TECHNOLOGY UTILIZATION REVIEW AND ANALYSIS

FINAL REPORT

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VOLUME I

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NASA WESTERN OPERATIONS OFFICE
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CONTRACT NAS 7-277

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PREFACE

This final report was prepared by

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for the National Aeronautics and Space Administration under Contract NAS 7-277, TECHNOLOGY UTILIZATION REVIEW & ANALYSIS. The report consists of three volumes as follows:

- Volume I
- Volume II
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Volume I

SECTION 1

INTRODUCTION

This final report covers the period from 28 February 1964 through 31 August 1964 and is the sixth and final report of the progress report series prepared by the Northrop Space Laboratories under NASA Contract No. NAS 7-277.

The objectives of the contract included the following four tasks:

1.1 TASK 1.

To determine what new technology has been developed by the Ranger Block III program and to what extent these technological advances may be of use to the scientific and industrial cummunities;

1.2 TASK 2.

To analyze similarly, engineering and technical reports selected by the NASA Contracting Officer from reports submitted to the NASA Western Operations Office, Jet Propulsion Laboratory, and NASA Headquarters;

1.3 TASK 3.

To prepare Flash Sheets disseminating information on invention disclosures already on file at the Western Operations Office during the contract and on other technical innovations identified by analysis of reports. This will include evaluation of these items and the preparation of recommendations regarding applications of new technology to the scientific and industrial communities; and

1.4 TASK 4.

To determine the most meaningful and promising technical innovations resulting from the space program and the best methods of presenting these subjects in Technology Utilization Workshops.

1.5 Contract Activation

To perform the Task 2, 3 and 4 work under this contract, Northrop Space Laboratories have provided personnel to work closely with NASA officials in Washington, D.C., and in Santa Monica, California. By having NSL personnel in close association with those NASA personnel who provide the reports, invention disclosures, and other material for analysis and who receive the results of NSL investigations, the flow of information was expedited and the effectiveness of the program enhanced. Northrop had a six man team at Santa Monica, for WOO documents review, a three man team in Santa Monica for JPL documents review, and one man in Washington.

This report details the work performed on the various tasks listed above, and describes other significant events or accomplishments considered to be of interest to NASA. The methodologies employed by NSL in the Technology Utilization review of NASA technical documentation are described, followed by a discussion on some Technology Utilization philosophies and concepts developed by NSL in the performance of required tasks. Conclusions and recommendations are offered.

SECTION 2

GENERAL

2.1 Contract Status

The letter contract dated February 28, 1964, permitting work on contract NAS 7-277 was received by Northrop Space Laboratories and was signed and accepted on 4 March 1964.

The NSL personnel assigned to support the Western Operations Office on Tasks 2,3, and 4, began work in space borrowed from that office and on 25 March 1964 moved to rented quarters in the vicinity of the Western Operations Office in Santa Monica.

On 16 March 1964, NSL arranged a meeting with Mr. John Warden, the NASA-JPL Residency patent counsel, to decide on the physical location of the NSL personnel assigned to review reports resulting from JPL subcontracts. At this meeting which took place on 19 March 1964, the NASA-JPL Residency was represented by Mr. John Warden and NASA-WOO was represented by Dr. Brenneman and Messrs. Grifka and Benjamin. As a result a decision was reached to place the personnel performing JPL report review at the NSL-Santa Monica facility.

The Program Plan, NSL Report 64-107 (March 1964), initially submitted on 16 March, was later revised to reflect program changes resulting from the various negotiations and was re-issued as an "A" revision on 26 March 1964 and with a "B" revision dated 15 April 1964. On 16 April 1964, NASA approved the revised Program Plan and an executed contract dated 20 April 1964 was subsequently received from NASA.

The Program Plan, NSL Report 64-107 (March 1964), was revised to reflect a program change to provide for extended Task 4 functions and was reissued as a "C" revision dated 28 May 1964. Task 4 was modified

by this revision to provide for NSL attendance and monitoring of the NASA-UCLA Symposium and Workshop on the Transformation of Knowledge and its Utilization. Additionally, NSL was required to evaluate the effectiveness of the Symposium and present recommendations in a supplement to the Task 4 report "Technology Utilization Workshops Study" NSL 64-125, dated April 1964 (See Appendix C).

In response to a request by the Contracting Officer's Representative, Mordy A. Benjamin, action was taken to fulfill the requirements for handling classified documents at the NSL-Santa Monica Facility.

The Facility was surveyed by Gerald C. Gartland of the NSL Security Group and the USAF Security Representative, R. W. Culp, WCMR, preparatory to granting a Facility Security Clearance. This action was followed by memo 438-357 from the Security Group dated 18 June 1964, which established the necessary clearance to the Secret level effective 22 June 1964. A security inspection of the NSL Santa Monica facility was subsequently conducted by the NSL security officer accompanied by a U.S. Air Force security representative. Classified files, logs, and procedures were reviewed. No discrepancies were noted.

NSL letter 414-64-2002 covering a proposed amendment to the contract was submitted to NASA representatives W. Grifka and D. Sullivan by D. Vivrette and R. Craigo on 31 July 1964. Enclosures to the letter included a proposed work statement and cost details. Following discussions between NASA and NSL representatives relative to the contract amendment, formal proposals were transmitted to NASA-WOO on 20 August, 1964. (NSL Letter 414-64-2213.)

Five monthly progress reports covering the NSL Technology Utilization activities were prepared and submitted on schedule in accordance with Articles IV and V of the contract.

2.2 Program Activity Review

James T. Dennison, NASA Special Assistant for Technology Utilization, visited the NSL-Santa Monica facilities on 23 April 1964 to review the activities of the Technology Utilization teams operating in that location. The program history to date together with various problem areas were discussed. Mr. Dennison spoke to an assembly of the personnel located in Santa Monica and reviewed the objectives of the Technology Utilization Program together with the various programs operating in research institutes and industrial organizations.

Following this, Mr. Dennison reviewed the activities output of individual members of the program teams. On 24 April 1964, the Task 1 team activities at NSL-Hawthorne were similarly reviewed.

A presentation was made to NASA representatives on 28 July 1964 for the purpose of reviewing NSL contract performance to date. NASA attendees included J. T. Dennison, Louis B. C. Fong, Frank Godsey, Cliff Dillon, John Warden, W. Grifka, and Dr. R. Brenneman.

An overall program summary including project status was first presented. This was followed by a more detailed report by the various team captains for each of the four contract tasks. The presentation was then completed by a discussion of the NSL philosophies and concepts regarding improved techniques for implementing the Techology Utilization Program. These concepts were developed by NSL as a result of the experience and knowledge gained during the current contract effort.

2.3 Special Evaluations

In response to requests by the Washington member of the NSL Technology Utilization team, nineteen (19) Flash Sheets were evaluated, and recommendations for future action on each of the Flash Sheets were returned to Washington. The material processed included Flash Sheets from Goddard Space Flight Center, Marshall Space Flight Center, Manned Spacecraft Center and the Jet Propulsion Laboratory. In addition,

an analysis of a Shaft Angle Encoder innovation was completed and the results returned to Washington. Additional material received from Washington was reviewed and returned with written comments on potential commercial applications.

To support a special project in Washington, a conference was held with representatives of JPL to acquire information concerning a JPL innovation for including ethylene oxide in polymeric material to achieve sterilization. The data obtained during this meeting was forwarded to Washington along with information on Armstrong self-sanitizing ceiling material. The Armstrong product is a related type of application of the concept.

At the request of the NASA-WOO Technology Utilization Officer, draft copies of the proceedings covering the 2 June 1964 NASA/UCLA Technology Utilization Symposium were reviewed under the provisions of Task 2 of the contract. NSL reports covering the reviews were prepared and submitted to NASA on 14 August 1964.

SECTION 3

PROGRAM ACTIVITY AND PROGRESS

3.1 TASK 1. RANGER BLOCK III STUDY

The Ranger Block III Spacecraft System has been reviewed and analyzed to provide a comprehensive report on the extent and depth to which various technologies have been applied. In addition to technical review of the functional equipment and detail elements comprising the Ranger Block III System, the study included identification and analysis of significant functional concepts and procedures. For purposes of definition in this program; functional equipment included the spacecraft hardware assemblies and subassemblies; functional elements covered the types of component parts making up the subassemblies; and functional concepts considered such factors as the various operational requirements of the Ranger mission, the technical reasons for inclusion of specific items of equipment, and functional interrelations between various equipment or systems. The procedures covered in the review, originate primarily in fabrication, checkout, and testing operations.

The following Ranger III Subsystem technology reviews were accomplished:

Television Payload Subsystem
Structural Subsystem and Mechanical Devices
Temperature Control Subsystem
Communications Subsystem
Command Subsystem
Electrical Power Subsystem

Central Computer and Sequencer Subsystem
Data Encoder Sybsystem and Transducers
Attitude Control Subsystem
Pyrotechnics Subsystem
Cabling Subsystem
Midcourse Propulsion Subsystem

The subsystem technology reviews were summarized by preparation of analyses texts and development status matrices for the identified functional concepts, subsystem functional equipment and elements, and procedures. Ranger Block III Analysis material is integrated into Volume II of this Final Report.

As the second major objective of the Ranger Study, the subsystem review has included identification of Ranger technology items which could have potential application in scientific and industrial fields. During the course of the review activity, a total of 29 potential application items were identified. These include several electronic and servo-sensor subassemblies, and electronic functional elements and circuit techniques. Also included were functional concepts associated with the Ranger TV payload, communications, attitude control, and electrical power controlling equipment and significant test procedures employed in evaluating the functional integrity of the spacecraft systems. During the contract period, all of the potential items identified were analyzed in detail and were presented for full industrial application committee evaluation.

A total of eight application items received specific application recommendations after having undergone final analysis and committee evaluation. Descriptions of the items receiving specific application recommendations, in the format of the NASA Tech Brief, are submitted to NASA as part of the Final Report, Volume II.

3.2 TASK 2. TECHNOLOGY UTILIZATION REVIEW AND ANALYSIS

Technical Evaluation

Technical analysis of NASA Space Program documentation was accomplished by technically cognizant Northrop personnel assigned to the Technology Utilization effort. Consulting assistance from the Northrop home organization was obtained as required. A written review was furnished NASA on each document or related series of documents analyzed by the NSL Technology Utilization Team. The process of report review entailed the use of a check and balance system wherein selected reports received multiple scrutiny by specialists, thereby minimizing the possibility that an advance in technology would not be recognized.

3.2.1 Applications-Oriented Evaluation

The TU Committee was oriented toward areas of application. The same persons who conducted the original technical analyses were, in most cases, committee members and therefore reoriented their thinking along areas of alternate application lines to the technical analysis. This process formed a technology-applications matrix which permitted maximum productivity from a relatively small group.

When an element of new technology was identified, further analysis by the committee was conducted toward the primary objectives of the Technology Utilization Program, which is the application of new technology to American industry. Each element of new technology was subjected to a thorough imaginative analysis which occasionally included consultations with the other Northrop Corporation specialists, originating agencies, and specialists in the field. Included were forum discussions, library searches for related technologies, and for similar or duplicate applications. Where appropriate, Industrial Applications Flash Sheets (NASA Form 666) in draft form were prepared and submitted to NASA. Where applicable to specific industry needs,

recommendations were made for the preparation, publication and distribution of Applications Notes, Technology Handbooks, and Manuals.

A detailed description of the NSL Technology Utilization Review and Analysis process is contained in Section 4 of this document.

3.2.2 Review of Western Operations Office Contract Reports

A total of 452 reports or related series of reports were reviewed, evaluated, and returned to NASA during this contract period, together with summary reports for each report reviewed. These completed reports contained a total count of 35,010 pages. The review activity resulted in the preparation of 23 Flash Sheets which have been transmitted to the Contracting Officer's Representative.

3.2.3 Review of JPL Contract Reports

During the contract period, the review of 87 reports or related series of reports (a total of 13,976 pages) was completed and summary reports were written on the results of the review. For these reports, 14 Flash Sheets were prepared and submitted, along with the completed reports, and summary reports to the Contracting Officer's Representative.

A total of 539 WOO and JPL report groups were processed under Task 2 of the contract. These reports included a total of 48,987 pages.

It should be noted that the numbers of reports cited above were compiled from transmittal lists which frequently noted a related series of reports as being a single report. Many of these related series of reports contained up to fourteen individual volumes. The actual number of individual documents reviewed under the provisions of Task 2, therefore, is considerably higher than the numbers taken from the transmittal lists.

3.3 TASK 3. EVALUATION AND TRANSLATION OF DISCLOSURES

The methodology used in the analysis and review of Invention Disclosures by the Technology Utilization Team were basically a two step procedure similar to that described for Task 2. The major exception is that all invention disclosures were subjected to committee action while as a general rule, only the Task 2 documentation in which new technology was detected received committee action.

Each disclosure was analyzed by a specialist in the particular field involved in the innovation; and, a determination made as to its immediate commercial potential, public benefit, or general industry advancement. The disclosure and the action recommended by the specialist, in turn, was reviewed by the Technology Utilization Team, which as a group recommended the final course of action to be suggested to NASA. A written review which included a brief disclosure summary, with recommendations as to technology utilization applicability, was furnished to NASA on each disclosure analyzed by the Technology Utilization Team.

Where appropriate, Industrial Applications Flash Sheets were prepared in draft form and submitted to NASA.

During the contract period, the review and evaluation has covered a total of 180 invention disclosures for which a total of 23 Flash Sheets were prepared and submitted. Although the contract provided for the NSL review of up to 185 invention disclosures, no backlog of Task 3 work existed on the final day of the contract period.

Appendix "A" of this document contains a tabulation of all Industrial Application Flash Sheets prepared and submitted under the program. These data provide identification of the Flash Sheet by title, by reference to the contract source of the original report or patent disclosure material, and by WOO assigned identification number.

In addition, those Flash Sheets considered by NSL to be signigicant innovations are discussed in some detail in Section 5, of this volume, Technology Utilization Program Results.

3.4 TASK 4. TECHNOLOGY WORKSHOP STUDIES

During the initial few weeks of program activity, emphasis was placed on the accomplishment of study leading to the preparation of a required report.

The Task 4 report, "Technology Utilization Workshop Subjects Study," identified as NSL 64-125, was completed and delivered to NASA Western Operations Office on 6 April 1964, as scheduled. NASA approved the report by letter dated 28 April 1964. A major portion of the report, including the approach used, conclusions, and recommendations is contained in Appendix B of this document.

In accordance with the negotiated C revision to the Program Plan, both WOO and JPL Team members attended the NASA/UCLA Symposium and Workshop on the "Transformation of Knowledge and Its Utilization" at UCLA on Tuesday, 2 June 1964. The Plenary Session and the individual workshops were monitored to review and evaluate the effectiveness of the symposium.

An analysis of the NASA/UCLA Symposium was submitted as Supplement I (NSL 64-125-1) of the original Task 4 report and delivered to NASA on 12 June 1964 as scheduled. The supplement is contained in Appendix C of this document.

SECTION 4

METHODOLOGY

4.1 REVIEW PROCESS, TASKS 2 and 3

The specific procedure used in the Technology Utilization review of NASA documentation was basically a two step process in which the report was technically reviewed by appropriate individuals, and then carefully considered by an applications oriented committee chaired by the NASA-WOO Technology Utilization Officer. To accomplish this review and analysis process, the following procedure was used:

Documents, as received, were inventoried and logged.

Documents were categorized into one of six basic technological areas:

1) Bio-medical
2) Materials & Processes
3) Electrical and Electronic Systems
4) Mechanical Systems
5) Systems Engineering and Management
6) Manufacturing, Quality Control & Reliability Techniques

Documents were reviewed by specialists in each of the above categories, calling upon additional Northrop resources, where required. Technical review and summary sheets were prepared on each document or related series of documents.

The review sheets were screened for new technology items requiring committee action.

Document reviews requiring committee action were placed on an agenda and scheduled for action.

The committee analyzed each agenda item as to areas of applicability, novelty, producibility, etc, and made recommendations for further action.

Relative to the preparation of flash sheets, it was frequently necessary to obtain additional information in order to establish the feasibility of concepts or to clarify certain aspects of the new technology application. The required data were normally obtained through coordination with the NASA-WOO Technology Utilization Officer, the Contracting Officer's Representative, or the NASA-WOO Patent Counsel. On two occasions, meetings were conducted by the NASA-WOO Technology Utilization Officer with representatives from the contractor involved with the new technology and NSL Technology Utilization team members.

Where considered appropriate, Industrial Applications Flash Sheets were prepared and final recommendations were included on the review sheet.

A final administrative review of each report package was accomplished prior to transmittal of the material to NASA.

Figure 1 graphically depicts the flow of documentation through the review, analysis, and reporting process. Northrop considers that the procedure was effective, especially from the following points of view:

a. Extensive coverage of technological areas.
b. Maximum versatility and productivity from a comparatively small group.
c. Minimum possibility that an item of new technology would be overlooked.

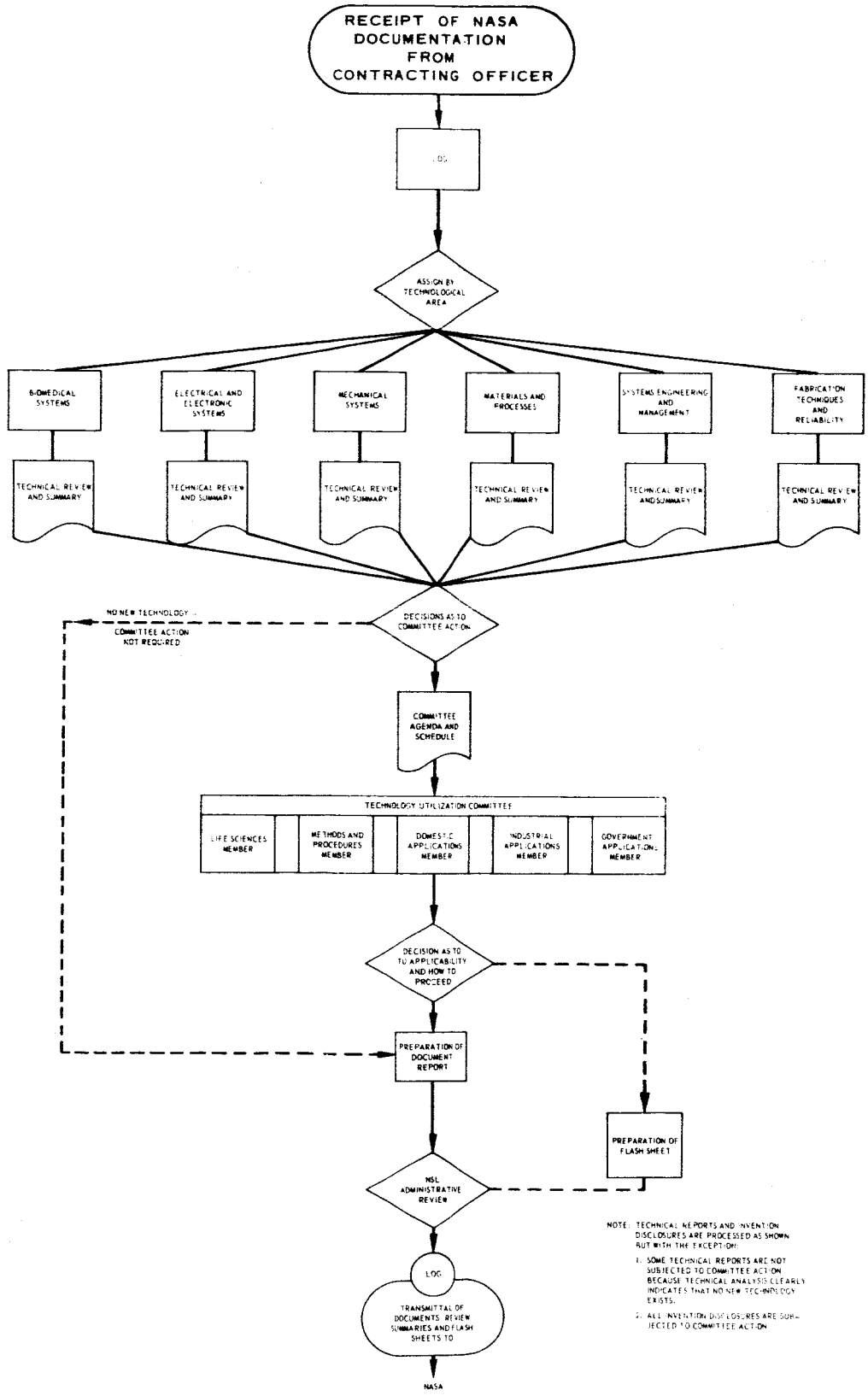


FIGURE 1 TECHNOLOGY REVIEW AND ANALYSIS OF NASA DOCUMENTATION

d. Constant return flow of documentation and review reports back to NASA (NSL submittals to NASA were accomplished on a weekly basis).

e. Effective inventory and logging system afforded positive document control and comprehensive administrative records.

4.2 DOCUMENT SELECTION

Through experience gained as a result of the technology utilication review and analysis of many hundreds of NASA documents, some criteria have evolved relative to the selection process used in obtaining documents for review. These criteria can be stated as follows:

a. Review contract work statements or briefs in order to determine the basic objectives of a contract; the reports from which are to undergo a Technology Utilization review. One should clearly keep in mind these objectives and have some regard for various states-of-the-art which must be advanced during the performance of the contract.

b. Review the abstract of a technical report to obtain a summary statement of what is contained in the report. This often leads to continued reading through the introductory paragraphs in order to derive a better understanding of the report contents.

c. Review the table of contents and select a chapter or portion to briefly scan. For example, if a given document is a progress report in connection with a large rocket program, one would possibly scan chapters regarding control systems, sealants, valves, electrical conversion equipment, etc., since those areas are known to have research and development implications in addition to favorable technology utilization applicability.

d. Explore documentation resulting from NASA Research Grants in the same manner as contract technical or progress reports. Although it has been stated that few NASA grants contain the technology utilization clause, these grants often represent pure research in areas highly significant to technology utilization objectives.

e. Progress reports from large programs such as Saturn, RIFT, J-2 Engine, etc., seldom contain direct reference to items of new technology. These reports are primarily concerned with fabrication and testing in accordance with an established schedule; however, indirect references to items which may constitute new technology are often noted. For example, a progress report may state that a method was developed to prevent further occurrences of a failure, leak, malfunction, etc., but will not state the nature of the developed method. This often leads a knowledgeable reviewer to reason that some innovation had taken place in order to resolve a described problem. The NSL Team has reported such instances to NASA as a part of the normal Task 2 review effort.

SECTION 5

TECHNOLOGY UTILIZATION PROGRAM RESULTS

5.1 INDUSTRIAL APPLICATIONS FLASH SHEETS

5.1.1 General

A total of 61 Industrial Applications Flash Sheets drafts were prepared and submitted to NASA under the NSL Technology Utilization Program exclusive of the eight industrial applications recommendations resulting from the Ranger Block III Study.

These Flash Sheet drafts are currently being processed by NASA preparatory to NASA Headquarters decision for conversion to NASA Tech Briefs or other forms of dissemination. Of those for which processing has been completed, a high percentage has been selected for publication and dissemination as NASA Tech Briefs.

5.2 FLASH SHEETS OF POTENTIALLY GREATER PUBLIC SIGNIFICANCE

While it has been indicated that most of the material contained in the flash sheets generated by NSL under this program will be expeditiously disseminated by NASA to American industry and business, thereby proving the effectiveness of the NSL approach and concept, Northrop considers that the innovations described on some flash sheets are of potential vital importance to the nation; and as such, warrant individual discussion in this report. Recommendations are included.

5.3 EXPERIMENTAL STUDIES FOR THE DETECTION OF PROTEIN (WOO Flash Sheet Number pending)

The technical report "Experimental Studies for the Detection of Protein in Trace Amounts" by Dr. R. E. Kay reveals a method for the analysis of biological macromolecules by means of a dibenzothiacarbocyanine dye. In addition, the report deals with some of the factors affecting the dye-macromolecule interaction and a survey of compounds that form a dye-complex. The dye-complex affords not only an extremely sensitive detector of certain types of molecules, but also provides information on the molecular structure based on the absorption maxima of the complex.

In view of the distinctive features of this dye, the application of this method for the measurement of specific compounds in the fields of biological and medical research is of primary importance. The detection of trace amounts of such macromolecule dye complexes by spectrophotometry presents a possibility of a new method of detecting abnormal blood, serum, tissue fluid and tissue changes which may become a method of laboratory diagnosis of disease and perhaps a method of detecting cancerous cells much earlier than is currently possible. For example, an increase in nucleic acids in body fluids due to the presence of cancer cells and their metabolic products with the concomitant increase in nuclear size and degree of DNA (deoxyribonucleic acid) saturation may possibly be recognized early by such tests.

Some recommended areas of investigation for the immediate application of the thiaocarboycyanine dye technique are listed below:

a. Quantitation of nucleic acid metabolizing enzymes in tissues and urine.

b. Exploration of the differential staining of micro-organisms and cells.

c. Analyses of albumins and globulins in spinal fluid.

d. The measurement of microproteins in urine in various disease states.

e. The staining of proteins fractionated by paper or cellulose acetate electrophoresis for subsequent quantitation.

f. Methods of detection and measurement of nucleic acids, proteins or polysaccharides that have been fractionated by chromatographic techniques.

g. A method for measuring growth of micro-organisms under variable environments.

The approach to the development of methods for the qualitative and quantitative analysis of compounds will entail a combined effort involving both basic and applied research. The definition of the variables and the experimental conditions in the development of accurate, reproducible and routine tests for specific compounds or classes of compounds will require investigations of the chemistry of the dye-macromolecule complexes. From these studies, specific tests can be devised and applied as diagnostic tests, as methods to study biological processes or in clinical investigations.

5.3.1 Recommendations

The potential magnitude of this innovation cannot be overemphasized. It is recommended that NASA initiate immediate action to implement a feasibility study for the exploration of the utility of thiacarbocyanine in clinical microchemical analysis. Since this effort would be directly related to the detection of abnormalities in astronauts due to radiation, direct sponsoring by NASA may be appropriate.

If direct sponsorship by NASA is not considered appropriate, it is recommended that NASA work through other government agencies to implement the expeditious exploitation of this discovery.

5.4 BIOCHEMICAL BATTERY FOR USE AS A MEDICAL DIAGNOSTIC TOOL - (WOO Flash Sheet Number Pending).

This flash sheet was prepared as a result of attendance of the NSL Technology Utilization team at the NASA/UCLA Technology Utilization Symposium (Reference Appendix C, Workshop E.) The contractor was conducting research to determine if measureable amounts of electrical energy from a biochemical cell (bacterial action) could be used in connection with the detection of extraterrestrial life.

The device used was described as a container separated into halves by a membrane. One section of the device contained selected bacteria in a suitable culture media while the other side contained an electrolyte. The present or exhibitted charts describing progress in terms of measureable electrical energies. It was observed that the type of bacteria used for most of these experiments was E. coli. At the close of the presentation, a Northrop representative questioned the speaker regarding the use of E. coli for this purpose, and if other form of bacteria life produced different electrical energy characteristics. The presenter replied in the affirmative.

The Northrop Technology Utilization Team believes that the research activity described by the contractor may form the basis for a valuable diagnostic tool in the practice of medicine.

The implications were summarized as follows:

a. Present methods used to identify bacterial agents in the diagnosis of disease usually require a smear and culture procedure which may take up to seventy-two (72) hours. This amount of time is excessive in the case of fulminating diseases such as, meningitis, tetanus, or diptheria because heroic treatment of the patient must be started immediately. This has compelled doctors to employ a "shot gun" approach, administering massive doses of combinations of antibiotics in the hope that one of them may be effective against the causative unidentified disease agent.

b. It appeared possible that the biochemical battery could be used in reverse for the purpose of making quick and positive identification of bacterial agents by the recording of voltage or current curves as produced by various bacteria. It may be possible that a bacteria or group of bacteria would produce characteristic measureable currents which would readily identify that particular bacteria or group.

c. The biochemical battery may also be useful to quickly determine which antibiotic agent is most effective against a certain unknown bacteria. This might be accomplished by innoculating the cell with a sample of the suspect bacterial agent from a diseased person into the battery, observing the rise of an electrical energy pattern using an electrographic recorder, and then adding a selected antibiotic to the culture. The resultant decline in energy reading or pattern change therefore might serve as an indication of the speed and effectiveness of the selected antibiotic.

d. It appeared possible that the fast identification of bacteria by use of the biochemical battery may be extended to include other micro-organisms such as; Rickettsia, PPLO, viruses, fungi, protozoa, and other pathogens. Upon receipt of the subject flash sheet from NSL, the NASA-WOO Technology Utilization Officer scheduled a meeting with NSL Technology Utilization representatives and the applicable contractor to establish the feasibility of the concept. The contractor concurred with the translation.

It is recommended that NASA take prompt action to assure that appropriate and objective research is undertaken specifically toward the use of the biochemical battery as a medical tool.

5.5 SOLAR CELL TECHNOLOGY

Innovations which are described in the following five flash sheets are being discussed under one general heading because they are interrelated, developed by the same cotractor and have relatively equal technology utilization application. These innovations were not reported in one basic flash sheet because the invention disclosures, from which the information came, were obtained at various times and reviewed over a period of five months.

a. Technique for the Growth of Single Crystal Films on Foreign Substrates. (WOO Serial No. -076) (Case No. 1841)

This flash sheet resulted from a review of an invention disclosure describing a technique to provide for the growth of single crystalline semi-conductor films on a substrate. The film material in this case was germanium and the base material was molybdenum. The germanium film is evaporated onto a molybdenum sheet and the temperature is increased so that the germanium is alloyed into the molybdenum below the molybdenum melting point. A second germanium evaporation is then alloyed, but at a somewhat lower termperature. Finally a germanium layer is evaporated onto the alloy which can be melted without appreciably reacting with the alloy. Thus, the germanium film can be melted and recrystallized into single or large crystalline film by established techniques. The described technique could therefore be used in the development of large area solar cells.

b. Fabrication Technique - Large Area Solar Cells (WOO Serial No. -099) (Case No. 1964)

This flash sheet was generated as a result of a review of an invention disclosure and describes a method of mounting a single layer of semiconductor particles in a form suitable for making solar or electro-luminescence cells. The significance of this innovation is three fold; one, a reduction

in the fabrication cost of the cell itself and two, by using larger cells, a reduction in assembly time and three, by reducing the number of parts and connections in the panel a greater efficiency and reliability can be obtained.

c. Vapor Deposition of GaAs Films to Polycrystalline Manganese. (WOO Serial No. -105) (Case No. 1328)

The invention disclosure discussed on this flash sheet describes a method of vapor depositing crystalline films of GaAs on suitable substrates. Thin evaporated manganese layers, in this case, provide the suitable substrate. GaAs films grown to such substrates have been found to be comparable to those deposited on evaporated germanium. The technique described in the invention disclosure has been successfully used to produce large area, thin, continuous films of P-type GaAs.

d. Control of Doping (in semi-conductors) by Side Reactions. (WOO Serial No. 111) (Case No. 1961)

The invention disclosure which generated this flash sheet is directly related to the growth or deposition of single layer crystalline films on a substrate and illustrates a method of controlling the doping of semiconductor crystals which are grown by transport reactions. An extension of the techniques described, has the advantage in that a semiconductor deposit can have its conductivity type changed or programmed without stopping the crystal growth process so that the N&P layers are epitaxial with respect to each other.

e. A Method of Reducing Leakage in Polycrystalline Junction Devices (WOO Serial No. 110) (Case No. 1957)

The flash sheet generated from this invention disclosure describes a method of interposing insulating elements into paths where excessive currents flow in polycrystalline junction devices, by evaporating on a semi-conductor layer, a

metal layer, where the metal layer will form a rectifying barrier with single crystals of the semi-conductor and the metal layer can be converted to a continuous insulating layer by anodic oxidation. The process described should improve the rectification efficiency of polycrystalline junction devices and would, in all probability, be applicable to the fabrication of large area solar cells.

5.5.1 Recommendations

There are many potential uses for economical and efficient solar cell power systems that yield 1 kilowatt or more of electric power. The fabrication of large solar cell arrays, however, is both difficult and costly principally because of the small size of the cells. The methods and techniques described on the flash sheets noted above may resolve some of these problems, which currently precludes a wide utilization of this type of power system in commercial applications.

It is, therefore, recommended that NASA, in order to promote and expedite the commercial development of solar cell power systems, consider the preparation and issue of a Technology Survey on the subject: "Semi-Conductor Solar Energy Systems."

5.6 FLASH SHEET DRAFT SUPPLEMENTARY DATA

During the early weeks of the NSL Technology Utilization effort, WOO team members held several discussions with NASA representatives from both Headquarters and WOO regarding the preparation of flash sheets. Although no specific ground rules were derived, NSL interpreted the discussions as follows:

a. The Industrial Applications Flash Sheet (NASA Form 666) would be the method of communicating detected items of new technology from NSL to NASA.

b. NSL's primary objective was to detect the existence of new technology and report to NASA accordingly. Additional research or follow-up actions required to develop a Tech Brief would be done by other agencies or NASA contractors.

During a subsequent Program Summary presentation, NASA Headquarters representatives indicated that some NSL generated flash sheets did not contain sufficient information to facilitate complete review and Tech Brief preparation. In addition, NASA Headquarters did not have research or follow-up capability required to provide complete data. The following was determined:

a. Some of the most significant flash sheet items have resulted from the review of a single summary status report, often no more than ten to fifteen pages in length. The extraction of new technology, in many cases, has been made from a few lines or a short paragraph from such reports. It is not always possible, without obtaining additional documents and performing additional research, to generate a flash sheet containing all data needed for subsequent review at various government and research institute levels.

b. It was the policy of the WOO Team to request additional documentation required in order to thoroughly evaluate a detected item of new technology. The availability of these documents have been limited to those which can be found in the local WOO Library. In many cases, additional information could not be made available on a timely basis.

c. It had rarely been possible for the NSL Technology Utilization Team to make even indirect contact with the NASA contractor involved with the new technology.

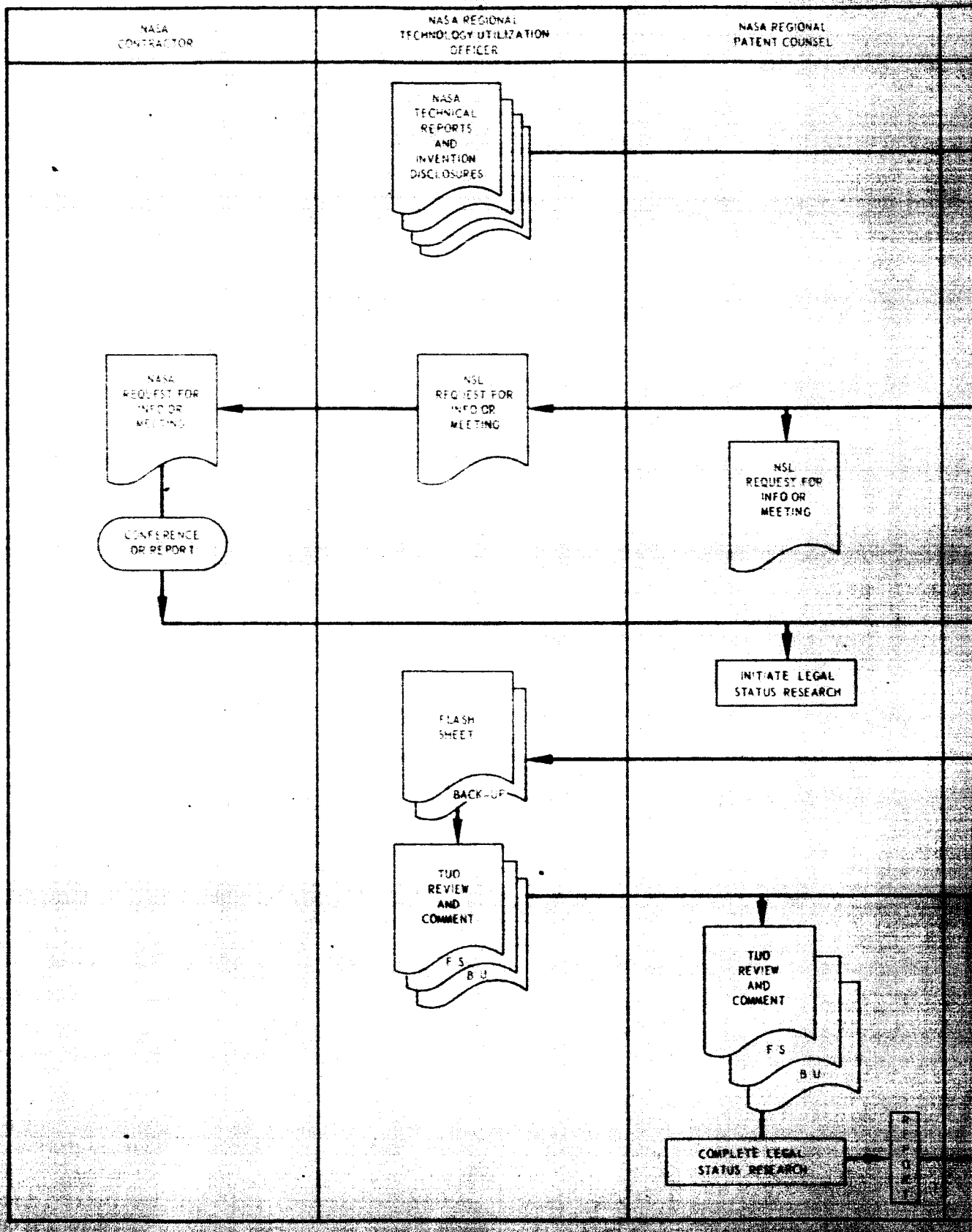
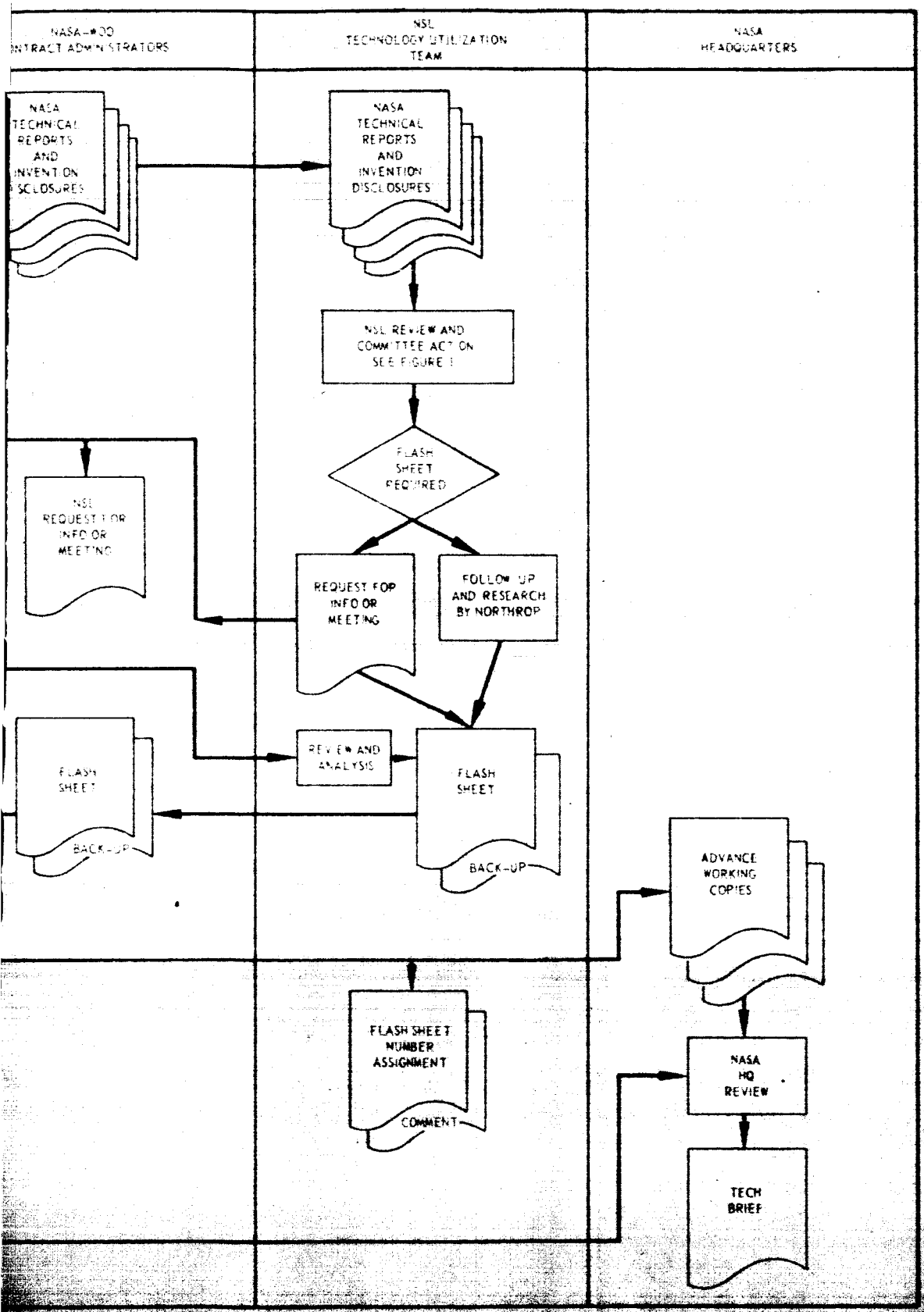


FIGURE 2 . . . FLASH SHEET DOCUMENT FLOW DIAGRAM


NASA-*OO
NTRACT ADMINISTRATORS
NSL
TECHNOLOGY UTILIZATION
TEAM
NASA
HEADQUARTERS
NASA
TECHNICAL
REPORTS
AND
INVENTION
SCLOSURES
NASA
TECHNICAL
REPORTS
AND
INVENTION
DISCLOSURES
NSL REVIEW AND
COMMITTEE ACTION
SEE FIGURE 1
FLASH
SHEET
REQUIRED
NSL
REQUEST FOR
INFO OR
MEETING
REQUEST FOR
INFO OR
MEETING
FOLLOW UP
AND RESEARCH
BY NORTHROP
FLASH
SHEET
BACK-UP
REVIEW AND
ANALYSIS
FLASH
SHEET
BACK-UP
ADVANCE
WORKING
COPIES
FLASH SHEET
NUMBER
ASSIGNMENT
COMMENT
NASA
HQ
REVIEW
TECH
BRIEF

d. While it was very desirable for the NSL team to conduct the intensive research and follow-up which would facilitate the amplification of flash sheets, page count reading requirements under the terms of the current fixed price contract precluded this effort.

Pursuant to NSAS Headquarters expressed desire for the NSL Technology Utilization Team to accomplish the required actions relative to providing additional information on flash sheets, it is recommended that NASA implement a flash sheet processing procedure similar to that suggested in Figure 2.

5.7 TECHNOLOGY UTILIZATION TEAM CONCEPT

Northrop considers that the essential element of an effective technology utilization review and analysis program is the high quality coverage of all technological areas, coupled with efficient intercommunication among personnel representing these areas. This concept is probably the most significant factor which contributed to the success of NSL's participation with the NASA Technology Utilization Program. This was especially true relative to the operation of the Technology Utilization Applications Committee. While much has been written in connection with identification of new technology, it was often clearly brought out in the committee proceedings that application of new technology is an integral part of the identification process. In many instances, the committee was able to arrive at a novel applicability of an element of new technology, which in turn resulted in not only expansions on the original identification, but in additional identification of other items of new technology. Such extensive cross fertilization of ideas by interdisciplinary team action is considered to be a basic requirement to an effective transformation process.

Some additional factors appear to have contributed to the team concept operation. One was the selection of an office facility in close proximity to NASA-WOO which afforded a closely knit communicative atmosphere, free from distractions, and prompt access to the

NASA-WOO Technology Utilization Officer and the Technical Library. It is also apparent that an advantage was realized through having both the WOO and JPL Technology Utilization teams placed in adjacent quarters. The mutual support derived by each team had the effect of extending the depth of technical knowledge without reducing the productivity of either team.

It is recommended that a team concept be employed by NASA in its Technology Utilization Program activities wherever practicable.

5.8 SYSTEMS APPROACH

A portion of the current NSL Technology Utilization effort was devoted to a study to determine the most appropriate subject matter for dissemination through the medium of Technology Utilization Workshops, (Task IV). The study resulted in conclusions directly responsive to the requirement, and in doing so, brought forth a philosophy which would seek to first determine the public or industrial need for advances or improvements in urban living conditions, and then attempt to fit technological innovations or advances from the space programs to those particular needs. Critical aspects connected with everyday modern living were pointed out in such areas as health, water supply and purity, waste disposal, mass transportation, etc., to which technological advances borne of the space programs could possibly contribute or alleviate. This resulted in the development of the concept of a "Systems Approach" to Technology Utilization. Simply stated, this concept offers the suggestion:

> Instead of searching for items of new technology and then attempting to find applications for them, analyze public problem areas to determine needs and then fit various space space program technological advances to those needs.

This concept was also offered by a participant on the panel of a round table discussion on the dissemination and use of new technology at the NASA/USCL Technology Utilization Symposium, 2 June 1964.

In response to these suggestions, the NASA-WOO Technology Utilization Officer initiated with the NSL Technology Utilization team, a schedule of three meetings per week of an Interdisciplinary Committee whose objective it was to seek out and analyze the critical areas within urban living and to match them with current or completed research and development efforts connected with the space programs. Although the Interdisciplinary Committee was in being only a few weeks, results were encouraging.

It is believed that this activity could be extended to include intensive research into areas which, from the results of preliminary investigations, appear to show promise of significant Technology Utilization application. This would include analyses of space program research projects at or near their inception to determine their potential for producting technological advances previously identified as being needed to resolve or alleviate a condition of wide public concern. Such analyses would allow the NASA Office of Technology Utilization to closely monitor the progress of selected programs and to begin the transformation or dissemination process immediately after the Technology Utilization potential objectives had been met.

5.9 APPLICATION OF THE TECHNOLOGY UTILIZATION CLAUSE

NSL's experience with the NASA Technology Utilization Program suggests that the implementation of some actions and requirements at the outset of a space project could serve to significantly increase the effectiveness of new technology analysis programs, and with less detailed review by NASA or TU contractors, of contractor reports and documentation. This could be accomplished by placing emphasis on the Technology Utilization aspects of a space project through a more selective application of the Technology Utilization clause.

5.9.1 Recommendations

a. Analyze precontract work statements to ascertain the extent to which the Technology Utilization clause should be applied. This analysis would be based upon the amount of new development involved in relation to guideline criteria relative to areas of Technology Utilization application.

b. Require prospective contractors to submit Technology Utilization Program Plans with their proposals. The plan would indicate areas where new technology might develop and methods, schedules, etc., to be used in determining and reporting innovations.

c. Indicate to prospective contractors that the Technology Utilization Program Plan will be evaluated as a part of a proposal and will be a factor in making the award.

d. Furnish contractors with basic criteria relative to the accomplishment of an effective Technology Utilization research and reporting program.

5.10 NASA-WOO LIBRARY

A recent survey of the NASA-WOO Technical Library indicated that there were 5167 contractor reports and 1135 grant reports on hand. In addition, of the 264 contracts under WOO cognizance having report requirements, one third (88) require monthly reports, one third require monthly and quarterly reports, and one third require quarterly reports. These requirements result in the receipt by WOO of contractor technical progress reports at the average rate of 205 per month. This does not include the receipt of reports resulting from NASA research grants.

It is recommended that Technology Utilization review emphasis be maintained on NASA contract documentation to include reports, resulting from NASA grants.

5.11 TECHNOLOGY UTILIZATION SYMPOSIA

Under the terms of Task 4 of the contract, as amended, the NSL Technology Utilization Team attended the NASA/UCLA Technology Utilization Symposium on 2 June 1964, for the purpose of reviewing the overall activity and preparing a critique covering the event. (See Appendix C.) Subsequently, the NSL Team reviewed, under the provisions of Task 2, the accounts of the symposium proceedings and presentations relative to the symposium. Reports covering the reviews of Task 2 were submitted to NASA.

In addition to the conclusions and recommendations offered in the NSL report covering the conduct of the symposium (Appendix C), it is recommended that NASA consider the use of an experienced contractor activity, such as the NSL Technology Utilization Team, to support the preparation, coordination, and conduct of future symposia.