. R. Seikel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E</td>
<td>D. R. Packe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>R. Breitwieser</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>S. J. Kaufman</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>M. J. Saari</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>D. T. Bernatowicz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>J</td>
<td>H. J. Schwartz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director of</td>
</tr>
<tr>
<td>Astronautics</td>
</tr>
<tr>
<td>Director of</td>
</tr>
<tr>
<td>Development</td>
</tr>
<tr>
<td>Office of Chief of Operations Analysis &amp; Planning</td>
</tr>
<tr>
<td>Electromagnetic Propulsion Division - Plasma Physics Branch</td>
</tr>
<tr>
<td>Power Systems Division - Reactor Brayton Technology Branch</td>
</tr>
<tr>
<td>Direct Energy Conversion Division - Thermionic Branch</td>
</tr>
<tr>
<td>Nuclear Systems Division</td>
</tr>
<tr>
<td>Power Systems Division - Power Systems Evaluation Branch</td>
</tr>
<tr>
<td>Direct Energy Conversion Division - Solar Cell Branch</td>
</tr>
<tr>
<td>Direct Energy Conversion Division - Electrochemistry Branch</td>
</tr>
</tbody>
</table>
### Center: Langley

<table>
<thead>
<tr>
<th>Code</th>
<th>Individual</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>C. H. Nelson</td>
<td>Office of Director</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For Space</td>
</tr>
<tr>
<td>L</td>
<td>G. W. Brooks</td>
<td>Office of Director</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For Structures</td>
</tr>
</tbody>
</table>

### Center: JPL

<table>
<thead>
<tr>
<th>Code</th>
<th>Individual</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>A. Briglio, Jr.</td>
<td>Research and Advanced Development Program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Office - Space</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power and Electric Propulsion</td>
</tr>
</tbody>
</table>

### Center: Goddard

<table>
<thead>
<tr>
<th>Code</th>
<th>Individual</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>J. Epstein</td>
<td>Engineering Physics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Division - Advanced Power Section</td>
</tr>
<tr>
<td>O</td>
<td>W. R. Cherry</td>
<td>Engineering Physics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Division</td>
</tr>
<tr>
<td>P</td>
<td>T. J. Hennigan</td>
<td>Engineering Physics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Division - Electrochemical Power Sources Section</td>
</tr>
</tbody>
</table>

### Center: Manned Spacecraft Center

<table>
<thead>
<tr>
<th>Code</th>
<th>Individual</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>W. E. Rice</td>
<td>PPD - Power Generation</td>
</tr>
</tbody>
</table>
KEY WORD INDEX

ACCIDENT PREVENTION
A - Ames

ACCELERATORS
C - Lewis

AERODYNAMIC HEATING
A - Ames

AERODYNAMICS
A - Ames

AEROSPACE ENVIRONMENTS
O - Goddard
M - JPL
K - LRC
I - Lewis

AIRCRAFT
M - JPL

ALKALINE BATTERIES
P - Goddard
J - Lewis

ALLOYS
M - JPL

AMMONIA
K - LRC

APPLICATIONS TECHNOLOGY SATELLITES
L - LRC
B - Ames
C - Lewis
P - Goddard
M - JPL
K - LRC
ARRAYS
0 - Goddard

ASSEMBLY
M - JPL

ATTITUDE CONTROL
K - LRC

AUXILIARY POWER SOURCES
M - JPL
0 - Goddard
N - Goddard
J - Lewis

BIOCHEMICAL FUEL CELLS
K - LRC

BRAYTON CYCLE
E - Lewis G - Lewis

BREADBOARD MODELS
H - Lewis

BROADCASTING
M - JPL

CAVIATION CORROSION
M - JPL

CHEMICAL AUXILIARY POWER UNITS
J - Lewis

CATHODES
C - Lewis

CESIUM DIODES
F - Lewis

CESIUM PLASMA
F - Lewis

-67-
CIRCUIT RELIABILITY

O - Goddard
M - JPL

CIRCUITS

O - Goddard
M - JPL

CONSTRUCTION MATERIALS

M - JPL

CORROSION RESISTANCE

M - JPL

DETERIORATION

M - JPL

DIRECT POWER GENERATORS

M - JPL
B - Ames

DIRECTION CONTROL

G - Lewis

DYNAMIC CHARACTERISTICS

O - Goddard
M - JPL
K - LRC

DYNAMIC MODELS

G - Lewis
M - JPL

DYNAMIC RESPONSE

O - Goddard
M - JPL
K - LRC
EARTH ORBITS
P - Goddard
M - JPL
K - LRC
J - Lewis

EFFICIENCY
C - Lewis

ELECTRIC BATTERIES
M - JPL
P - Goddard
K - LRC
J - Lewis

ELECTRIC CONDUCTORS
J - Lewis

ELECTRIC CONTACTS
O - Goddard

ELECTRIC GENERATORS
H - Lewis
G - Lewis
M - JPL
O - Goddard
N - Goddard

ELECTRIC POWER
M - JPL
P - Goddard
J - Lewis

ELECTRIC POWER PLANTS
M - JPL

ELECTRIC PROPULSION
L - LRC
D - Lewis
C - Lewis
M - JPL
O - Goddard
ELECTRIC ROCKET ENGINES
   M - JPL
   K - LRC
   L - LRC
   D - Lewis

ELECTRICAL INSULATION
   M - JPL
   F - Lewis
   N - Goddard

ELECTRICAL MEASUREMENT
   G - Lewis
   M - JPL

ELECTROCATALYSTS
   J - Lewis

ELECTROCHEMICAL CELLS
   J - Lewis
   P - Goddard

ELECTROCHEMISTRY
   J - Lewis
   P - Goddard

ELECTRODES
   J - Lewis
   P - Goddard

ELECTROLYTES
   J - Lewis

ELECTROLYTIC CELLS

ELECTRON-ION RECOMBINATION
   L - LRC
   D - Lewis
   C - Lewis
ELECTRON BEAMS
L - LRC
C - Lewis

ELECTROSTATIC PROPULSION
L - LRC
D - Lewis
C - Lewis

ELECTROSTATICS
O - Goddard
M - JPL

ENERGY CONVERSION
H - Lewis
G - Lewis

ENERGY CONVERSION EFFICIENCY
O - Goddard
M - JPL
I - Lewis
N - Goddard

ENERGY SOURCES
P - Goddard
M - JPL
J - Lewis

ENERGY STORAGE
P - Goddard
M - JPL
J - Lewis
ENVIRONMENTAL TESTS

O - Goddard  
M - JPL  
B - Ames  
J - Lewis

EROSION

M - JPL

EXTRATERRESTRIAL ENVIRONMENTS

O - Goddard  
M - JPL

EXTRATERRESTRIAL RADIATION

O - Goddard  
M - JPL

FABRICATION

P - Goddard  
M - JPL  
J - Lewis

FAILURE

O - Goddard  
M - JPL  
G - Lewis

FAIL-SAFE SYSTEMS

C - Lewis

FISSION PRODUCTS

G - Lewis

FLEXIBLE BODIES

O - Goddard  
M - JPL  
K - LRC  
I - Lewis

FLIGHT TESTS

H - Lewis

FLOW MEASUREMENT

G - Lewis  
M - JPL
<table>
<thead>
<tr>
<th>Category</th>
<th>Symbols</th>
<th>Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Cells</td>
<td>K - LRC J - Lewis P - Goddard M - JPL</td>
<td></td>
</tr>
<tr>
<td>Ground Tests</td>
<td>H - Lewis C - Lewis</td>
<td></td>
</tr>
<tr>
<td>Hazards</td>
<td>A - Ames</td>
<td></td>
</tr>
<tr>
<td>Heat Resistant Alloys</td>
<td>M - JPL</td>
<td></td>
</tr>
<tr>
<td>High Strength Alloys</td>
<td>M - JPL</td>
<td></td>
</tr>
<tr>
<td>High Strength Steels</td>
<td>M - JPL</td>
<td></td>
</tr>
<tr>
<td>High Temperature</td>
<td>M - JPL O - Goddard J - Lewis P - Goddard G - Lewis</td>
<td></td>
</tr>
<tr>
<td>High Temperature Tests</td>
<td>M - JPL O - Goddard</td>
<td></td>
</tr>
<tr>
<td>High Thrust</td>
<td>D - Lewis</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Oxygen Fuel Cells</td>
<td>K - LRC</td>
<td></td>
</tr>
<tr>
<td>Heat Exchangers</td>
<td>C - Lewis G - Lewis</td>
<td></td>
</tr>
</tbody>
</table>
INTERPLANETARY FLIGHT
M - JPL
B - Ames

INTERPLANETARY SPACECRAFT
M - JPL
B - Ames
P - Goddard

ION ENGINES
L - LRC
D - Lewis
C - Lewis

ION EXCHANGE MEMBRANE ELECTROLYTES
J - Lewis

ION PROPULSION
L - LRC
D - Lewis
C - Lewis

ISOTOPES
G - Lewis

JUPITER ATMOSPHERE
M - JPL
B - Ames

JUPITER (PLANET)
M - JPL
B - Ames

LAUNCHING
O - Goddard
M - JPL

LIFE (DURABILITY)
J - Lewis
M - JPL

LASERS
D - Lewis
LIFE (DURABILITY) - Cont'd
H - Lewis
G - Lewis
O - Goddard
N - Goddard
P - Goddard
K - LRC

LIQUID METAL COOLED REACTORS
G - Lewis
M - JPL

LIQUID METALS
G - Lewis
M - JPL

LIQUID VAPOR EQUILIBRIUM
M - JPL

LOW ALTITUDE
P - Goddard
M - JPL
K - LRC
J - Lewis

LOW COST
O - Goddard
I - Lewis

LOW TEMPERATURE
J - Lewis
P - Goddard

LOW THRUST
L - Langley

LOW WEIGHT
O - Goddard
M - JPL
N - Goddard
MAINTAINABILITY
M - JPL
O - Goddard

MAGNETOHYDRODYNAMIC FLOW
M - JPL

MAGNETOHYDRODYNAMIC GENERATORS
M - JPL

MANNED SPACECRAFT
L - LRC
D - Lewis
P - Goddard
M - JPL
K - LRC

MARS EXCURSION MODULE
O - Goddard
M - JPL
B - Ames

MATHEMATICAL MODELS
G - Lewis
M - JPL

MEASURING INSTRUMENTS
G - Lewis
M - JPL

MECHANICAL DRIVES
O - Goddard
M - JPL
K - LRC
MERCURY (PLANET)

M - JPL
B - Ames

METAL SURFACES

M - JPL

METALS

M - JPL

MISSION PLANNING

M - JPL

MISSIONS

M - JPL

MODULES

C - Lewis

MOLTEN SALT ELECTROLYTES

J - Lewis

NUCLEAR ELECTRIC POWER GENERATION

G - Lewis
M - JPL
E - Lewis
H - Lewis
A - Ames
F - Lewis
N - Goddard
B - Ames

NUCLEAR ELECTRIC PROPULSION

G - Lewis
L - Langley
M - JPL

NUCLEAR POWER PLANTS

G - Lewis
M - JPL

MONTE CARLO METHOD

G - Lewis

NEUTRALIZERS

C - Lewis

NEUTRON SPECTRA

G - Lewis

NUCLEAR FUEL ELEMENTS

G - Lewis
NUCLEAR REACTORS
   G - Lewis
   H - Lewis

ORGANIC COMPOUNDS
   J - Lewis

PACKAGING
   M - JPL

PERFORMANCE TESTS
   H - Lewis
   A - Ames

PHOTOELECTRIC GENERATORS
   O - Goddard

PITTING
   M - JPL

PLANETARY ENVIRONMENTS
   M - JPL

PLASMA ACCELERATORS
   L - LRC
   D - Lewis

PLASMA DENSITY
   L - LRC
   D - Lewis

PLASMA DYNAMICS
   F - Lewis

PLASMA ENGINES
   K - LRC

PLASMA PHYSICS
   F - Lewis

PLASMA PROPULSION
   L - LRC
   D - Lewis

P-N JUNCTIONS
   I - Lewis
POLARIZATION
P - Goddard
J - Lewis

POSITION ERRORS
L - LRC

POSITIONING
M - JPL
L - LRC

POWER EFFICIENCY
0 - Goddard
1 - Lewis
M - JPL
N - Goddard

POWER SUPPLIES
C - Lewis

0 - Goddard
M - JPL

POWER SUPPLY CIRCUITS
C - Lewis

0 - Goddard
M - JPL

POWER TRANSMISSION

0 - Goddard
M - JPL

PRELAUNCH TESTS

0 - Goddard
M - JPL

PRESSURE MEASUREMENTS
G - Lewis
M - JPL
PROPELLANT MASS RATIO
L - LRC
D - Lewis

PROPULSION
M - JPL
B - Ames

PROPULSION SYSTEM CONFIGURATIONS
L - LRC
D - Lewis
C - Lewis
M - JPL
B - Ames

PROPULSIVE EFFICIENCY
L - LRC
D - Lewis
C - Lewis

RADIATION DOSAGE
M - JPL

RADIATION EFFECTS
I - Lewis
O - Goddard
G - Lewis
M - JPL

RADIATION HAZARDS
A - Ames

RADIATION TOLERANCE
O - Goddard
M - JPL

RADIO COMMUNICATION
M - JPL

RADIO TRANSMISSION
M - JPL

PROPELLANTS
C - Lewis
RADIOACTIVE CONTAMINANTS  
A - Ames

RADIOACTIVE ISOTOPES  
M - JPL  
O - Goddard  
N - Goddard

RADIOACTIVE MATERIALS  
A - Ames  
G - Lewis

RADIOACTIVITY  
A - Ames

RADIOISOTOPE BATTERIES  
M - JPL  
O - Goddard  
N - Goddard

RANKINE CYCLE  
H - Lewis  
G - Lewis

REACTION CONTROL  
K - LRC

REACTOR SAFETY  
A - Ames

RE-ENTRY  
A - Ames

RE-ENTRY EFFECTS  
A - Ames

RE-ENTRY TRAJECTORIES  
A - Ames

REGENERATIVE FUEL CELLS  
J - Lewis
RELIABILITY
  M - JPL
  O - Goddard

RELIABILITY ENGINEERING
  O - Goddard
  M - JPL

RESISTOJET ENGINES
  K - LRC

ROCKET ENGINES
  L - LRC
  D - Lewis

ROCKETS
  L - LRC
  D - Lewis

SAFETY
  A - Ames

SAFETY FACTORS
  A - Ames

SCIENTIFIC SATELLITES
  P - Goddard
  M - JPL
  K - LRC

SELF REPAIRING DEVICES
  M - JPL
  O - Goddard

SEMICONDUCTOR DEVICES
  O - Goddard
  M - JPL
SEMICONDUCTOR JUNCTIONS
  0 - Goddard

SEPARATORS
  M - JPL

SERVICE LIFE
  H - Lewis
  M - JPL

SILICON JUNCTIONS
  0 - Goddard

SNAP
  H - Lewis

SNAP 8
  H - Lewis

SOLAR AUXILIARY POWER UNITS
  0 - Goddard
  M - JPL
  K - LRC
  L - Lewis

SOLAR CELLS
  0 - Goddard
  M - JPL
  L - Lewis
  K - LRC

SOLAR COLLECTORS
  0 - Goddard
  M - JPL
  K - LRC
  L - Lewis

SOLAR GENERATORS
  0 - Goddard
  M - JPL
  K - LRC
  E - Lewis
SOLAR GENERATORS Cont'd
I - Lewis
C - Lewis
B - Ames

SOLAR POSITION
O - Goddard
M - JPL
K - LRC
I - Lewis

SOLAR PROBES
O - Goddard
M - JPL
B - Ames

SOLID STATE DEVICES
O - Goddard
M - JPL

SPACE ELECTRIC ROCKET TESTS
A - Ames
C - Lewis

SPACE ENVIRONMENT SIMULATION
O - Goddard
M - JPL
B - Ames

SPACE ERECTABLE STRUCTURES
O - Goddard
M - JPL

SPACE EXPLORATION
M - JPL

SPACE MISSIONS
M - JPL

SPACE NAVIGATION
M - JPL
SPACE POWER UNIT REACTORS
H - Lewis

SPACE SHUTTLE

O - Goddard
M - JPL
Q - MSC

SPACE STATIONS

O - Goddard
M - JPL
L - LRC
D - Lewis

SPACE STORAGE

M - JPL

SPACECRAFT
L - LRC
D - Lewis

SPACECRAFT COMPONENTS
L - LRC

SPACECRAFT CONTROL

O - Goddard
M - JPL
K - LRC
C - Lewis

SPACECRAFT DESIGN

O - Goddard
M - JPL
K - LRC
A - Ames
SPACECRAFT GUIDANCE

M - JPL
K - LRC

SPACECRAFT MANEUVERS
M - JPL
C - Lewis

SPACECRAFT POSITION INDICATORS
M - JPL

SPACECRAFT POWER SUPPLIES
M - JPL
O - Goddard
J - Lewis
Q - MSC
P - Goddard
H - Lewis
C - Lewis

SPACECRAFT PROPULSION
L - LRC
D - Lewis
C - Lewis

SPACECRAFT STERILIZATION
P - Goddard
M - JPL

SPECIFIC IMPULSE
L - LRC
D - Lewis
C - Lewis

STATION KEEPING
C - Lewis
STATIONARY ORBITS
P - Goddard
M - JPL
K - LRC

STERILIZATION
P - Goddard
M - JPL
J - Lewis

STORAGE BATTERIES
P - Goddard
M - JPL
K - LRC
J - Lewis

STRESS ANALYSIS
O - Goddard
M - JPL

STRESSES
O - Goddard
M - JPL

STRUCTURAL DESIGN
O - Goddard
M - JPL
K - LRC
I - Lewis
A - Ames

STRUCTURAL MEMBERS
M - JPL

SUPersonic FLOW
M - JPL

SUPersonic NOZZLES
M - JPL
SWITCHING CIRCUITS
C - Lewis

SYNCHRONOUS SATELLITES
P - Goddard
M - JPL
K - LRC
J - Lewis

SYSTEM ANALYSIS
G - Lewis
M - JPL
A - Ames
B - Ames

SYSTEM FAILURES
G - Lewis
M - JPL
C - Lewis

SYSTEMS ENGINEERING
Q - MSC
G - Lewis
M - JPL
H - Lewis
O - Goddard
K - LRC

TEMPERATURE MEASUREMENT
G - Lewis
M - JPL

TEMPERATURE MEASURING INSTRUMENTS
M - JPL

TEST EQUIPMENT
H - Lewis

TEST FACILITIES
H - Lewis
C - Lewis

TESTS
H - Lewis
THERMAL STRESSES

0 - Goddard
M - JPL

THERMIONIC CATHODES
F - Lewis

THERMIONIC EMISSION
F - Lewis

THERMIONIC POWER GENERATION
F - Lewis

THERMODYNAMIC EFFICIENCY
M - JPL
N - Goddard

THERMOELECTRIC MATERIALS
N - Goddard

THERMOELECTRIC POWER GENERATION
N - Goddard  G - Lewis
M - JPL
D - Goddard

THRUST
L - LRC
D - Lewis

THRUST CONTROL
K - LRC

THRUST VECTOR CONTROL
L - LRC
D - Lewis
C - Lewis

TRAJECTORY ANALYSIS
M - JPL
B - Ames

TURBINES
G - Lewis
M - JPL
TWO PHASE FLOW

M - JPL

UNMANNED SPACECRAFT

L - LRC
D - Lewis

VENUS ATMOSPHERE

M - JPL
B - Ames

VENUS PROBES

O - Goddard
M - JPL
B - Ames

WEIGHT ANALYSIS

M - JPL
N - Goddard

WEIGHTLESSNESS

J - Lewis