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Prepared for
Manned Spacecraft Center
National Aeronautics and Space Administration
Houston, Texas

C66-00697

Contract No. NAS9-3140

Accession No. 04756-65

SID 65-500-2A

CLASSIFICATION CHANGE
CLASSIFIED
Authority of GDS-GP-4 Date 12/74
Signed by L. Shirley
Classified Document Master Control Station, NASA
Scientific and Technical Information Facility

EXTENDED APOLLO SYSTEMS UTILIZATION STUDY

ADDENDUM 1

Final Report

Volume 2. Experiment Analysis and Requirements

Part I: NASA Flights (U)

5 May 1965

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(NASA-CR-158551) EXTENDED APOLLO SYSTEMS UTILIZATION STUDY, ADDENDUM 1. VOLUME 2: EXPERIMENT ANALYSIS AND REQUIREMENTS. PART 1: NASA FLIGHTS Final Report (North American Aviation, Inc.) 309 p
N79-77449
Unclas
00/12 26218
FACILITY FORM
(PAGES) x12
(CODE) 12
(NASA CR OR TMX OR AD NUMBER) CR-70446
(CATEGORY) 31

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FOREWORD

This document constitutes a portion of the final report (SID 65-500) for Addendum 1 of Contract NAS9-3140, Extended Apollo Systems Utilization Study, dated 6 July 1964, prepared by the Space and Information Systems Division of North American Aviation, Inc. The analyses described herein and in the volumes listed below were conducted under the direction of the National Aeronautics and Space Administration's Spacecraft Center as an addendum to the basic contract which included the Apollo X Study (SID 64-1860) and the Prolonged Missions Study (results to be published later). This final report has been prepared in a series of five volumes as follows:

1. Summary

2. Experiment Analysis and Requirements

   Part I: NASA Flights
   Part II: Air Force Flights
   Appendix A. NASA Experiments
   Appendix B. Air Force Experiments
   Appendix C. Mission Scheduling Computer Printout for NASA Flights

3. Configuration Analysis and Experiment Accommodation

   Appendix A. Engineering Drawings
   Appendix B. Air Force Missions

4. Subsystems Analysis

5. Development Planning

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TECHNICAL REPORT INDEX/ABSTRACT

ACCESSION NUMBER	DOCUMENT SECURITY CLASSIFICATION
04756-65	[redacted] C

TITLE OF DOCUMENT	LIBRARY USE ONLY
EXTENDED APOLLO SYSTEMS UTILIZATION STUDY ADDENDUM 1, FINAL REPORT, VOLUME 2, PART 1 (U)	
AUTHOR(S) H. P. BURNS, J. BATES, J. M. ALTMAN, S. L. TALLMAN, N. H. BLITCH	

CODE	ORIGINATING AGENCY AND OTHER SOURCES	DOCUMENT NUMBER
	S&ID, NAA	SID 65-500-2A

PUBLICATION DATE	CONTRACT NUMBER
6 MAY 1965	NAS9-3140

DESCRIPTIVE TERMS

APOLLO EXTENSION SYSTEMS, SPACECRAFT/EXPERIMENT INTEGRATION, BLOCK II APOLLO, BLOCK IIA APOLLO, APOLLO X, APOLLO MODIFICATIONS, CONFIGURATION C, CONFIGURATION D, CONFIGURATION 1, CONFIGURATION D', RACK, PALLET, AUXILIARY MODULE

ABSTRACT

This report defines the design characteristics of four potential extended mission Apollo spacecraft designed to specific NASA mission and configuration requirements. All configurations are for Earth-orbital missions, which include low inclination, polar, and synchronous orbits and comprise a total of 15 NASA missions.

The four configurations studied present various degrees of modification to the Apollo Block II CSM. Configuration 1 is employed for 14-day missions and requires minimum modification. It may be used with either an experiments rack or pallet or both. Configuration C is identical to the Apollo X CSM and is utilized with an experiments rack for durations of up to 45 days. Configuration D is essentially a Block II CSM, with subsystems for life extension installed in the experiments rack. Additionally, an experiments pallet may be installed in the Configuration D CSM. Configuration D' is for 30-day missions and uses the Block II CSM as a baseline, similar to Configuration D. Early schedule requirements, however, dictate the prototype modification of critical subsystems in Configuration D' in order to meet the 30-day mission requirement.

The capability of each configuration was measured against the requirements dictated by 15 NASA-derived experimental packages. Additionally, the Air Force MOL experiments were examined and optimally grouped in a minimum number of flights. It was found that all NASA missions could be accommodated within the capabilities of the applicable configurations with certain revisions to experiment operation and/or mission duration to meet launch vehicle payload limits. All Air Force experiments could be accommodated in five flights.

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PREFACE

Over the past two years, a number of investigations have been performed to determine the characteristics of modifications required to extend the orbital duration of the Apollo spacecraft for alternate mission applications. Initial studies examined system characteristics for application as a 120-day Earth-orbital laboratory vehicle. Because of this extended duration, it was necessary that advanced subsystem concepts be employed in several cases to remain within the payload capabilities of the Saturn IB launch vehicle. Subsequent studies determined the characteristics of the Apollo CSM assuming restriction to use of only current Apollo subsystems concepts. Under this restriction, it was found that the Earth-orbital duration capability of the CSM was limited to approximately 90 days because of Saturn IB payload limits.

The recently concluded Apollo X study examined in depth the CSM characteristics and modifications required to perform NASA near-term missions of interest. These missions included both extended Earth-orbital and lunar-orbital mission durations of 45 and 34 days, respectively. Concurrent with the Apollo X study, separate contractors were examining the characteristics of: (1) the LEM ascent stage modified for use as an experiment module, and (2) an experimental laboratory module of new design.

Since the conclusion of the Apollo X study, several configuration innovations have been conceived by NASA which could warrant inclusion in the Apollo Extension Systems (AES) program. Two of these innovations take the form of experimental modular appendages and are identified as a "rack" and a "pallet"; the rack could be used in place of the modified LEM or a new laboratory module, and the pallet could be installed in the empty bay (Sector I) of the service module. Using these modular appendages, the alternate mission capability of the Block II Apollo could be increased through the addition of experiments as well as subsystems required for mission life extension beyond 14 days. It became apparent that further studies were warranted relative to (1) the comparative operational effectiveness of the various experimental appendages, and (2) the possible methods for extending the orbital duration capability of the CSM. The method selected to achieve orbital-life extension could actually result in varying degrees of CSM changes—depending upon the subsystem extension philosophy implemented.

A matrix of configurational approaches could readily be defined as only partially indicated in the accompanying chart, AES Concepts (Figure 1), with corresponding variations in costs, schedules, and operational capabilities. Therefore, in order to evaluate the characteristics and capabilities of each of the

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CSM CONFIGURATIONS	EXPERIMENTAL APPENDAGES		
	S&ID	GRUMMAN LEM A/S	BOEING LAB MODULE
I BLOCK II	RACK EXPERIMENTS ONLY EXPERIMENT PALLET	EXPERIMENTS ONLY	EXPERIMENTS ONLY
C APOLLO-X	RACK EXPERIMENTS ONLY	EXPERIMENTS ONLY	EXPERIMENTS ONLY
D BLOCK II MODIFIED	RACK EXPERIMENT AND SUBSYSTEMS EXPERIMENT PALLET	EXPERIMENTS AND SUBSYSTEMS	EXPERIMENTS AND SUBSYSTEMS

Figure 1. AES Concepts

possible combinations, parallel AES studies were initiated by NASA. S&ID was responsible for evaluating the characteristics of the CSM, rack, and pallet; Grumman and Boeing conducted separate studies of the LEM experimental module and new laboratory module design, respectively. The results of the three contractor studies were to be in a form such that the design and development characteristics of all possible system elements could be assembled by NASA into complete configurations and development programs of their own choosing.

The S&ID study was concerned with the examination of several basic configuration approaches, each of which represents varying degrees of Block II CSM modification, experimental capability, operational complexity, and program costs. These configuration approaches are defined as follows:

CONFIGURATION 1

By NASA definition, Configuration 1 is essentially the Block II CSM—without major changes, but with the addition of an experimental pallet (in SM Sector 1) and/or an experimental appendage (rack or laboratory module) docked to the CM during orbital operations. Orbital life is necessarily limited to 14 days or less since changes to the CSM subsystems are precluded. Subsystems support for the experiments—except for those in the pallet—is provided by the CSM.

CONFIGURATION C

Configuration C is identical to the CSM approach derived in earlier Apollo X studies where mission life extension to 45 days was achieved through

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the addition (in the CSM) of expendables, spares, and redundancies of Apollo Block II subsystems. Since the service module Sector 1 is occupied by subsystems in this approach, the pallet does not apply here. However, the rack or either of the laboratory modules would be included. As in Configuration 1, support of the experiments housed in the rack or laboratory module is provided by the subsystems located in the CSM.

CONFIGURATION D

Configuration D was to be based upon use of the Block II CSM with minimum modifications, in combination with an experiments/subsystems rack or laboratory module and with a pallet if required. Experiment support is provided by the CSM subsystems during the first 14 days (approximately) of orbital operation, after which subsystems life extension provisions installed on the (experimental appendages) would provide support both to the CSM and the experiments for the remainder of the 45-day orbital duration. By definition the subsystems installed on or in the experimental appendage were to be of the type defined under the prior Apollo X study; these included, for example, extended life fuel cells with in-space start, new cryogenic tankage, etc. During the early phases of the study, the Configuration D approach was modified through mutual agreement by NASA and S&ID at a series of weekly interface meetings. As a result, additional Configuration D ground rules were —of necessity—formulated which yielded a configuration that does not absolutely adhere to the requirement that the Block II CSM remain unchanged. More explicitly, revised Configuration D ground rules resulted in the installation of only the power system life-extension capability on the external device.

CONFIGURATION D′

Additionally, a requirement for one early 30-day mission (Flight 211), dictated the establishment of a unique approach—which was identified as Configuration D′ by S&ID. This configuration is similar to Configuration D with respect to subsystem location and general arrangement. However, in Configuration D′ the mission life-extension is provided by the use of only Block II subsystems that are "stretched" through prototype modifications to accomplish the required 30-day mission. The cryogenic storage system included on the rack, for example, is comprised of multiples of Block II cryogenic tanks rather than of the new and larger tanks defined in the Apollo X study.

A summary of characteristics of the four configurations of interest is presented in Table 1. A detailed definition of the vehicle and subsystems ground rules for each configuration may be found in appropriate volumes of this report.

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Table 1. Configuration Characteristics

		Configuration 1 (14 Days)	Configuration D' (30 Days)	Configuration C (45 Days)	Configuration D (45 Days)
Command Module	Structure Subsystems LiOH and crew systems Umbilical to rack	Block II Block II 1 day	Block II Block II modified 1 day	Block IIA Apollo X 1 day	Block IIA Apollo X 1 day
Service Module	Structure Cryogenics Fuel cells RCS SPS tankage Sector I	Block II Block II Block II Block II Block II Empty or pallet	Block II Block II Block II Block II Block II LMS installation	Block IIA Apollo X 1000 hours As needed As needed EPS installation	Block II modified Block II Block II As needed Block II Empty or pallet
Rack (external device)	Cryogenics Fuel cells LiOH and crew systems	None None 13 days	Block II Block II modified 29 days	None None 44 days	Apollo X 1000 hours 44 days

The design approach for each configuration was based upon consideration of the application of a standard vehicle capable of performing the defined NASA missions and Air Force experiments. Additionally, CSM/external appendage interfaces were mutually defined among NASA, S&ID, Boeing, and Grumman such that the CSM for each appropriate configuration could be used alternately with either the rack, pallet, LEM laboratory or separate laboratory module without change. S&ID studies of the rack were also oriented toward providing a common rack design for all configurations and missions which would be capable of containing experiments, or experiments and subsystems as required.

The primary objective of the study was to define the characteristics and capabilities of various CSM/rack/pallet combinations as applied to experimental flight package and mission constraints defined by NASA. The actual grouping of each of 15 experimental flight packages was the responsibility of IBM under the direction of NASA. Consequently, S&ID's role in the NASA experiments area was limited to defining the configuration and subsystems requirements demanded by each of these experimental flight groupings as a basis for the experiment integration task. The Air Force individually specified experiments were integrated into similar, but separate, vehicles; however, the optimal grouping of these experiments—in order to minimize the number of flights required—was accomplished by S&ID.

In order to assess the cost and schedule ramifications attendant upon each of the matrix considerations, development planning studies were performed based upon the NASA defined launch schedule (AE 65-1), which entails a total of 28 manned AES flights through the first quarter of 1972.

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INTRODUCTION

The objectives of the experimental analysis part of the study were to: (1) demonstrate the operational compatibility of specified experiments with Apollo Extension System (AES) missions and performance parameters, (2) examine the feasibility of accommodating these experiments in specified AES configurations, and (3) conduct a preliminary integration analysis of assigned groupings of experiments on given flight missions.

The scientific or operational objectives, individual experiment designs, basic experiment groupings, and assignment of these groups to flight missions were specified by NASA for the series of 15 AES Earth-orbital flights considered. Design variations and engineering assumptions were allowed, within the overall constraint that there would be no deviation from NASA-specified experimental objectives. With the exception of relatively minor additions to NASA-specified "designs," this study has not included any significant experimental design effort. Physical accommodation was defined to the preliminary design level, as necessary, to confirm packaging and performance feasibility. Specified equipment data were applied whenever possible.

Standardization and minimum modification were sought throughout the study, which was conducted under the following broad ground rules:

- All flights are assumed to have three crewmen
- All flight groupings are to include the biomedical, behavioral, and radiation monitoring experiments specified by NASA.
- The experimental accommodation analysis sequence for each flight is as follows:

  1. If possible, place all experiments in the Command Module
  2. If Command Module volume is exceeded, attempt to accommodate the remainder of the experiments program on an experimental pallet carried in Sector 1 of the Service Module
  3. If still more space is needed, substitute the experimental rack for the pallet and again attempt integration
  4. If not feasible any other way, use both pallet and rack

- If any case is found to be weight-limited, or if other system limits prevent experiment scheduling, reduce experiment frequencies or flight duration while retaining maximum accomplishment of flight objectives. Experiments are to be eliminated only after other less drastic alternatives are considered.

A different basic approach was necessary in the case of integration analysis of the Air Force experiments, which were unspecified as to mission grouping or flight assignment. In this case, the S&ID study objective was to integrate the entire AF experimental program in a minimum number of launches with maximum mission accomplishment. A more specific discussion of the approach to integrating Air Force experiments in AES vehicles will be found in Part 2 of this volume with results of the analysis.

The integration analysis included parallel examination of subsystems design (reported in detail in Volume 4) and physical accommodation in various configurations (Volume 3). This document, Volume 2, presents the summary results of operational integration, to include the establishment of requirements, operational feasibility analysis and scheduling of experiments relative to crew time and system operations. By agreement with NASA, 11 of the 15 NASA AES flight missions were carried through the preliminary integration analysis level by S&ID. The other four missions were examined only to the extent necessary to establish preliminary accommodation and to provide interfaces between rendezvous flights.

APPROACH

The overall experiment integration study logic is shown in Figure 2. The specified experiments were received in a standard NASA descriptive format. Because the degree of definition of individual experiments varied considerably, it became necessary to reduce all experiments to data formats amenable to both technical analysis and computer scheduling. The Critical Interfaces Standard Format was utilized as the uniform tabulation from which equipment requirements and individual subsystems operating profiles were derived. Concurrent technical analyses of data management, controls, displays, and crew operations contributed to the derivation of system design factors which were applied in the computer scheduling analysis.

The product of the study can be termed (as noted in Figure 3) "Determination of Mission Feasibility." Such a product can consist of a simple yes or no statement — the value of which is based on the level of confidence with which the statement is made and on the depth of analysis.

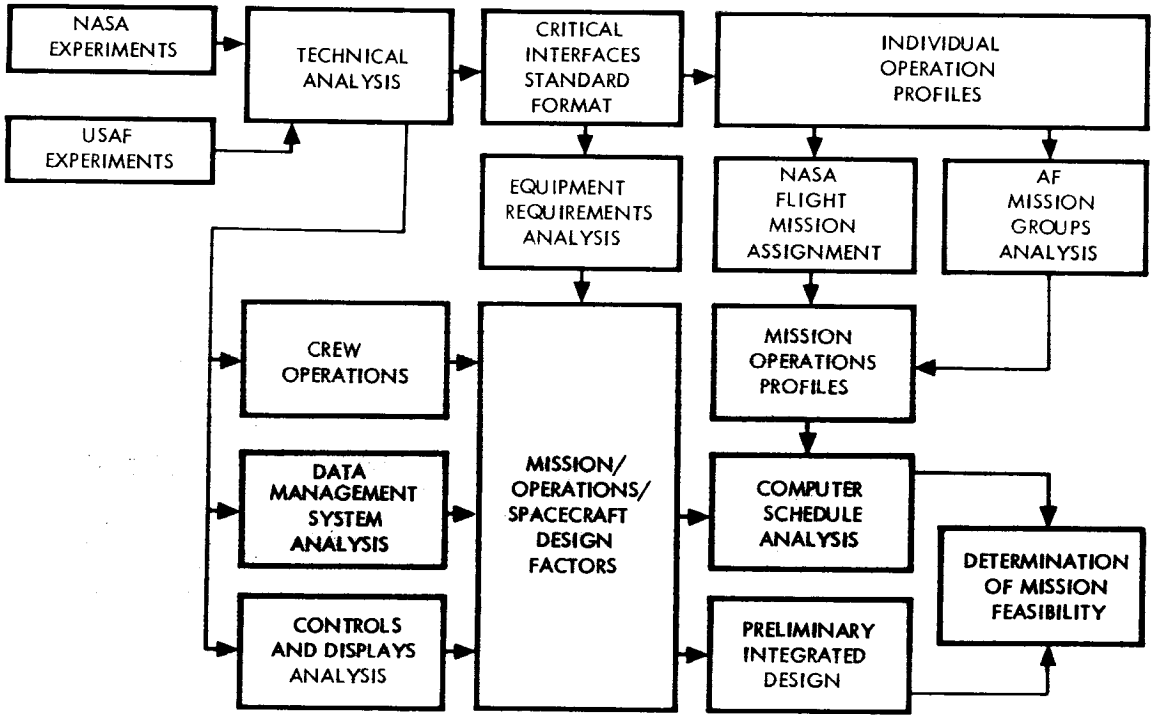

Figure 2. Experiments Integration Study

For the NASA study, a further product might have been a detailed analysis of the relative capability of various study configurations to accomplish some proportion of an assigned mission. However, because the defined missions tended not to challenge total experimental capacities, relative effectiveness in a purely experimental sense turned out to be either difficult to measure or not applicable. Data to support choices between study configurations, therefore, is generally limited to system and weight comparisons.

Several byproducts of the study were produced in the process of integration analysis. These are discussed in the following paragraphs.

STANDARD EXPERIMENT FORMATS

Before the Apollo Extension Systems (AES) experimental flights actually occur, many changes in currently defined experiment parameters may be expected. Existing spacerated equipment will be improved and new equipment will be developed. Manned and unmanned orbital flight programs will precede extended Apollo studies and will affect the basic requirement for scientific observation. The experiments themselves will be subject to increasing scrutiny and continuous redefinition. Under these conditions, the value of current experiment design varies not only with the representativeness of operational demands, but also with the consistency with which experiment data are applied among various comparison studies. To achieve this consistency and representativeness, a standardized tabulation of critical interface data, based on formats originally furnished by NASA, has been used during this study. The completed formats, in most cases incorporating engineering assumptions that were necessary to achieve completeness, are contained in Appendixes A and B. Data presented in these formats formed the basis for all spacecraft integration analysis.

SYSTEM OPERATING PROFILES

The first step in reducing experiment definitions to actual spacecraft operating requirements is the specification of time-sequenced operating profiles for each critical subsystem. During the preliminary integration phase of the current study, the effects of interaction between subsystems themselves could be considered only in the more obvious cases. Advanced integration will require complete analysis of such interactions. Because of the extremely compressed study schedules, conversion of individual subsystem profiles to a total mission profile was often handled by assuming an average level of subsystem operation, rather than use of a detailed profile. Although this made it possible to expedite completion of the integration analysis, it is also believed to have resulted in generally conservative estimates.

This problem is strikingly illustrated by the case of the power subsystem profile of Flight 215. This mission was re-run in the computer scheduling program, using detailed task power profiles on the second run. When so scheduled, a significant decrease in estimated power demand resulted. It is possible that advanced integration studies, undertaken with better experiment definition and incorporating more sophisticated subsystem interactions and detailed profiles, will continue to reflect general decreases in experimental demands.

The system operating profiles applied during this study are included, when pertinent, in each flight mission section. As mentioned previously, considerable difficulty was encountered in the conversion of individual experiment operating profiles for each subsystem to a mission profile, which accurately reflected task requirements on a time-sequenced basis. Although the logic for mission integration of task profiles is clear, the number of integrations required at each scheduled time interval suggests that a computer program to handle the problem is essential.

An example of the complexity of relationships is afforded by the inclusion of G&N system power demand in a detailed task profile. If more than one task should be scheduled by the computer to occur simultaneously, only the G&N power increment for one of the tasks should properly be included. This, in turn, may affect the scheduling, and so on. Practically, it was necessary at this phase of integration methodology to provide manual conversion to mission profiles with resultant inaccuracies as well as higher costs of operation. The next phase of computer development, discussed in the next section, will provide more sophistication and may achieve the degree

of advanced integration necessary for determination of system experimental efficiency. It will be noted that the current study is considered to be limited to the third level, preliminary integration analysis, on the scale of integration phases shown in Table 2.

Table 2. Experiment/Spacecraft Integration Phases

Phase	Provides	Useful For
I. Preliminary accommodation analysis	Parametric feasibility	Conceptual planning
II. Advanced accommodation analysis	Operating feasibility Within system segments Parametric system capacities	Preliminary configuration selection & design
III. Preliminary integration analysis	Operating efficiency within total system under parametric mission cond Gross scheduling of experiment increments within overall system constraints	General system & mission planning
IV. Advanced integration Analysis	Operating effectiveness of total system experiment complex Detailed scheduling of system interactions & experiment interfaces Maximum use of total system experiment capacity for each experiment increment	Comparisons between systems
V. Experiment/ system integration	Hardware specs for each experiment flight increment Flight mission operati ns plans	Flight & production schedule

MISSION EXPERIMENT SCHEDULING

Multiple Activities Scheduling Technique (MAST) is a computer program developed by S&ID to schedule routine and experimental activities. This program insures reasonable allocation of crew time and automatically schedules all activities to obtain good use of subsystem capacities within imposed restraints.

Prior to automatic scheduling, all experiments and routine tasks are defined in terms of their demands on the system capacities. These capacities are related to design factors and include crew member availability, electrical power, thermal capacity, and availability of specified items of equipment. Routine tasks include such items as sleep, meals, hygienic functions, and recreation. MAST distributes all activities over a design factor-time-percent utilization cube so that the capacity of each design factor is never exceeded and the logical dependencies among tasks are respected.

Tasks are said to be either singular or repetitive. For repetitive tasks, the time of the initial execution, the number of repetitions, and the inter-repetition interval is to be specified. Singular tasks are those that are executed only once during the mission. Slack time may be assigned permitting the task to be scheduled to start within a prescribed interval after the specified start time.

Tasks may be divided into as many as six time segments to permit greater precision in the assignment of design factor loads, should these vary significantly during task execution. This feature also permits the combination of several tasks of short duration without the loss of detail. Because the execution of one task may require that other tasks be accomplished first, MAST permits the specification of up to five logical prerequisites for each task. The prerequisite tasks may themselves have up to five prerequisite tasks each. No task will be scheduled for execution earlier than all prerequisite tasks.

For some tasks, a particular requirement might be satisfied by imposing a load upon any of several design factors, depending upon which ones are available. A design factor set contains those that will meet a particular type of requirement equally well. If a certain task could employ any available crew member, this set would be specified. Another set might be that subset of the crew possessing particular qualifications. This feature of MAST permits fuller utilization of subsystem capacity by specifying the elements of a set to be equivalent in ability to satisfy certain requirements.

Experience with scheduling spacecraft activities has shown that most task items are of the repetitive type; hence, all tasks are treated as repetitive, with singular tasks having zero repetitions. From this experience, it is now apparent that most task items are of the fixed start-time variety; it is also evident that all items can be assigned a fixed start-time with slack time. For items that can be executed at any time during the mission, the specified start time is the first time unit and the slack time is the duration of the mission. For these items, the scheduled execution time depends only upon the system capacities, the loads imposed by the task, the logical prerequisites, and the priority value assigned the item. The general task item is treated as repetitive and fixed start-time with slack. The number of repetitions may be as small as zero (singular tasks), and the slack may be between zero and mission length.

Application of the scheduling program in this study demonstrated the feasibility of scheduling experimental missions for each flight and experiment group under consideration. Minor deviations that resulted from scheduling conflicts are described when they occur in each flight mission section. The complete mission scheduling printout for each flight mission appears in Appendix C.

DISPLAYS AND CONTROLS

The technical analysis of each experiment and experiment mission group included analysis of experimental control/display requirements and system constraints. Potential control/display approaches were examined in terms of state of development, availability, adaptability for AES use, user-acceptability, and functional redundancy.

Based on preliminary analysis, a trial control/display configuration was conceived for a single typical flight. This configuration was then reviewed for its ability to accomplish the control/display requirements of all other flights, with the aim of achieving standardization between flights and resultant benefits in cost reduction or efficiency.

Flight 209, the first of the series, was selected as the representative design example. Table 3 is typical of the analytical process used to establish requirements for each flight. Matching of the Flight 209 control/display panel and console design against the experimental requirements of all other flights established that only a minimum of electromechanical changes would, with extensive programming modification, achieve standardization. The conceptual integrated display configuration is shown in Figure 3.

The system incorporates a computer and cathode ray tube. The data processor is used as a display generator for the cathode ray tube, and to meet requirements for data storage and retrieval typical of the behavioral experiments series. Dissimilar presentation formats are used for the experiments. These formats can be modified along with total data displays by reprogramming the computer. Computer reprogramming is achieved by a data link either prior to launch or while in orbit. Parallel processors may be used. A simplified block diagram of an available system is shown in Figure 4. This system also provides for the potential input of operational subsystems data.

Table 3. Flight 209 Analytical Phase

Flight Number 209				
Experiment	Information Required	Display Required	Operation Required	Control Required
1501	Image of external activity (CCTV)	CRT video scan	Display select	Selector key
1502	Image of external activity (CCTV)	CRT video scan	Display select	Selector key
1503	Image of external activity (CCTV)	CRT video scan	Display select	Selector key
	Experiment malfunction	Matrix of legend lights audio alarm	Alarm reset	Toggle switch
0501	Rads per hour rads per cumulative Inductance Capacitance Particle movement	Digital readout or alphanumeric CRT display Circular meter Circular meter CRT trace	Display selection Display selection Display selection Display selection Display selection	Selector key Selector key Selector key Selector key Selector key
0100 series (21 total)	EKG trace EMG trace EEG trace	CRT trace CRT trace CRT trace	Display selection Display selection Display selection	Selector key Selector key Selector key
0111	Foot-pounds force	Torque on vertical scale indicator	Displacement of hand control; display/ function select	Three-axis hand control selector key
0202 (Task simulator)	Tracking trace and tracking blip per indicator	Sine wave trace and spot on CRT	Display/function selection Tracking sine wave	Selector key three-axis hand control
	Reentry format and related data Spot matrix	Analog and alpha-numerics on CRT Lights in matrix or matrix of CRT spots (blips)	Display/function selection Simulated reentry task Display/function selection Spot selection	Two 3-axis hand controls Selector key Electronic pencil or combined light switch data entry key

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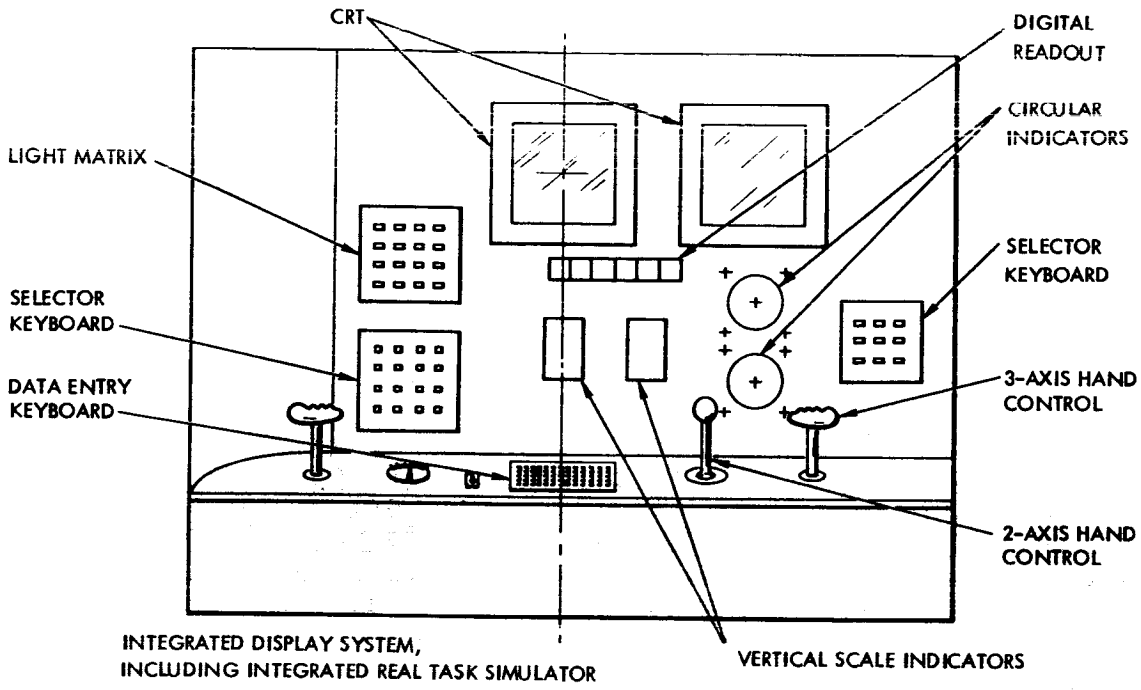

Figure 3. Integrated Display System

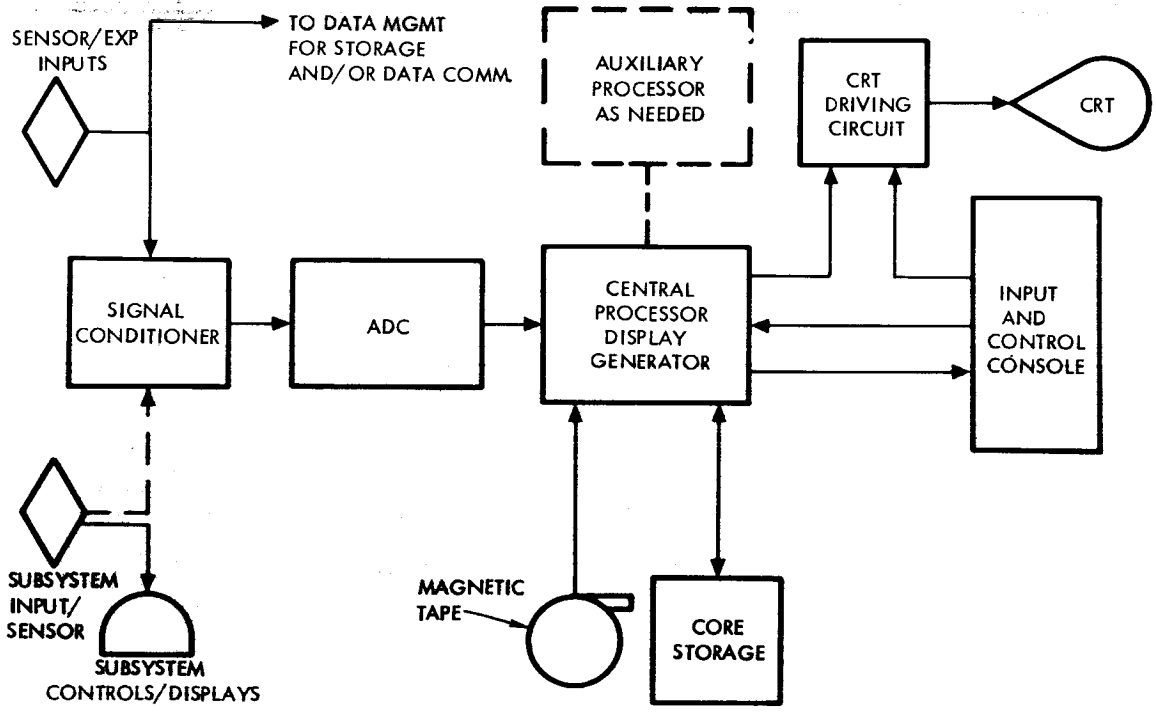

Figure 4. Simplified Functional Diagram Integrated Control Display System

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DATA MANAGEMENT SYSTEM

The pertinent functional requirements imposed upon the data system by the experiments determine the form of data (analog or digital), the amount of storage capacity required (feet of magnetic tape per experiment), and the total transmission minutes required per day. To arrive at this summary, each of the experiments selected for the mission was first analyzed to convert the measurements of scientific phenomena into data-handling requirements.

Form of data, dynamic range, accuracy, and bandwidths were all considered. Analog frequency response and the digital-bit rates required determined the tape speed. The quantity of tape was derived from the experiment data acquisition period. The experiment repetition frequency then determined the rate at which information must be collected, stored and transmitted to avoid overloading the data management subsystem.

A standardized data management subsystem is proposed for use with each of the NASA missions. This system is described in detail in Volume 4 of this report. The standardized data subsystem can simultaneously record nine analog continuous channels (frequency response 12.5 to 5000 cps) and one serial PCM-NRZ digital channel (51,200 bps). The recorder speed is 15 inches per second for a period of 30 minutes per reel of magnetic tape.

The analog-to-digital converter, multiplexers and programer of the standardized data management subsystem can be arranged to process a multiplicity of analog high-level, analog low-level, digital parallel, and digital serial input channels (described in Volume 4).

As an example, the system can digitally process 270 high-level analog channels and 50 low-level analog channels into eight bit words at sampling rates varying from 200 to 1 sample per second. The unit also includes a provision for processing 32 digital parallel inputs at sampling rates of from 200 to 1 samples per second and one 40-bit serial word at 50 samples per second.

In an alternate mode of operation, the standardized system can process and record nine analog continuous channels (frequency response 12.5 to 1250 cps) and one serial PCM-NRZ digital channel (1600 bps). The recorder speed is 3.75 inches per second for a period of 128 minutes. During transmission of this data, the playback tape speed is 120 ips when only digital readout is desired; this playback speed permits 120 minutes of recorded data to be transmitted to ground in a period of 3.75 minutes.

CREW OPERATIONS

The functions of the crew members in an orbital research laboratory are to operate and maintain the laboratory as a spacecraft, to maintain themselves as an important subsystem of the spacecraft/laboratory, and to implement the research program to the extent that this program will benefit from onboard human participation. In an experiment integration study, the crew functions of major interest are those derived from the crew members' role in the experiment program. However, it is also necessary to give attention to spacecraft operations and crew maintenance functions, if only because of their constraint upon time for crew research functions.

In analyzing and describing the operations which derive from the spacecraft management, personal maintenance, and experiment functions of the orbital spacecraft/laboratory crew, it is first necessary to describe the general operations which the crew members carry out. Following this general description, it is necessary to examine influence of configurations, systems, experiment design, etc. upon these operations as they are carried out in the missions under study. On the basis of general description and specific determinants of crew operations it is then feasible to arrive at realistic, if tentative, estimates of crew operation time requirements.

In accordance with the experiment integration emphasis of the present study, it has not been considered necessary to initiate new investigations of crew operations associated with spacecraft management and personal maintenance. This being the case, only sufficient reference is made to these areas of crew operations to present more or less standardized procedures which would be compatible with configurations, systems, and missions within whose context the various experiments are integrated into various flights. However, it is safe to say that the individual experiments and associated equipment have been as thoroughly analyzed from a crew operations standpoint as the scope, duration, and organization of the present study would permit. It is furthermore safe to say that the principal limitation upon precision of definition of crew experiment operations has been the precision of definition of the experiments themselves.

TYPES OF CREW OPERATIONS

As noted previously, crew operations for all of the various flights break down into spacecraft management, crew maintenance, and experiment operations, of which the last category is of most importance in the present study.

Spacecraft management operations include launch operations, systems management, piloting, inflight maintenance, deorbit and entry, access, and abort. Crew operations during launch are expected to be largely confined to manual back up of certain automatic of ground controlled system functions. System management operations are those associated with initiation, checkout, monitoring, adjustment, and other routine attention to systems status and action. Piloting functions include attitude control, Delta V and such navigation operations as may be assigned to on-board crew responsibility. De-orbit and entry are those operations which take place from time of CM/SM/rack or LEM separation to landing. Access functions refer to general crew movement during the course of spacecraft management, personal maintenance, and (possibly) inter-vehicular transfer. Inflight maintenance includes such routine adjustment and replacement as may be required or allowed by spacecraft systems and such non-scheduled or emergency repair as may be allowed for the in-the-system design and reliability philosophy. Abort operations include a possible on-board manual back up for launch abort as well as emergency procedures associated with non-scheduled de-orbit and entry. These crew operations are described in greater detail in the individual flight mission sections of this volume. Crew operations associated with personal maintenance include sleeping, food preparation, eating, exercise, personal hygiene, waste management, and recreation. These are routine crew operations which are common to all flights, except as they may be modified by certain biomedical and human performance experiment requirements.

The crew operations required in and by the research program, i. e., directly associated with experiments, vary by experiment or groups of experiments. However, it is feasible to classify crew experiment operations into type categories. These categories of operations are defined in the following paragraphs.

Experiment Logistics

This category includes operations which are involved in preparing for an experiment or test session, tearing down equipment after an experiment or test session, or otherwise supporting actual data collection or observation phases.

1. Set-up, initial - Once per mission, assembly, preparation, and check out of experiment equipment.

2. Set-up, periodic - Assembly, preparation and check out of equipment before (usually) each test session or at other intervals.

3. Tear down, periodic - Disposition of equipment after (usually) each test session or at other intervals. Includes item storage.

4. Tear down, final - Disposition of equipment at end of mission or after last test session. Includes storage of items for Earth return.

5. Calibrate - standard usage.

6. Align - standard usage.

7. Pilot - Spacecraft control, e. g. attitude control, by a crew member in direct support of experimentation.

8. Extra-vehicular Activity (EVA) - EVA may be considered a standard type of operation even though the operations carried out therein may vary over experiments. As used herein, EVA presupposes an airlock and includes the following standard operational procedure:

Crewman #1 (C-1)	Crewman #2 (C-2)
a. Obtain, don, check out pressuresuit and PLSS	Obtain, don, check out pressure suit.
b. Enter airlock, pressurize suit, obtain tools, tether, etc.	Assist C-1; close internal airlock hatch
c. Depressurize airlock	Monitor C-1 and airlock
d. Open external airlock hatch	Monitor C-1 and airlock
e. Egress airlock	Monitor C-1 and airlock
f. Attach tethers, obtain, don, check out AMU	Monitor C-1 and procedure
g. Accomplish experiment task	Monitor C-1 and procedure
h. Release tether, store AMU	Monitor C-1
i. Ingress airlock	Monitor C-1 and airlock
j. Close external airlock hatch	Monitor C-1 and airlock

Crewman #1 (C-1)	Crewman #2 (C-2)
k. Pressurize airlock; depressurize suit; store tether, tools, etc.	Monitor C-1 and airlock
l. Open internal airlock hatch; leave airlock	Assist C-1
m. Doff, replenish, check, store pressure suit and PLSS	Doff, store pressure suit.

The above procedure is applicable to full EVA. "Partial" EVA, i.e. lean-out or reach-out without leaving the airlock would essentially call for steps a through d and g through m.

Data Collection

This category includes functions which are directly involved in the collection of data during an experiment session.

1. Apply equipment, self- Application of equipment to self where such application is a direct source of data, e.g. handling objects for tactile discrimination of shape.

2. Apply equipment, other - Same as item 1 to another crew member, e.g., bioelectronic sensors and leads.

3. Observe, self - Observation of own performance, sensations, etc.

4. Observe, other - Observation, primarily non-instrumented, of another crew member's performance.

5. Observe, direct, non-personnel - Direct observation, possibly assisted by an optical device, of status or behavior of an object or scene.

6. Panel operation - Control-display utilization from panel or console specific to experiment grouped equipment.

7. Observe, non-display - Direct read-off of data from a non-quantitative change, e.g. change in color of a solution.

8. Bio-sample, self - Obtain a biological sample from self, e. g. urine.

9. Bio-sample, other - Obtain a biological sample from another crew member, e. g. blood.

10. Subject - Cooperation in being observed by another crew member (or by ground support)

11. Bio-sample, process - Laboratory analysis of bio-samples.

12. Other, process - Processing of other than bio-samples as a data collection technique, e. g. processing an emulsion exposed to radiation.

13. Other - Any infrequently occurring crew function not covered by the above.

It should be noted that any of the preceding operations except No. 's 8, 9, and 11 could conceivably be in the EVA mode, i. e., constitute step g of the EVA operational procedure described under Experiment Logistics.

Data Handling

This category includes crew functions which are involved in the direct disposition of formating collected data.

1. Photo, etc. - Camera and TV recording of observed events.

2. Processing - Changing of data from its derived form to its form for disposition. Includes film processing, if any.

3. Direct transmit - Crew control of data transmission to Earth, e. g. real time voice, initiate tape play out.

4. Record - Log book recording of observed data. Log book recording includes voice-to-tape as well as written records.

SYSTEM OPERATIONS

Crew operations associated with the spacecraft system management are based on the following system assumptions:

1. The EPS is based on fuel cells, with auxiliary battery power for certain rack and pallet experiments and for CM reentry.

2. The ECS is based on active thermal control and the use of lithium hydroxide cannisters.

3. The RCS is a fuel and oxidizer system.

4. The SCS can mediate manual or automatic control of the RCS.

5. The G&N is Block II Apollo.

It is further assumed that neither crew safety nor mission success requires or could profit from constant duty station monitoring of system parameters, although occasional periods of such monitoring may be required in connection with certain experiments. For this assumption, it is necessary to postulate an auditory warning device to provide adequate warning of impending or actual system malfunction in time for any action required. With the elimination of constant monitoring as a required crew operation tasks associated with systems management will be reduced to periodic checks, adjustments, and other relatively short term actions.

PERSONAL OPERATIONS

Personal operations involve the utilization of spacecraft facilities to meet personal requirements. The spacecraft facilities thus utilized include the EPS, the ECS, the CES, the waste management system, and various storage facilities. It should be noted that the personal operations are not characterized by the simplicity and short-time actions of system management operations. In almost every case, personal operations require a relatively complex and often laborious interface with the spacecraft systems utilized.

EXPERIMENT OPERATIONS

Although the crew operations associated with the various experiments vary widely in detail from experiment to experiment, it is feasible to describe all of these operations to the individual task level under the crew operation categories described for the research program in the preceding section, of Types of Crew Operations. This analysis is done for each flight mission. Because the experiments were originally conceived and designed within the context of recognized epistomological areas, each with certain traditional characteristics of research operations, it is feasible to generalize brief crew procedural descriptions for disciplinary groups of experiments:

1. Medicine - This group of experiments is characterized by standary laboratory techniques of provocative testing and bio-sample analysis and observation. With a few exceptions, the usual

procedure involves experimenter and subject although the data derived are usually bio-logical and bioelectronic rather than direct observational.

2. Behavior - This group of experiments utilizes standard sensori-psychomotor-intellectual performance tests, most of which can be adapted to one-man performance utilizing a standardized console. The artificial gravity experiments may be considered as special cases of behavioral and medical experiments.

3. Living Organisms - These experiments seem to require technician-type crew operations similar to those of bacteriological or small animal study procedures.

4. Space Environment - These three experiments require a wide variety of operations including simple monitoring, operation of ejection devices, sophisticated observation of extra-vehicular events and on-board chemical processing of materials.

5. Liquid/Gas and Solids Behavior - These studies tend to require the Astronaut to initiate and control rather complex on-board liquid, gas, and solid processing devices.

6. Astronomical Observations - These experiments generally involve crew utilization of and data gathering from external optics and sensors, both by visual observation and display readout.

7. Remote Sensing of Earth's Atmosphere and Surface - These experiments require crew operations very similar to those required by astronomical observations and utilizing much of the same equipment in much the same way.

8. Electromagnetic Propagation and Transmission - These experiments emphasize communications control and the analysis of resulting displayed data.

9. Space Structures Technology - These experiments involve crew operations in deploying, operating, and observing structures external to the spacecraft. While these operations are usually by remote control and on-board visual observation, some EVA is involved.

10. Subsystem Development and Test - These studies emphasize the observation by the crew of systems operation and of other crew members utilizing on-board operational equipment.

11. Extra-vehicular Operations - These studies utilize the crew as subjects in various EVA tests.

12. Maneuvering and Docking - These studies utilize the crew as subjects in spacecraft piloting and external observation and control tests.

The crew-time requirements summary (Table 4) includes the following for each flight:

1. The total crew-time required for sleep and for personal maintenance.

2. The total crew-time required for daily scheduled systems management, i. e., management of the operational systems of the spacecraft.

3. The total time required by the experiments.

4. The total unscheduled time remaining after items one through three are deducted from total mission time.

Table 4. Crew-Time Requirements Summary

Requirement	Flt	209	211	507	509	215	513	218*	219	221	516*	518	521*	523*	229	230	AF-1	AF-2
	Days	14	30	14	14	14	14	45	45	45	45	45	45	45	45	45	45	45
	Men	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Sleep		315	675	315	210	315	315	1013	1013	1013	1013	1013	1013	1013	1013	1013	1013	1013
Personal (incl food)		189	405	189	126	189	189	608	608	608	608	608	608	608	608	608	608	608
Systems mgmt		17	36	17	17	17	17	54	54	54	54	54	54	54	54	54	54	54
Experiments		181	276	193	106	181	181	(1072)	1073	362	(1458)	677	(654)	(1514)	1104	1043	542	404
Unscheduled		306	768	294	213	306	306	(493)	492	1203	(107)	888	(911)	(51)	461	522	1023	1161
Total (man hr/flt)		1008	2160	1008	672	1008	1008	3240	3240	3240	3240	3240	3240	3240	3240	3240	3240	3240

*Not Integrated by NAA

The systems management time allows for the following crew tasks:

Function	Description
Set-up	Initial activate and adjust ECS Post-dock connect and check out rack
Teardown	Final separation of CM for de-orbit
Calibrate/align	Align G&N system prior to each use after extended non-use (2 men) Warm up SCS prior to each use after extended non-use Align SCS gyros prior to each use after extended non-use
Pilot	Attitude control and retrofire for entry (2 men) Transposition and dock with rack (2 men) Transfer from initial to mission orbit (2 men) Rendezvous and docking where relevant (3 men)
Apply equipment	CES utilization for pilot operations and during launch and reentry
Observe - self or other crew-member	Post-launch crew welfare check
Other observation	Periodic check of system operations indicators

Function	Description
Other tasks	Staging back-up during launch
	Change ECS cannisters
	Activate fuel cells after 14 days
Data Handling	Monitor telemetry
	Verbal description of tasks

CREW TIME PROFILES

Crew time profiles were prepared for each task of each experiment. Although these profiles are available, in the interests of reducing the total report volume, they have not been included. Since detailed computer schedules by task and crew member are contained for every flight mission in Appendix C, it is felt that the usefulness of preliminary profiles would, in any case, be limited.

COMPOSITE EQUIPMENT LIST

In order to achieve uniformity in the use of equipment dimensions among various experiments and flight missions, a preliminary composite equipment list was prepared and used as the standard for determining experiment equipment weight and volume (Table 5). A detailed common-use equipment analysis has not yet been undertaken for the AES series of experimental missions. Pending such analysis, the attached composite list serves to improve the degree of standardization, but is by no means presented as complete or definitive. The next phase of integration will require further development and verification of the composite equipment data applied in this limited study. Air Force equipment specifications were used directly as contained in Air Force experiment formats.

[redacted]

Table 5. NASA Experimental Equipment

Name	Size	Volume (ft^3)	Weight (lb)
AMU	45" x 27" x 20"	14.06	100.0
Fuel system	30" x 25" x 15"	63.00	100.0
Antenna		930.00	250.0
Parabolic	10'D x 5' x 1'	10.00	40.0
Periodic array	5'D x 10' x 1'	1.00	20.0
Tunable, Mono and Dipole	1"D x 22'	0.01	50.0
Parabolic 12-in.	12'D x 6"	0.50	-
Parabolic 24-in.	24"D x 8"	1.00	-
Parabolic 48-in.	48"D x 10"	8.00	-
Accelerometer, 1 G	3"D x 6"		0.5
Altimeter, radar	9.75" x 9" x 11.5"	0.58	26.0
Assembly, scanning mirror	12" x 12" x 12"	1.00	8.0
Analyzer, pulse height		1.00	15.0
Balloon			100.0
Bladder and Capillary Fluid Tubes	24" x 8.4" x 8.4"	1.00	60.0
Back pack, PLSS	25" x 16" x 8"	19.21	61.0
Binoculars	9" x 4" x 3"		6.0
Booms		1.00	0.1
Board, task	24" x 24" x 24"	4.00	75.0
Camera			
TV	4" x 9.5" x 12"	0.26	8.8
Movie	3" x 4" x 7.25"	0.05	3.0
Still	8" x 8" x 10"	0.37	8.0
Poloroid	6" x 4" x 9"	0.20	3.0
35 mm		0.08	.5
Multi-spectral	40" x 40" x 15"	14.00	150.0
Mapping, 24-in.	18" x 18" x 30"	4.00	300.0
Mapping, 6-in.	12" x 12" x 13.5"	1.20	100.0
70 mm	15" x 6" x 9.0"	0.50	5.0
Spectrographic	30" x 12" x 12"	2.50	20.0
Cannisters, Chemical	13"D x 6.5"	5.00	60.0
Couplers, Coaxial and Wave Guide		0.50	2.0
Cooling, IR			100.0
Containers			
Water	18" sphere		200.0
LH_2	36" x 36" x 72"	54.00	100.0
LO_2	18" x 18" x 36'	6.75	100.0
Dummy cargo		2.00	20.0

 [redacted]

[redacted]

Table 5. NASA Experimental Equipment (Cont)

Name	Size	Volume (ft^3)	Weight (lb)
Collector, Optical	12" x 12" x 12"	1.00	8.0
Converter, Analog-Digital and Commutator	4.2" x 9.4" x 16.5"	0.40	24.0
Conditioner, Signal	6" x 9.8" x 20.3"	0.60	45.0
CRT with drive circuitry	12" x 12" x 12"	1.00	70.0
Chest pack PLSS	12" x 12" x 8"	0.67	35.0
Chamber, Residence		1.00	30.0
Compartment Personal Hygiene		10.00	50.0
Detector			
X-ray	2"D x 6"	0.02	1.0
Gamma ray	4" x 4" x 12"	0.11	5.0
Neutron	3" x 3" x 6"	0.03	7.0
Electron	3" x 3" x 6"	0.03	4.0
Proton	6" x 6" x 12"	0.24	6.0
Infra Red	12" x 12" x 12"	1.00	35.0
Failure and warning		2.00	12.0
Decoder, Comm.	6" x 9.7" x 18.3"	0.60	20.0
Dosimeter, Film Pack and Charger	2" x 2" x 4"	0.01	3.0
Damper			32.0
Dewar	30"D sphere	1.00	60.0
Doppler and Frequency Standard		2.42	49.0
Data Storage Equipment	6" x 9.5" x 22"	0.7	28.5
Emulsions, Nuclear	6" x 6" x 6"	0.13	5.0
Enclosure, Emergency Protective	12" x 12" x 12"	1.0	15.0
Equipment, Personal Transfer		1.50	8.0
File, Instruction	24" x 12" x 12"	2.0	6.0
Flowmeter ultrasonic	4" x 4" x 4"	0.05	2.0
Generator and Integrator	6" x 8" x 10"	0.28	40.0
Guide, Antenna Wave	12"D	0.13	1.8
Guns			
Sun	6" x 6" x 6"	0.13	2.5
Electron	4'D x 9"	0.06	8.0

 [redacted]

[redacted]

Table 5. NASA Experimental Equipment (Cont)

Name	Size	Volume (ft^3)	Weight (lb)
Gauges Strain	Negligible	Negligible	Negligible
Head Scanning Rotating sensor	 18"D x 18"	 .02 2.65	 5.0 135.0
Harness, task equipment	10" x 16" x 4"	0.15	12.0
Imagers IR Multispectral, with Antenna Passive Microwave with Antenna	 10"D x 24" 40" x 40" x 15" 36"D x 72" 24" x 24" x 24" 72"D x 6"	 1.5 68.00 8.80	 20.0 150.0 100.0
Intensifier S-20	4"D x 9"	0.07	3.0
Indicators and Meters	6" x 6" x 6"	.13	3.8
Keyboard and selector	15" x 5" x 5"	0.20	3.5
Kits, repair Mechanical Spares Personal Hygiene Medical	 15" x 15" x 10" 11" x 5" x 4.5" 12" x 9" x 9"	 0.15 3.00 0.44	 37.0 2.0 20.0 2.0
Laser, Head, Electronics, and Module		0.10	50.0
Locomotion aids		3.30	15.0
Lines Safety Static	 12" x 12" x 4" 12" x 12" x 4"	 .33 .33	 10.0 10.0
Mount Gimbal Bezel Camera	 7"D x 5" 16" x 6" x 9"	 0.11 1.00 0.50	 20.0 2.0 1.0
Magnetometer	15" x 9" x 5"	0.50	7.0
Modulator, Frequency		0.25	15.0
Meter, Frequency		0.20	10.0
Multi "G"	 3"D x 6"	0.02	2.0 .5
Multiplexer, PCM	4.2" x 9.4" x 16.5"	0.4	23.0
Module, cargo net	30" x 24" x 42"		75.0

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Table 5. NASA. Experimental Equipment (Cont)

Name	Size	Volume (ft^3)	Weight (lb)
Materials, Logistics	Variable	Variable	10.0 - 60.0
Net, snare		1.0	15.0
Panel, central	20" x 13" x 6"	0.90	5.0
Photometer	24" x 8" x 12"	3.00	2.0
Platform, stable		1.50	30.0
Image motion compensation		5.00	100.0
w/rails	18' x 3'	-	75.0
Pointer, optical			10.0
Power Supply	18" x 18" x 36"	7.00	100.0
Pyroheliometer	6" x 2" x 2"	0.03	5.0
Probes, Plasma	8" x 8" x 12"	0.44	10.0
Propellant			1000.0
Recorders			
Tape 5 channel		0.02	15.0
Tape 10 channel		0.02	15.0
Data	24" x 12" x 12"	2.00	25.0
Video tape	4" x 9.5" x 12"		8.8
Reflector	48"D x 72"	151.00	1250.0
Rods, Tape	200'	1.00	30.0
Radiometer,			
Microwave	24" x 24" x 24"	14.0	100.0
with Antenna	72'D x 12"		
Reel, motor		1.0	100.0
Restraint system	8" x 4" x 2"	0.36	8.0
Spectrometer			
Electron	3" x 3" x 6"	0.03	4.0
Proton-alpha	6" x 6" x 12"	0.25	6.0
LET	6" x 6" x 6"	0.13	3.0
Microwave	24" x 4" x 30"	1.90	90.0
Infrared		1.50	23.0
UV-Visible	4" x 10" x 16"	0.25	50.0
Solar array		75.00	250.0
Sensor, sun		0.10	5.0
Rotation rate	3"D x 6"		0.5

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Table 5. NASA Experimental Equipment (Cont)

Name	Size	Volume (ft^3)	Weight (lb)
Syncom	28.3"D x 31"	1.10	73.3
Snare, Retractable	6" x 12" x 24"	1.50	15.0
Systems			
Waste control		1.50	50.0
Pressurizing		0.20	6.0
Optical	10" x 20" x 30"	3.50	40.0
Fuel transfer	24" x 24" x 36"	12.00	350.0
Spacesuit			
Soft	72" x 28" x 15"	17.47	73.0
Hard	72" x 30" x 23"	30.00	50.0
Satellite, target			100.0
Lenticular	-	-	-
Sequencer, Experiment	4.2" x 9.1 x 10.9	0.3	10.0
Screen, flat plates, syringes	18" x 18" x 6"	1.50	119.0
Telescope		5.10	125.0
16-inch	87" x 25" x 65"	70.00	400.0
Comparator	24" x 18" x 12"	3.00	25.0
Theodolite	3"D x 12"	1.00	15.0
Tether, work face	8" x 4" x 2"	0.35	8.0
Tracer, Radioisotope	4" x 4" x 4"	0.05	2.0
Tank, Cryogenic		2.00	200.0
T.E.I.C.	2"D x 6"	0.01	3.0
Transmitters	2" x 4" x 8"	0.35	5.0
Tetrode			50.0
Klyston			50.0
Backward wave oscillator			50.0
X-band		1.75	56.0
Tools	12" x 4" x 4"	0.11	5.0
Tracker, Optical	8" x 8" x 12"	0.44	20.0
Tuner, s-band		0.25	1.0
Tubes			
Wire mesh	1500'	2.00	45.0
Viewfinder		2.50	100.0
VHF pulse reflectivity	1' x 1' x 1.25	1.25	40.0
Window 16-in.	16"D x 1"	0.15	15.0

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BIOMEDICAL AND BEHAVIORAL EXPERIMENTS COMMON TO ALL MISSIONS

Based upon implicit guidelines from NASA Headquarters and NASA MSC, the individual experiments in the Biomedical/Behavior Experiment Program were to be considered as autonomous. Equipment techniques and procedures were to correspond to the information incorporated in the Experiment Identification and Description form. Where pertinent information was not provided, equipment concepts, techniques, and crew-time requirements were to be utilized from Lockheed's "Conceptual Design of a Measurement System for Apollo X" and/or from NAA's Apollo X publications. When these guidelines were applied, the Biomedical/Behavior Experiments Program demanded more crew time than was available.

On 25 March 1965, headquarters NASA issued a directive which altered some frequencies and crew-time requirements for the experimental program. Now it was possible to integrate the twenty-one biomedical and three behavior experiments into all projected AES missions. Tables 6 and 7 present the relationships between equipment requirements, the parameters measured, and the experiments for the Biomedical/Behavior Experiment Program. Tables 8 and 9 present the frequencies and crew times for the program on all flights.

It should be especially noted that the basic Biomedical/Behavior Experiments Program is included in all AES missions. In actual practice it is likely that the basic program will be included in the first and possibly the second flight of each incremental flight duration. The remaining flights of each duration will most likely be designed on the basis of the results of previous flights. The precise experiments for projected flights cannot be known in advance.

CRITIQUE OF THE BIOMEDICAL/BEHAVIOR EXPERIMENT PROGRAM

In a broad sense, the Biomedical/Behavior Experiment Program (Experiments 0101-0121/0201-0203) is designed to evaluate the effects, over time, of prolonged space flight on man's physiological functioning and performance capability. In general the biomedical experiments will study a comprehensive cross-section of selected physiological functions. In addition these experiments include measures that will assess the effects on man of vehicle maneuvers; will identify the causes of observed degradation; will predict the onset and determine the degree of impairment; and will validate selected preventive or countermeasures. The behavior experiments will

sample a representative cross-section of man's response repertoire and will include real operational tasks, simulated crew tasks and experimental measurement of performance components. The objectives of the overall Biomedical/Behavior Program will most likely be realized by the sum of the twenty-one biomedical and three behavior experiments. However, from a systems engineering point of view several experiments prove to be excessively costly, and there is some redundancy and confounding of experimental objectives.

OBJECTIVE REDUNDANCIES

The fuel requirements for vehicle maneuvers in Experiments 0101 and 0102 exceed system capability. The need to evaluate vestibular functioning and crew tolerance of variable rotation rates of zero-g is acknowledgedly critical. However, it is possible to measure response to linear acceleration and rotation in flight with a modified Barany chair. Although it is obvious that the sensory aspects of acceleration (linear and angular) of a chair within a vehicle are somewhat different than when the vehicle is accelerated and rotated, the differences are probably not gross. At least vestibular functioning can be measured in space and compared with ground functioning. Most importantly, on flight 221, vestibular functioning can be thoroughly studied and effects of zero-g with artificial-g can be systematically evaluated. Therefore, it is recommended that Experiments 0101 and 0102 be accomplished without special vehicle maneuvering or that the acceleration and rotation requirements of these experiments be accomplished on only one flight.

Experiments 0103, 0104, 0105, 0106, 0107, and 0108 are concerned with evaluation of the cardiovascular system. There is no argument with the need to try a variety of measures so as to derive the optimum index of cardiovascular functioning. However, the use of the LBNP, the exercycle, and other devices for provocative testing, confounds the controls essential for evaluating countermeasures and also confounds the results of the provocative tests themselves. In addition, the frequencies for the experiments are different and this complicates the problem of measurement synthesis. Particularly, the evaluation of countermeasures is contingent upon an acceptable measure of cardiovascular functioning; yet the frequency of countermeasures is unrelated to the cardiovascular assessment experiments.

The use of radio-isotope procedures for assessing fluid compartment volumes is costly. Equipment requirements for this experiment cost 463 pounds. However, there is a difference of opinion among biomedical specialists as to the best technique for assessing blood volume, total body water, and other fluid compartment volumes with a radio-isotope system.

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Table 6. NASA Equipment and Experiment List

NASA Equipment	NASA Measures	NASA Experiments																				
		0101	0102	0103	0104	0105	0106	0107	0108	0109	0110	0111	0112	0113	0114	0115	0116	0117	0118	0119	0120	0121
A. BIOELECTRONIC SYSTEM (Sensors and Conditioners)																						
A.1 Electrocardiograph	1 Heart function - heart rate		X	X	X		X	X	X													
A.2 *Electrocuprograph	2 Eye movement, nystagmus	Not used																				
A.3 Electromyograph	3 Muscle potential											X										
A.4 *Electroencephalograph	4 Alertness and CNS activity	Not used																				
A.5 Cardiac output (band electrodes)	5 Cardiac output (pulmonary blood flow)			X	X				X													
A.6 Microphone (with arm cuff)	6 Blood pressure			X	X		X	X	X													
A.7 Plethysmograph (with venous cuff)	7 Venous pressure				X		X	X														
A.8 Impedance pneumograph	8 Respiration rate and depth									X	X			X								
A.9 Telethermometer	9 Temperature			X	X				X							X	X					
A.10 Oximeter	10 Blood oxygen content										X											
A.11 Capacitance plethysmograph	11 Limb volume						X	X														
A.12 Endo-radio-sonde	12 Gastric motility and pH														X							
B. SPECIAL DEVICES FOR TESTING CARDIOVASCULAR FUNCTION																						
B.1 LBNP	13 Applied negative pressure			X			X	X	X													
B.2 Limb cuffs	14 Applied pressure																					
B.3 Ergometer	15a Work load				X				X					X								
B.4 Isometric and isotonic devices	15b Work load																					
C. PULMONARY EVALUATION SYSTEM																						
C.1 Mass flowmeter	16 Pulmonary function									X	X			X								
C.2 Gas analyzer (mass spectrometer)	17 Gas exchange									X	X			X								
D. VESTIBULAR EVALUATION SYSTEM																						
D.1 Otolith goggles	18 EVLH and illusions	X	X																			
D.2 Optic fiber bundle (with TV camera) (or cine camera)	19 Eye movements	X	X																			
D.3 Psychomotor chart (with rotation)	20 Psychomotor performance		X																			
D.4 Calibration spring	21 Linear acceleration	X																				
E. BIOCHEMICAL AND MICROBIOLOGICAL SYSTEM																						
E.1 Microscope																						
E.2 Microcentrifuge	22 Urine volume																					
E.3 Micromixer	23 Urine analysis																					
E.4 Spectrophotometer	24 Hematological status																					
E.5 Refractometer	25 Blood and urine chemistry					X							X	X				X	X	X	X	
E.6 Liquid measure	26 Microbiological analysis																					
E.7 Miscellaneous: slides, reagents, test papers, test tubes, sample containers, etc.	27 Sample storage																					
E.8 Lyophilizer/freezer																						
E.9 Refrigerator																						
E.10 Incubator																						
F. RADIO ISOTOPE TRACER SYSTEM																						
F.1 Pre-set count scales																						
F.2 Shielded well detector																						
F.3 Container isotope shield	28 Total body water and compartment volumes					X								X								
F.4 Beta spectrometer																						
F.5 Microcentrifuge (see above)																						
F.6 Spectrophotometer (see above)																						
G. MASS DETERMINATION DEVICES (Harmonic spring, pogo stick)	29 Body mass					X								X								
H. DENSIOMETER	30 Bone density												X									
I. MUSCLE EVALUATION SYSTEM																						
I.1 Tape measure	31 Muscle size											X										
I.2 Dynamometer	32 Muscle strength											X										
J. PLASTIC BAG	33 Body volume													X								
K. WATER COOLED SUIT SYSTEM																						
K.1 Long johns																						
K.2 Plastic tubing	34 Temperature regulation															X						
K.3 Temperature sensors																						
*Not in NASA program																						

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	Equipment	Measure
A.	Integrated Display System - utilized as -	Memory
	Integrated Real Task Simulator	
	Rotary control and circular indicator	Fine motor
	CRT and controller	Continuous process
	CRT, vertical scale and circular indicators and controller	Discrete processes
	Light matrix, selector keyboard and timer	Discrete processes
	Light matrix, indicators and selector keyboard	Vigilance
	Light matrix, auditory signals and selector keyboard	Attention Vigilance
	CRT and electron pencil (stylus)	Fine motor
	CRT and selector keyboard	Problem solving
	CRT and selector keyboard	Reading
	Ames Time Estimation Test	Time estimation
B.	Oculometer	
	Acuity slides	
	Brightness slides	
	Depth perception slides	Vision
	Blurred images slides	
C.	On-Board Operational Tape Recorder	
	Tape for intensity threshold	Audition
	Tape for pitch threshold	
	Tape for clipped messages	Speech perception
D.	Acceleration Chair and Attachments	Vestibular Kinesthesis
E.	Cameras (motion and still)	Gross motor Orientation
F.	Operational Pressure Suit (and timer)	Gross motor

Table 7. Biomedical/Behavioral Experiment Program

	0201 (Sensory and Perceptual Processes)											0202 (Psychomotor Functioning)									0203 (Higher Mental Processes)										
	a Vision				b Audition		c Vestibular		d Kinesthesis	e Orientation		Gross Motor		Fine Motor		Continuous Processes		Discrete Processes			Vigilance		Attention		Perception	Problem Solving			Reading	Memory	Estimation
												a	b	c	d	e	f	g	h	i	b		a	c	d	e			f	g	h
	Brightness	Acuity	Depth Perception	Form Discrimination	Intensity	Pitch	Linear	Angular	Limb Motion	Positional	Localization	Locomotion	Dexterity	Manipulation	Steadiness	Tracking (pursuit)	Tracking (compensatory)	Reaction (simple)	Reaction (complex)	Complex Sequence	Visual	Auditory	Visual (warning)	Auditory (warning)	Speech	Computation	Symbolic	Diagnostic	Comprehension	Long Term	Time
																														X	
														X																	
																X	X														
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Table 8. Integrated NASA Biomedical Experiment Program
Three Men—30 Days

	Experiment	Frequency No/Days	Time Per Test	Crew Time Per Test			No Tests Crewman				Average Experimental Crew Time (mins) 1 Man/1 Day	Total Experiment Crew Time (mins) 3 Men/30 Days
				Subj.	Exp.	Total	1	2	3	Total		
0102-0103	Vestibular Function	1/7	40	40	40	80	4	4	4	12	10.67	960
0103-0107	Cardiovascular	1/3	50	50	50	100	10	10	10	30	33.33	3000
0104	Cardiovascular/ Excercise	1/3	20	20	20	40	10	10	10	30	13.33	1200
0105	Body Fluid Volumes	1/7	80	10	80	90	4	-	-	4	4.00	360
0106	Cardiovascular Reflex	1/6	30	30	30	60	-	5	-	5	3.33	300
0108	Countermeasures	2/1	30	30	30	60	-	-	60	60	20.00	1800
0109-0110	Pulmonary Function	1/7	35	35	35	70	4	4	4	12	9.33	840
0111	Muscle Status	2/7	15	15	15	30	8	8	8	24	8.00	720
0112	Mineral Metabolism	1/7	5	5	5	10	4	4	4	12	1.33	120
0113	Nutritional Status	1/7	100	40	100	140	4	4	4	12	18.67	1680
0114	GI Motility and pH	2/7	10	10	-	10	8	-	-	8	0.89	80
0115	Thermal Regulation	1/10	10	10	-	10	3	3	3	9	1.00	90
0116	Thermal Stress	1/30	160	160	30	190	-	1	-	1	2.11	190
0117	Neuroendocrine Function	1/2	5	5	5	10	1	1	1	3	0.33	30
	Neuroendocrine Function	1/7	5	5	5	10	4	4	4	12	1.33	120
0118	Hemic Cell Function	1/2	23	-	23	23	1	-	-	1	0.26	23
	Hemic Cell Function	1/7	23	-	23	23	4	-	-	4	1.02	92
0119	Hematological Defense	1/2	30	-	30	30	1	-	-	1	0.33	30
	Hematological Defense	1/7	30	-	30	30	4	-	-	4	1.33	120
0120	Hemostasis	1/14	20	-	20	20	2	-	-	2	0.44	40
0121	Microbiological Analysis	1/14	35	-	35	35	2	-	-	2	0.78	70

Total crew time: 3 men, 45 days (including Experiment 0121) = 291.8 hours
Total crew time: 3 men, 30 days (minus Experiment 0121) = 194.9 hours
Total crew time: 3 men, 14 days (minus Experiment 0121) = 99.6 hours
Total crew time: 2 men, 14 days (minus Experiment 0121) = 77.6 hours

Table 9. Integrated NASA Behavior Experiment Program
Three Men—30 Days

Experiment	Frequency No/Days	Time Per Test	Crew Time Per Test			No Tests				Avg Experiment Crew Time (min) 1 Man/1 Day	Total Experiment Crew Time (min) 3 Men/30 Days
						Crewman					
			Subj.	Exp.	Total	1	2	3	Total		
0201											
a. Vision	1/3	25	25	-	25	10	10	10	30	8.33	750
b. Audition	1/6	8	8	-	8	5	5	5	15	1.33	120
c. Vestibular	1/3	25	25	25	50	10	10	10	30	16.67	1500
d. Kinesthesis	1/6	8	8	8	16	5	5	5	15	2.67	240
e. Orientation	1/6	8	8	8	16	5	5	5	15	2.67	240
0202											
a. Locomotion	1/3	9	5	9	14	10	10	10	30	4.67	420
b. Dexterity	1/6	9	9	9	18	5	5	5	15	3.00	270
c. Manipulation	1/3	6	6	-	6	10	10	10	30	2.00	180
d. Steadiness	1/3	5	5	-	5	10	10	10	30	1.67	150
e. Tracking (Pursuit)	1/3	8	8	-	8	10	10	10	30	2.67	240
f. Tracking (Compensatory)	1/3	7	7	-	7	10	10	10	30	2.33	210
g. Reaction (Simple)	1/6	6	6	-	6	10	10	10	30	2.00	180
h. Reaction (Complex)	1/3	4	4	-	4	10	10	10	30	1.33	120
i. Complex Sequence	1/3	9	9	-	9	10	10	10	30	3.00	270
0203											
a. Visual Warning	1/3	9	9	-	9	10	10	10	30	3.00	270
b. Vigilance	1/3	19	19	-	19	10	10	10	30	6.33	570
c. Auditory Warning	1/3	8	8	-	8	10	10	10	30	2.67	240
d. Speech Perception	1/3	7	7	-	7	10	10	10	30	2.33	210
e. Problem Solving	1/6	34	34	-	34	5	5	5	15	5.67	510
f. Reading Comprehension	1/3	9	9	-	9	10	10	10	30	3.00	270
g. Long Term Memory	1/6	6	6	-	6	5	5	5	15	1.00	90
h. Time Estimation	1/3	5	5	-	5	10	10	10	30	1.67	150

Total crew time: 3 men, 45 days = 180 hours
Total crew time: 3 men, 30 days = 120 hours
Total crew time: 3 men, 14 days = 56 hours
Total crew time: 2 men, 14 days = 37.3 hours

It is very likely that with some changes in the techniques or radioisotopes used, on-board equipment could be utilized and grossly reduce the 463-pound equipment requirement.

In order to derive the essential data for on-going physiological monitoring requirements from the biomedical experiments, some changes should be made in the frequencies of experiments.

Among the behavior experiments, the sensitivity and feasibility of the following measures are questionable: Experiment 0201-e-Orientation, position and location; Experiment 0202-a-Locomotion; and Experiment 0202-b-Dexterity (don and doff spacesuit).

PRESSURIZED VOLUME REQUIREMENTS FOR EXPERIMENTAL OPERATIONS

For the AES series of flights under consideration, the minimum pressurized volume requirement is established by the biomedical and behavioral experimental program, which is common to all flights. The estimated volume minimum for this program is about 200 cubic feet. This also fulfills minimum requirements for other experiments including the Air Force series. It is emphasized that this is not presented as an optimal volume, or as necessarily habitable for long durations, but as an adequate volume within which a specified set of operations can be accomplished. Among the factors considered were layout of standardized controls and displays, packaged equipment dimensions storage area, accessibility of the data management system panel and adequate work bench space, location of necessary hatches and ports, and structural configuration constraints. To these basic constraints can be added the operating volume required for two crewmen, acting as subject relationships, to accomplish minimum movements demanded by the experimental design. Experimental procedures require capability for face-to-face, side-to-side relationships, both sitting and standing. It will be seen from the scale drawing (Figure 5) that the specified volume of approximately 200 cubic feet is minimally adequate and can be used as the basis for sizing the rack airlock. Usable volume of this size cannot be provided within the three-man command module.

[redacted]

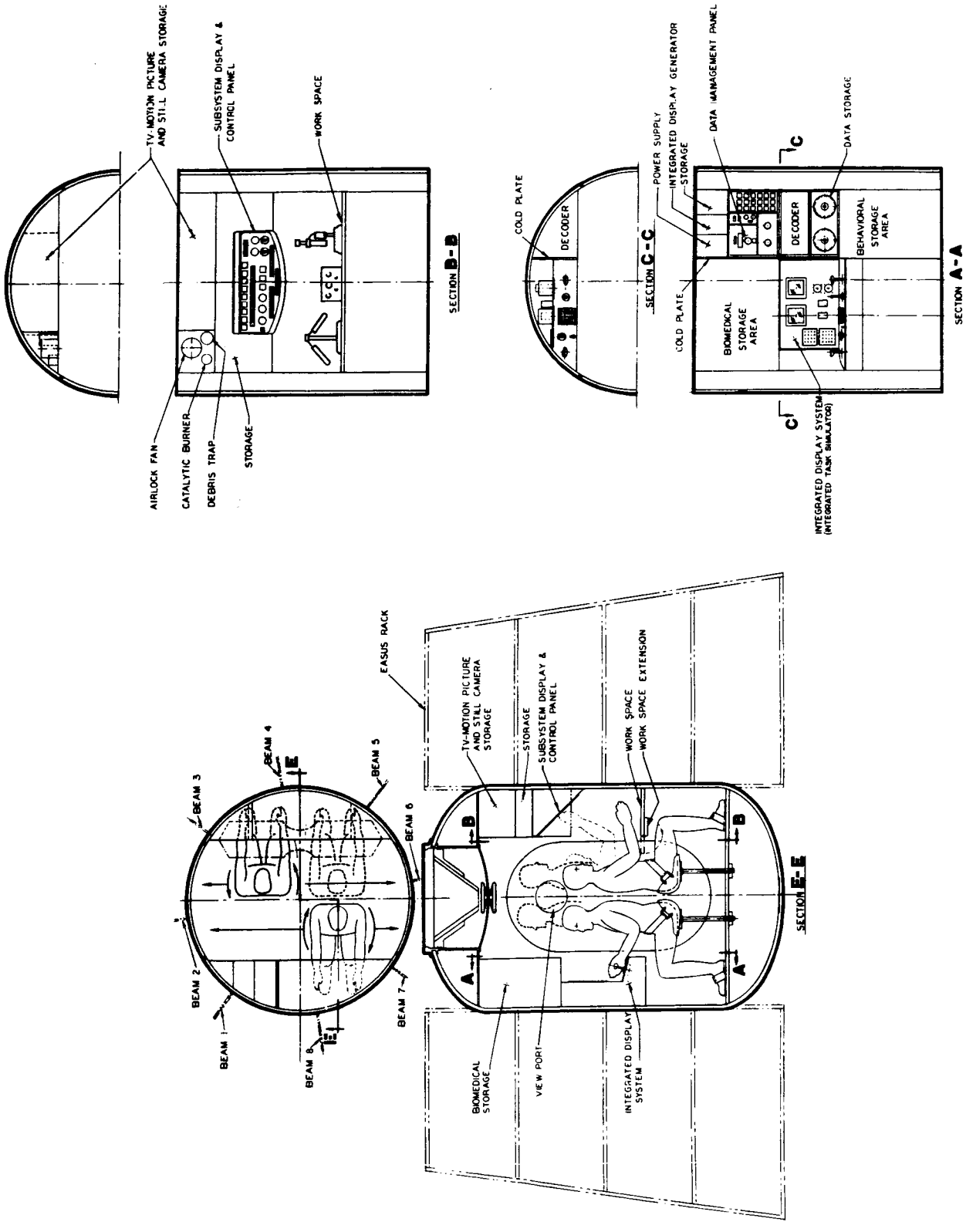

Figure 5. Pressurized Volume Requirements

[redacted]

EXPERIMENT MISSION DESCRIPTION, NASA FLIGHTS

This section presents descriptions of each of the NASA AES flight missions integrated during the study by S&ID. Detailed data summarized for each flight mission was derived from the basic experiment formats in Appendix A.

Experiment and spacecraft characteristics that are common to all flights were described in the preceding section of this volume. This section describes those characteristics of each flight mission not discussed previously. The format for describing individual flight missions is as follows:

1. Experimental Program
2. Mission Description
3. Basic Experiment Requirements
4. Condensed Mission/Experiment Characteristics
5. Data Management Requirements
6. Power Profiles
7. SPS and RCS Requirements
8. Controls and Displays
9. Crew Functions
10. Summary of Mission Accomplishment

FLIGHT 209: BASIC SPACE OPERATION

1. EXPERIMENTAL PROGRAM

Flight 209 will be launched into a 200-nautical-mile circular Earth orbit with an inclination of 28.5 degrees. It will carry a three-man crew and is scheduled for 14 days. The following experiments will be assigned to the flight:

Standard Group

0101-0120	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

1501	Evaluation of Advanced Space Suit Assemblies (abbreviated-anthropometric dummy not to be used)
1502	Development of Manned Locomotive and Maneuvering Capability
1503	Emergency Techniques, Equipment and Procedures for Rescue Operations
0601	Capillary Studies

2. MISSION OBJECTIVES

The Gemini and Apollo earth-orbiting missions will have demonstrated that man can perform adequately and survive in space for up to two weeks. From continuous physiological monitoring and space crew operations in these earlier flights, the gross effects on man's well-being and performance efficiency will probably have been identified. Also, there will be anecdotal data and some observations pertinent to crew operations and equipment functioning characteristics. Human research, however, will have been incidental to primary mission objectives.

Flight 209 will be the initial space station mission designed to evaluate systematically the effects over a period of time on man's physiological functioning, performance capability and operation, and personal equipment efficiency. The 20 biomedical experiments are designed to study selected physiological functions that are judged by experts as most likely to be altered by space flight. In addition, these experiments will detect the causes of observed degradation, predict the onset and degree of impairment, and validate ground-tested preventative measures and countermeasures. The behavior experiments are designed to sample a representative cross-section of man's response repertoire and include real crew tasks, simulated real crew tasks and experimental assessment of performance components. Human operations and equipment experiments will be undertaken in depth, with emphasis on development of advanced procedures, techniques, and equipment for extra-vehicular operations. During the 14-day mission, each of the manned operations experiments are scheduled twice. During the first seven days, experiment times will be 45 minutes each, and during the last seven days will be increased to 120 minutes each.

The series of biomedical, behaviorial, and radiation monitoring experiments will be performed on all flights. Twenty biomedical experiments (0100 series) include a wide range of physical measurements of interest such as; sensitivity to rotation or acceleration, work capacity, response of the circulatory system, effects on the pulmonary system, metabolism, thermal regulation, and neuro-endocrine functions. Three behavioral experiments (0200 series) concern sensory performance, psychomotor functioning, and the higher mental processes. The radiation monitoring experiment (0501) will accumulate data pertaining to the radiation environment. Scheduling of these experiments will be such as to extend throughout the mission without interference with other scientific and technical experiments. All crew members will serve as subjects at various times.

Preliminary studies of fluid dynamics in zero gravity are considered of sufficient importance to systems design to warrant their inclusion on this primary human research flight.

Experiments 1501, 1502, and 1503 will require operations both within the rack airlock and outside the vehicle. Equipment such as hard and soft spacesuits, auxiliary maneuvering unit (AMU), and portable life support systems (PLSS) will be used in common by the experiments. Each extra-vehicular phase of the mission will involve two crewmen, one outside the vehicle and one at standby inside the spacecraft.

Performance of Experiment 1501 requires extra-vehicular activity which will be further observed and expanded in Experiment 1502. Here the basic maneuvering capability of man in donning, doffing, and adjustment of his suit; self-control of his motion; use of the safety lines; free soaring and

powered AMU operation; point-to-point clambering techniques, and "buddy" and "self-help" operation. Others also will be investigated.

Experiment 1503 is designed to investigate emergency rescue techniques and will be concerned with evaluation of failure detection and warning systems of various types; the approach to, and docking with, a vehicle; opening of hatches; deployment of inflatable emergency airlocks; despinning and rescue of tumbling objects; and temporary life support and transfer of injured personnel into or out of the vehicle.

The data to be collected will consist of the equipment items themselves (suits, etc.) for examination for deterioration in use, plus verbal, written, and photographic records of the operations which have been performed, and on-site comments and recommendations of the participating crew test subjects. Flexibility of test sequences will probably be desirable in order that research in problem areas that develop during the mission may be pursued.

The capillarity phenomena Experiment, 0601, is aimed at recording photographically the static and dynamic action of fluids within tubes of small bore in a gravity-free environment.

The 200-nautical-mile low-inclination orbit provides protection from solar flare radiation. The only radiation of importance will be encountered in the South Atlantic anomaly, which should be avoided during extra-vehicular activities.

3. BASIC EXPERIMENT REQUIREMENTS

Table 209-10 summarizes the weight, volume, crew time, Electrical Power System (EPS), and Stabilization Control System (SCS) requirements.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

A summary of the experiment characteristics was prepared for each flight in a tabular format. The summary for Flight 209 is shown in Table 209-11. The first column, "Integration Number," is used for the experiment identification in the computer scheduling program. The first four numbers indicate the experiment number, the fifth number indicates the observer or secondary experimenter, and the sixth number is the subject or primary experimenter. The numbers are related to the crew members as follows: 1- Crew 1, 2- Crew 2, 3- Crew 3, 4- Crew 1 or 2, 5- Crew 1 or 3, 6- Crew 2 or 3, and 7- Any Crew Member.

The second column, "Experiment Number," is the identification number assigned by the NASA or USAF. If more than one number is given it indicates that the experiments are performed together. The next column, "Priority,"

Table 209-10. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0120, 0201-0203)	728.4	12.8	9.0	19.7	155.8	0.0	85.0	1.7	
Capillarity investigation (0601) Capillary test devices Stereo cameras, still and motion Flash unit Collision chamber Liquid reservoir	75.4	2.5	0.0	0.3	7.0	3.5	10.0	0.1	
Space suit evaluation, extra-vehicular activity and emergency techniques (1501, 1502, 1503) Space suit Dynamic test rigs AMU with extra tanks Recorders and cameras	800.0	10.0	144.0	1.2	17.5	6.0	40.0	0.5	
Radiation monitor (0501)	50.0	1.0	1.0	1.8	1.0	0.0	1.0	0.01	
TOTAL	1653.8	26.3	154.0	23.0	181.3	9.5	136.0	2.3	

is used for scheduling with the computer program. The number is assigned considering both the importance of the experiment in successfully completing the mission objectives and the difficulty in scheduling the experiment. For example, if two experiments have the same importance to the mission, the experiment requiring only one crew member would be given a lower priority than the one requiring two crew members.

The "Crew Time" columns indicate the crew member(s) that are assigned to the experiment and the time they devote to the experiment. The "Power" column is average power and only includes the power required for the experimental equipment. Power for SCS, G&N, data management, data transmission, etc. are not included. The "SCS" column indicates gross orientation and time of attitude hold when required. The "Data" column indicates the bits recorded during the experiment and the transmission time of the data that requires transmission.

The "Weight" column includes the weight of the experimental equipment used for the particular experiment. Equipment that is used in more than one experiment is only included in the weight of the first experiment in the table that uses the component. For example, several experiments may use a

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PRIORITY

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MIN		
				#1	#2	#3
010261	0101,0102	1141	1/7 Days	40		
010252	0101,0102	1142	1/7 Days		40	
010243	0101,0102	1143	1/7 Days			40
010361	0103,0107	1001	1/3 Days	50		
010352	0103,0107	1002	1/3 Days		50	
010343	0103,0107	1003	1/3 Days			50
010461	0104	1021	1/3 Days	20		
010452	0104	1022	1/3 Days		20	
010443	0104	1023	1/3 Days			20
010561	0105	1151	1/7 Days	10		
010652	0106	1011	1/6 Days		30	
010843	0108	1031	2/1 Days			25
010961	0109,0110	1041	1/7 Days	35		
010952	0109,0110	1042	1/7 Days		35	
010943	0109,0110	1043	1/7 Days			35
011161	0111	1111	2/7 Days	15		
011152	0111	1112	2/7 Days		15	
011143	0111	1113	2/7 Days			15
011261	0112	1044	1/7 Days	5		
011252	0112	1045	1/7 Days		5	
011243	0112	1046	1/7 Days			5
011361	0113	1121	1/7 Days	40		
011352	0113	1122	1/7 Days		40	
011343	0113	1123	1/7 Days			40
011307	0113	1124	1/7 Days			
011407	0114	1131	2/7 Days			
011501	0115	1161	3/Mission	10		
011502	0115	1162	3/Mission		10	
011503	0115	1163	3/Mission			10
011652	0116	1171	1/Mission		160	
011761	0117	1051	1/2 Days	5		
011752	0117	1052	1/2 Days		5	
011743	0117	1053	1/2 Days			5
511761	0117	1055	1/7 Days	5		
511752	0117	1056	1/7 Days		5	
511743	0117	1057	1/7 Days			5
011807	0118	1054	1/2 Days			
511807	0118	1058	1/7 Days			

UTES)	POWER				SCS		DATA			WEIGHT	STO
ANY	STAND-BY		OPERATING		ORIENTATION		ATTITUDE	BITS	TRANS-	(LB)	VO
CREW	WATTS	MIN	WATTS	MIN			HOLD	STORED	MITTED		CU
MEMBER							(MIN)				
40			40	30	-	-	*	7 min A	7 min▲	7.0	
40			40	30	-	-	*	7 min A	7 min▲	-	
40			40	30	-	-	*	7 min A	7 min▲	-	
50			6	40	-	-	-	1 min A	1 min	33.6	
50			6	40	-	-	-	1 min A	1 min	-	
50			6	40	-	-	-	1 min A	1 min	-	
20			6	15	-	-	-	3 min A	3 min	5.0	
20			6	15	-	-	-	3 min A	3 min	-	
20			6	15	-	-	-	3 min A	3 min	-	
80			25	60	-	-	-	-	-	473	
30			8	30	-	-	-	2 min A	2 min	-	
5			5	15	-	-	-	4 min A	4 min	3.0	
35			56	10	-	-	-	4 min A	4 min	30.0	
35			56	10	-	-	-	4 min A	4 min	-	
35			56	10	-	-	-	4 min A	4 min	-	
15			15	5	-	-	-	1 min A	1 min	3.2	
15			15	5	-	-	-	1 min A	1 min	-	
15			15	5	-	-	-	1 min A	1 min	-	
5			10	5	-	-	-	-	-	36.8	
5			10	5	-	-	-	-	-	-	
5			10	5	-	-	-	-	-	-	
40			5	40	-	-	-	2 min A	2 min	0.6	
40			5	40	-	-	-	2 min A	2 min	-	
40			5	120	-	-	-	2 min A	2 min	-	
60			5	60	-	-	-	-	-	-	
10			4.5	10	-	-	-	-	-	0.5	
			1	10	-	-	*	-	-	-	
			1	10	-	-	*	-	-	-	
			1	10	-	-	*	-	-	-	
30			5	160	-	-	-	-	-	47.9	
5			-	-	-	-	-	-	-	-	
5			-	-	-	-	-	-	-	-	
5			-	-	-	-	-	-	-	-	
5			-	-	-	-	-	-	-	-	
5			-	-	-	-	-	-	-	-	
5			-	-	-	-	-	-	-	-	
23			10	15	-	-	-	-	-	12.8	
23			10	15	-	-	-	-	-	-	

Table 209-11. Flight 209 Experiment Parameters (Sheet 1 of 2)

ORED LUME . FT.	REMARKS
0.6	* 0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
1.8	
-	
-	
1.0	
-	
-	
9.0	
-	
0.25	
1.5	
-	
-	
0.05	
-	
-	
2.1	
-	
-	
0.01	
-	
-	
-	Lab work for 0113
0.25	
-	Schedule on 3 successive days
-	* Minimum rotation
-	
2.0	
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Start 7 days after 011743
0.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

[redacted]

PRIORITY

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STORE VOLUM CU. F
011907	0119	1061	1/2 Days				30			10	30							
511907	0119	1062	1/7 Days				30			10	30							
011207	0120	1071	1/14 Days				20			10	15							
511207	0120	1072	1/14 Days				20			10	15							
611207	0120	1073	1/14 Days				20			10	15							
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.							
020161	0201	1091	1/6 Days	82			33			30	26						75.0	3.
020152	0201	1092	1/6 Days		82		33			30	26							
020143	0201	1093	1/6 Days			82	33			30	26							
520161	0201	1094	1/6 Days	32			8			30	26							
520152	0201	1095	1/6 Days		32		8			30	26							
520143	0201	1096	1/6 Days			32	8			30	26							
020261	0202	1081	1/3 Days	63			14			105	50							
020252	0202	1082	1/3 Days		63		14			105	50							
020243	0202	1083	1/3 Days			63	14			105	50							
020361	0203	1101	1/6 Days	100						160	75							
020352	0203	1102	1/6 Days		100					160	75							
020343	0203	1103	1/6 Days			100				160	75							
520361	0203	1104	1/6 Days	40						160	15							
520352	0203	1105	1/6 Days		40					160	15							
520343	0203	1106	1/6 Days			40				160	15							
050101	0501	1231	1/3 Days	4						5.3	Cont				12,500	1 sec	50	2
050102	0501	1232	1/3 Days		4						for				per	per		
050103	0501	1233	1/3 Days			4					14 Days				orbit	orbit		
150161	1501	1201	1/Mission	45			45			200	20			20			800	154
150152	1502	1202	1/Mission		45		45			200	20			20				
150143	1503	1203	1/Mission			45	45			200	20			20				
650161	1501	1204	1/Mission	120			120			200	95			95				
650152	1502	1205	1/Mission		120		120			200	95			95				
650143	1503	1206	1/Mission			120	120			200	95			95				
060107	0601	1211	1/Day				20			10	15			10			75.4	2
560107	0601	1212	1/Day				11			250	5			5				

Table 209-11. Flight 209 Experiment Parameters (Sheet 2 of 2)

D							REMARKS							
ME														
T.														
	Schedule during 1st 2 days only													
	Start 7 days after 011907													
13														
	Schedule 3 days after 020161													
	Schedule 3 days after 020152													
	Schedule 3 days after 020143													
	Schedule 3 days after 020361													
	Schedule 3 days after 020352													
	Schedule 3 days after 020343													
	Schedule during first 7 days (EVA)													
	Schedule during last seven days (EVA)													
5														

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telescope as a component, but the weight of the telescope is included in the equipment weight of only one of the experiments. Entries in the "Volume" column represent the stored volume of the equipment.

The "Remarks" column contains mainly supplementary information to be used in scheduling the experiments. However, such items as peak power, equipment components, and what phase of the experiment is being performed are included when they are considered significant.

5. DATA MANAGEMENT REQUIREMENTS

A comparison of capabilities of the standarized data management subsystem with the experiment requirements of Flight 209 is presented in Table 209-12. The total magnetic tape required for each experiment is well within the system capability of 2250 feet of tape per reel, while transmission of the data collected from all experiments selected for the mission is a total of 264 minutes for the 14 days, or an average of 18.9 minutes per day. This is lower than the communication periods available as shown in station contact periods analysis of the subsystem portion of this study. The number of analog and digital channels available also exceed the measurement requirements of the experiments listed.

The data management profiles for each experiment are shown in Figure 209-6. The data processing figure shows the requirements for the two functions, data processing and data storage. Included as part of the data storage function are those operations required for converting the data into storable form, i.e., commutation, encoding, and multiplexing. The data processing function, then, includes such operations as data comparisons, data reduction for experiment control, and extrapolations of experiment data for prediction of future events or states. The data transmission figures show the requirements for real time transmission of data on the down link and real time up-data link utilization. The delayed data transmission and the up-data link commands for later execution are not included since these operations are more dependent upon ground station contacts and less dependent upon the individual experiment operating profile. Experiments not included in the figures do not require real time data management.

6. POWER PROFILES

The operating power profiles from experiments requiring electrical power are shown in Figure 209-7.

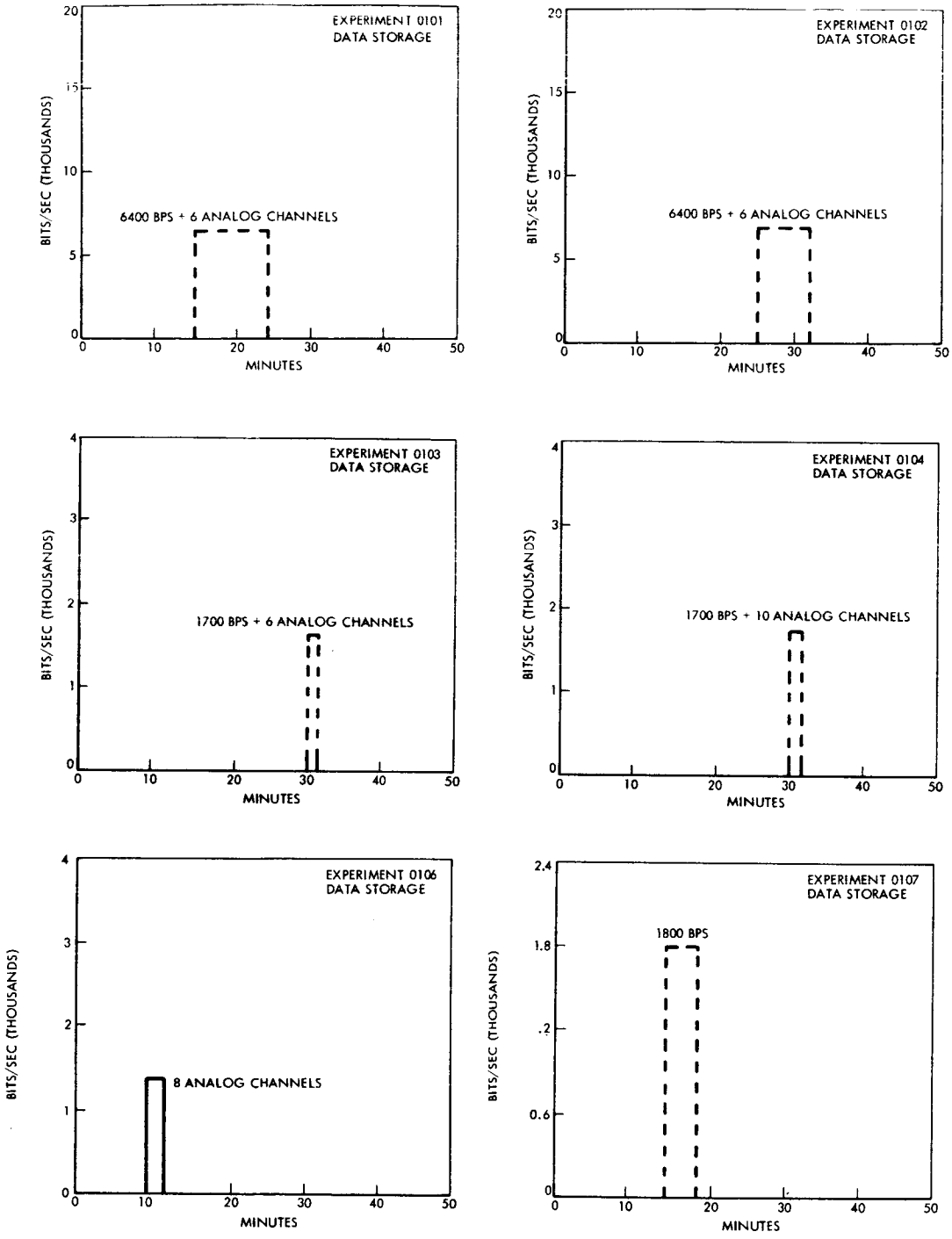

Figure 209-6. Data Management Profiles (Sheet 1 of 3)

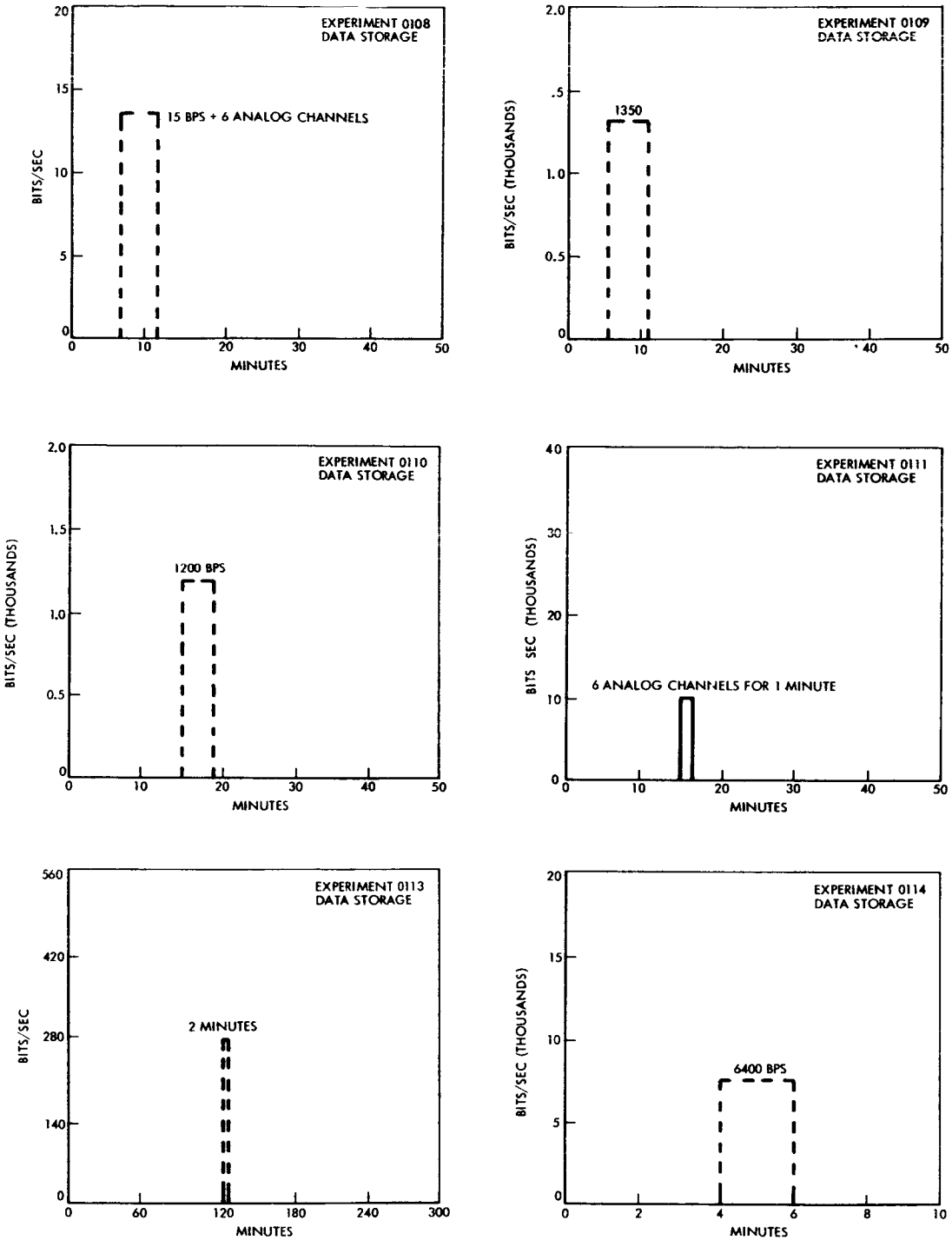

Figure 209-6. Data Management Profiles (Sheet 2 of 3)

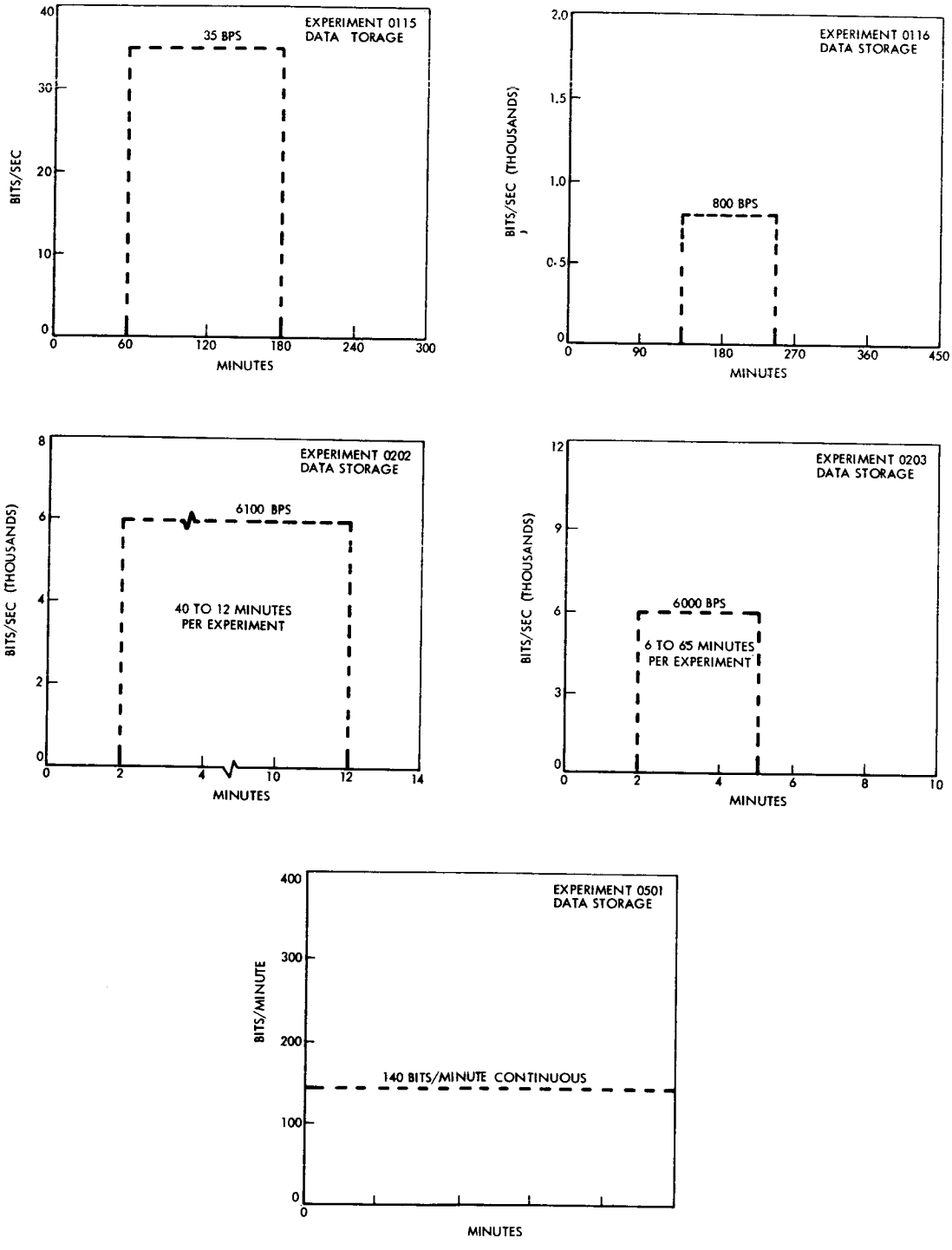

Figure 209-6. Data Management Profiles (Sheet 3 of 3)

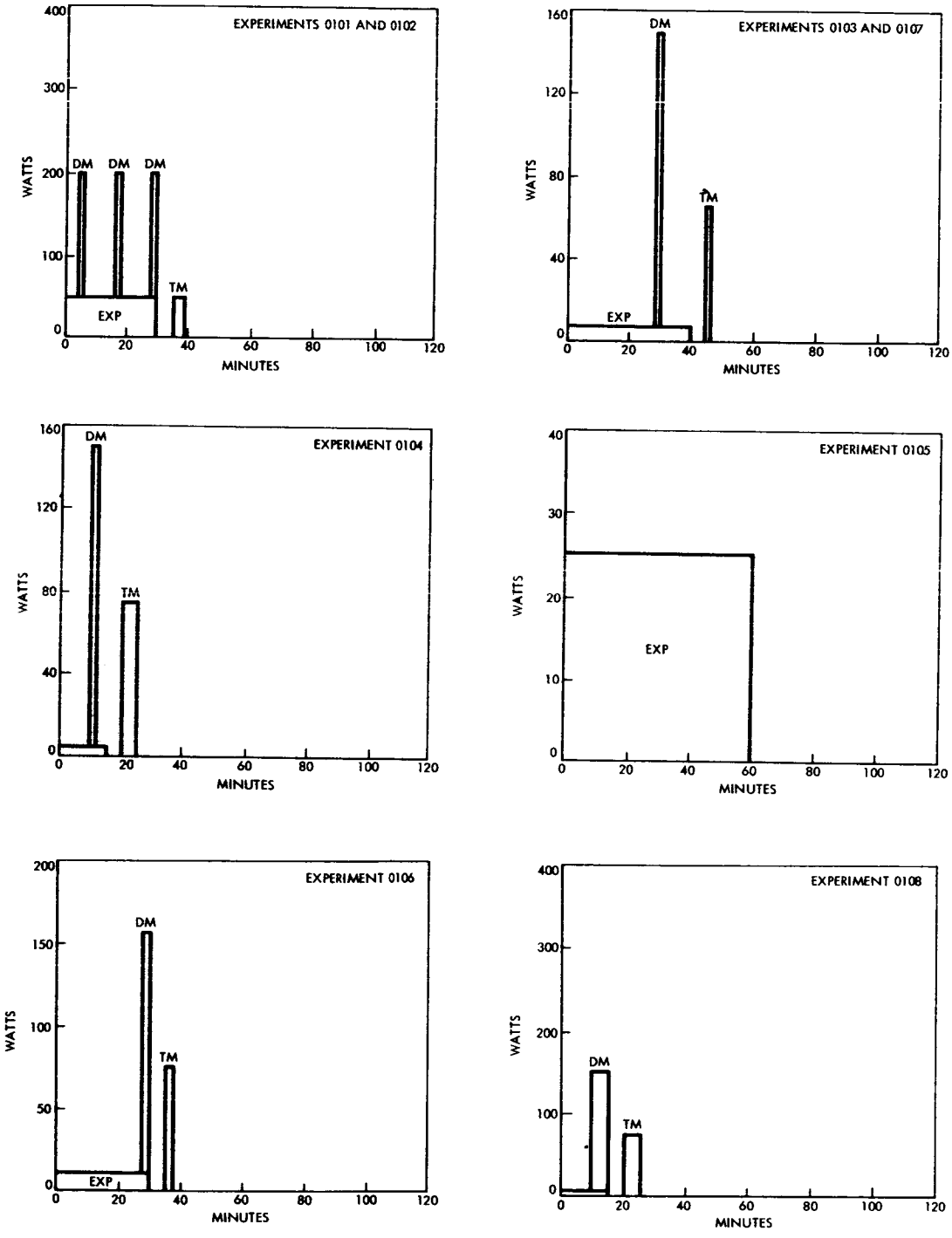

Figure 209-7. Operating Power Profiles (Sheet 1 of 5)

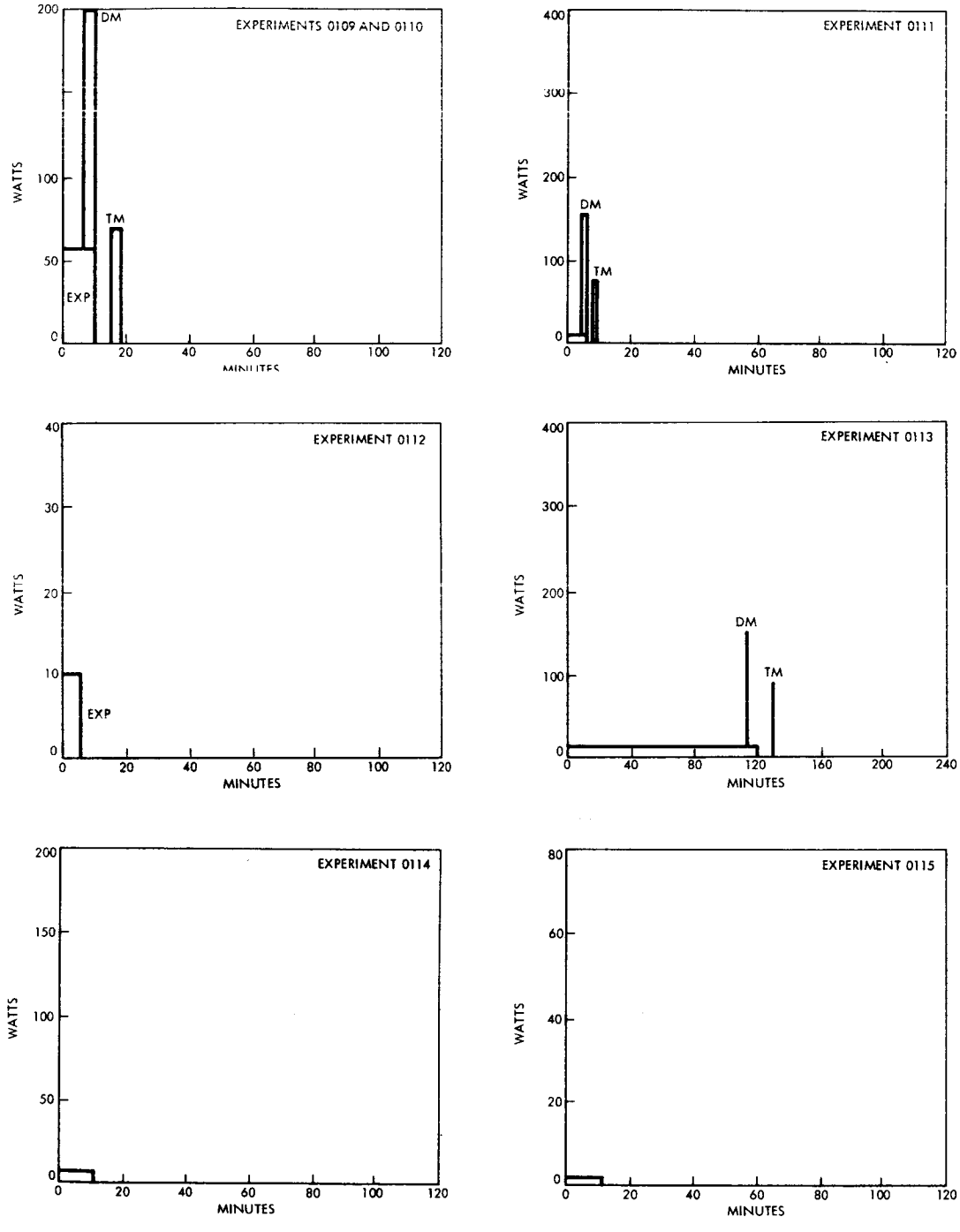

Figure 209-7. Operating Power Profiles (Sheet 2 of 5)

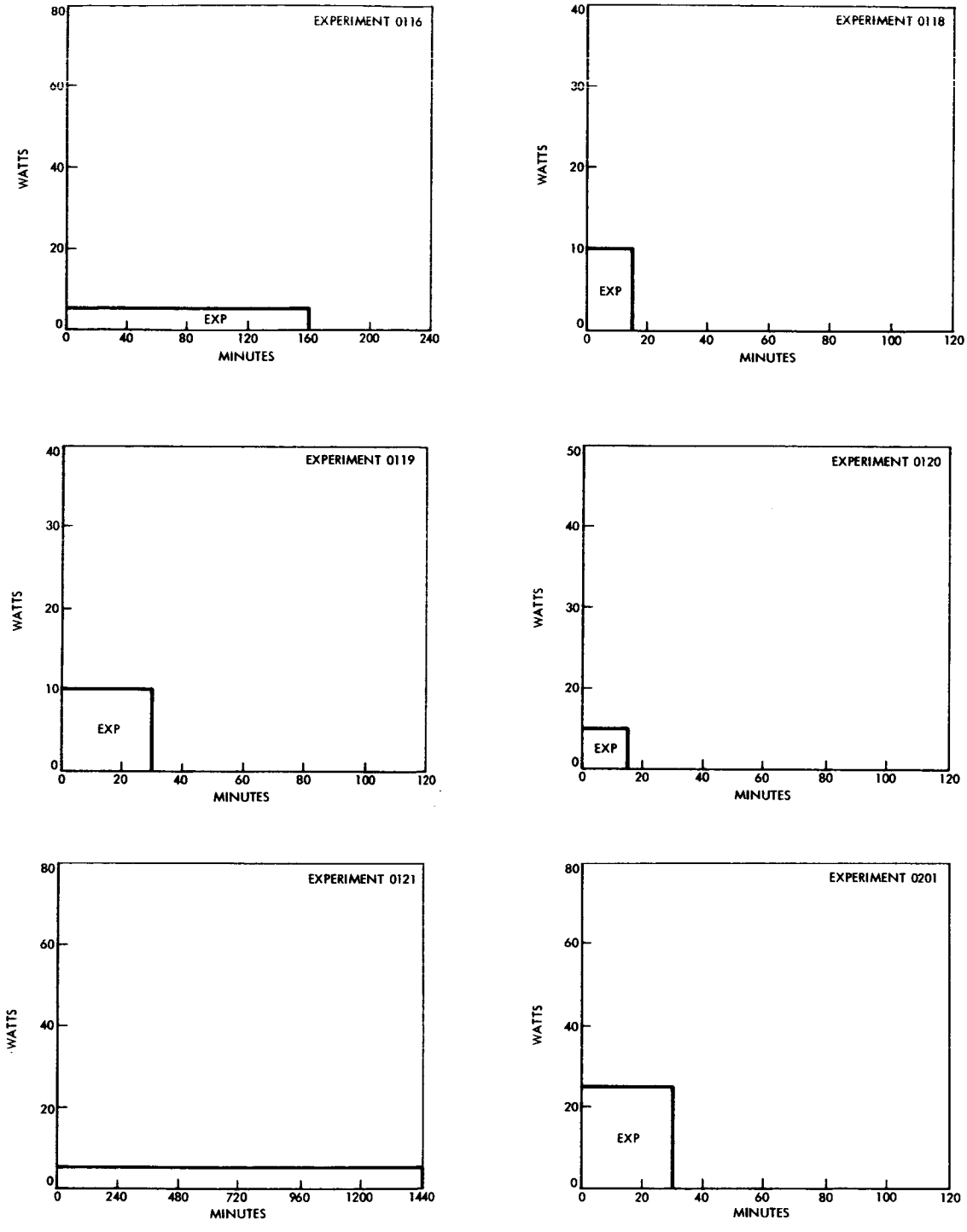

Figure 209-7. Operating Power Profiles (Sheet 3 of 5)

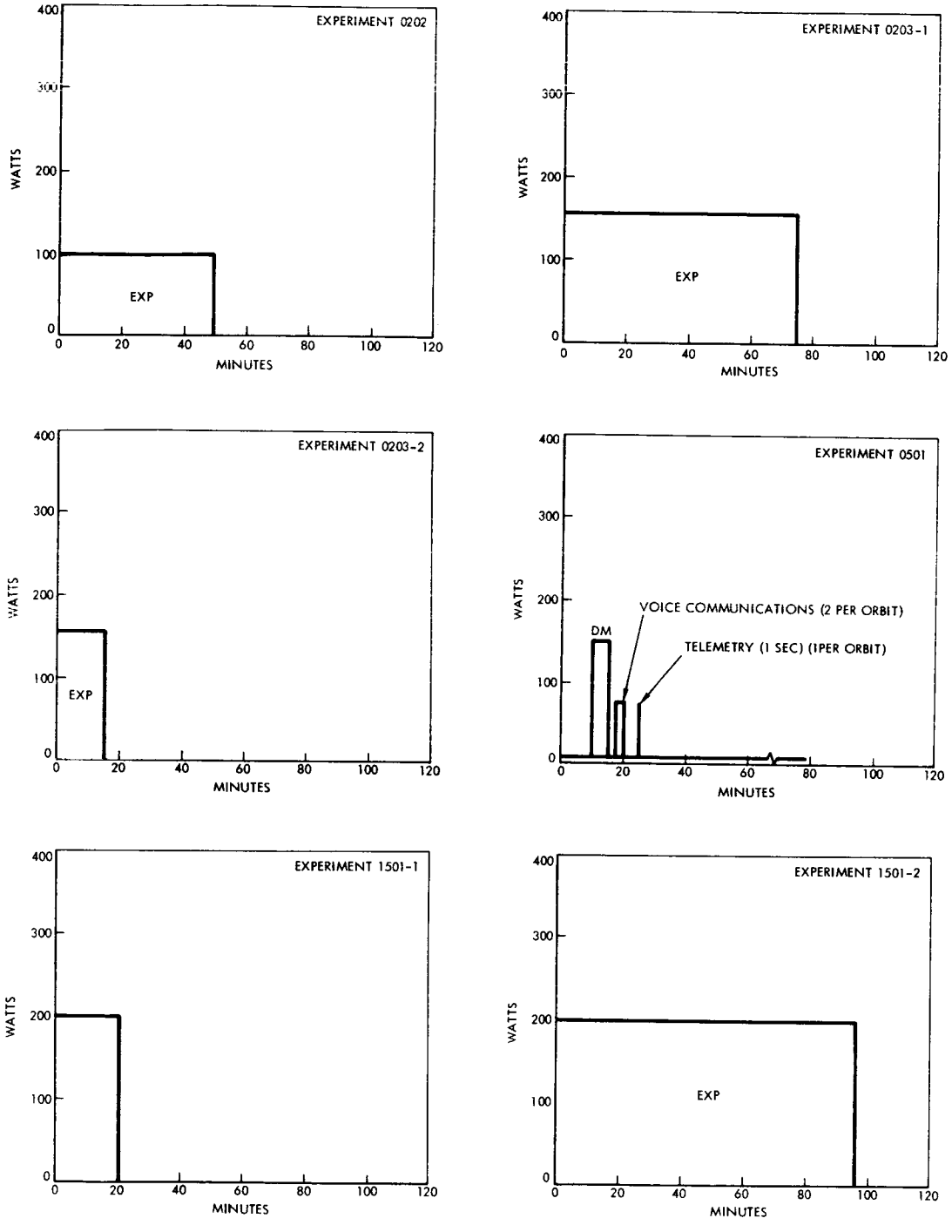

Figure 209-7. Operating Power Profiles (Sheet 4 of 5)

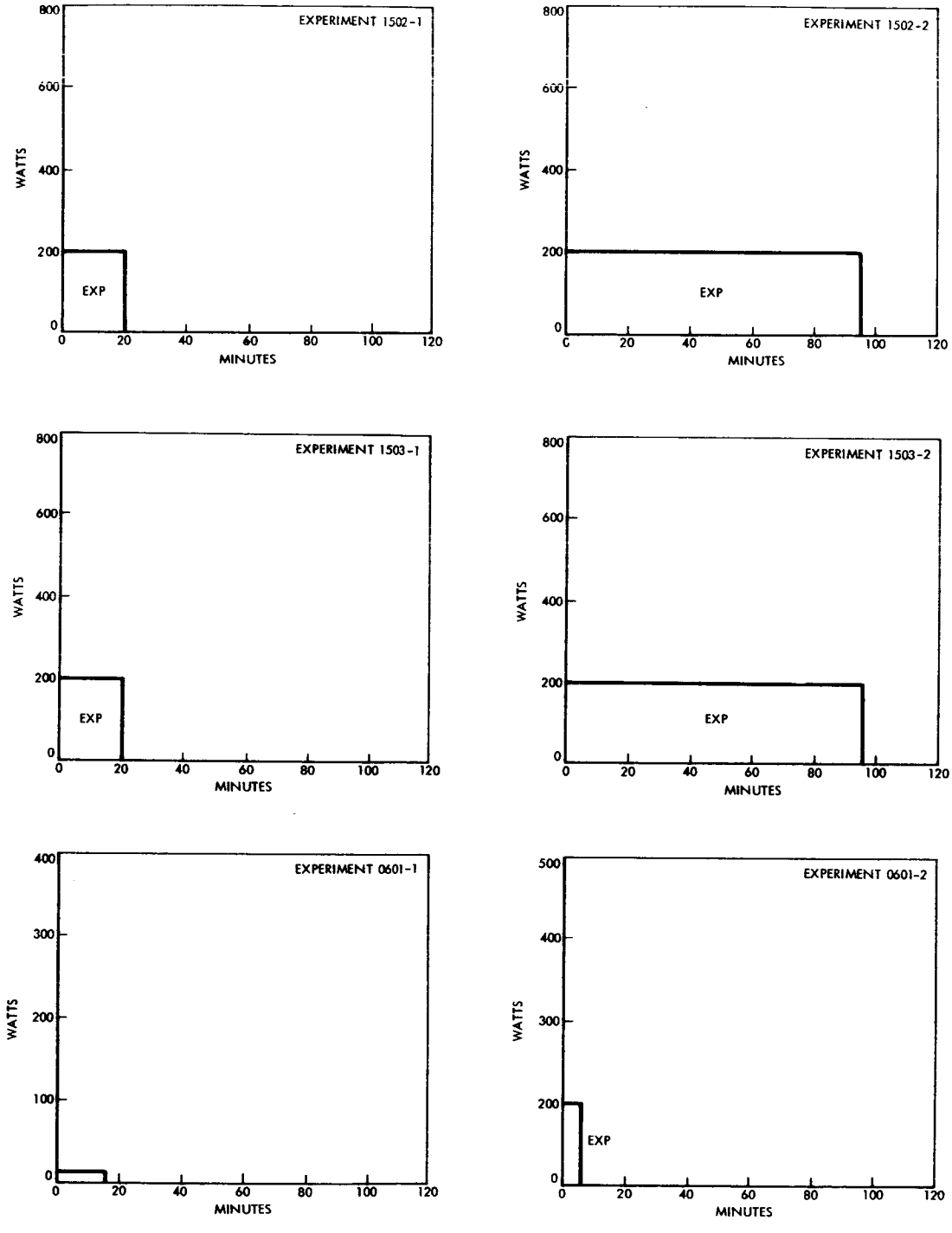

Figure 209-7. Operating Power Profiles (Sheet 5 of 5)

Table 209-12. Data Requirements Summary — 14-Day Flight

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	42	
0103, 0107	Analog	1	1/Day	15	75	14	
0104	Analog	3	1/Day	15	225	42	
0105	--	--			--	--	None
0106	Analog	2	1/6 Days	15	150	4.7	
0108		4	2/Day		300	12	
0109, 0110		4	3/7 Days		300	24	
0111	Analog	1	6/7 Days	15	75	12	
0112	--	--	--		--	--	None
0113	Analog	2	3/7 Days	15	150	12	
0114, 0121	--	--	--		--	--	None
0201-0203	--	--	--		--	--	
0501	3	Cont	1/Day		--	--	Multiplexed with Other Exper
1501	250	20	2/Mission	3-3/4	375		
1502	--						None
1503	--						None
0601	--						None

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

Requirements for RCS and SPS propellants as a function of the experiments are shown in Table 209-13.

8. CONTROLS AND DISPLAYS

The Integrated Control and Display panel discussed earlier in this volume meets all the requirements of this flight.

9. CREW FUNCTIONS

Crew times for experiments. except biomedical and behavioral which are included in the approach section, are shown in Table 209-14. Crew member specific times are indicated for crew member 1, 2, and 3 by C-1, C-2, and C-3 while time test can be attributed to any remaining crew member is shown as "Any C."

Crew operations on this flight encompass the standard medical and behavioral experiments described the approach along with 14 systems management and personal operations which, as shown in Table 209-15, are very similar for all flights.

Personal maintenance operations are standard sleeping, eating, personal hygiene, etc. functions which are common to all flights. Routine system management and personal functions occupy approximately 54 percent of orbital mission time for any mission.

Table 209-16 summarizes crew operations and crew times for each experiment, other than medical and behavioral, in this mission. The EVA sequence is described in the preceding section.

10. SUMMARY OF MISSION ACCOMPLISHMENT

While no major deviations from the specified experimental program are recommended for this flight, several unique mission characteristics became apparent as a result of the special environmental conditions required for conducting the biomedical/behavioral experiments. Experiments 0101 and 0102, required on all NASA flights, are designed to assess and evaluate the effects of linear acceleration and rotation on specific biomedical functions. In order to accomplish these experimental objectives, the spacecraft will be rotated at rates of 3, 6, and 9 rpm, once per week per crewman. A schedule of linear accelerations, up to a maximum of 1 g, is also required. For study purposes, an SPS firing interval of 10 seconds will be employed.

Liquid dynamics studies will also impose attitude control requirements up to a mission total of 3-1/2 hours.

Extra-vehicular activities required for this flight include space unit tests and manual locomotion and emergency rescue rehearsal experiments

Table 209-13. RCS and SPS Propellant Requirements

Experiment	Maneuvers	Propellant per Maneuver (lb)	Operations	Propellant (lb)
RCS REQUIREMENTS				
0101-0102	Spin profile	79.2	6	476.0
	Linear accelerations	13.0	4	52.0
1501	Maneuvers	1.56	16	25.0
1503	Maneuvers	1.56	16	25.0
1502	Maneuvers	1.56	16	25.0
0601	Attitude hold	0.25	14	3.5
TOTAL WEIGHT				606.5
SPS REQUIREMENTS				
0101	10 sec each - 4 cycles	700.0	4	2800.0

Table 209-14. Crew Times

Experiment	Specific Time (min.)				Flight Total (Hr)	Remarks
	C-1	C-2	C-3	Any C		
0501				4	1.0	Primarily monitoring
0501	45			45		
0502		45		45		Primarily EVA exercises
1503			45	45	17.5	
1501	120			120		
1502		120		120		
1503			120	120		
0601				20	7.0	Primarily equipment setup and control and observation
0601				11		
0100-0200					155.8	
TOTAL					181.3	

Table 209-15. Systems Operation

System	Crew Operation
ECS	Monitor; temperature and humidity regulation; change Lithium hydroxide cannisters every 12 hours
EPS	Monitor power parameters; purge fuel cells; switch to CM batteries for reentry
RCS	Monitor fuel parameters; attitude control as required; pilot operations in connection with transposition and dock
ECS	Align gyros prior to transfer to mission orbit
G&N	Navigation and automatic attitude hold inputs
Launch systems	Manual backup for staging, abort
Crew equipment systems	Utilization of seats, restraints as required

Table 209-16. Crew Experiment Function Description

Function	Description
Experiment 0501	
Calibrate	Possible periodic calibration of same sensing and display equipment
Observe, display	Monitor radiation display panel
Observe, non-display	Possibly note indications on films, emulsion packs, etc.
Other, process	Possibly process films, emulsion packs, and other indicators
Direct transmit	Real time transmission of critical developments
Record	Logbook recording of display readings and other observations
Tear-down, final	Store film, emulsion packs, etc. for Earth return

Table 209-16. Crew Experiment Function Description (Cont)

Function	Description
Experiment 0601	
Setup, initial	Set up cameras and other photo equipment; set up surfaces, timing equipment, and radioactive and other fluid-behavior recorders
Setup, periodic	Change tubes, deposit liquid on flat surface with syringe
Teardown, final	Disassemble and store equipment general to experiment
Teardown, periodic	Store equipment and materials used in one test which is not used in succeeding tests; e.g., syringe, radioisotopes
Observe, direct, non-man	Observe drop formation and behavior of liquids in transparent tubes
Observe, display	Monitor radiation and inductance readouts
Photo	High speed and still photography of fluid behavior
Record	Log records of observations - visual and instrument readouts
Experiment 1501	
Setup, periodic	Extra-vehicular activity (See EVA sequence in approach)
Teardown, periodic	Extra-vehicular activity (See EVA sequence in approach)
Apply, equipment, self	Maneuver, attitude control, ECS control of suit and AMU
Observe, self	Systematic self-test of maneuverability and suit environment control

Table 209-16. Crew Experiment Function Description (Cont)

Function	Description
Observation, other	Monitor all maneuvering, suit durability, ECS and safety parameters by inside observer; monitor AMU displays by subject in suit
Observe, display	Monitor suit pressurization, gas flow, force displays by observer; monitor AMU displays by subject in suit
Subject	Coordinate suit tests with vehicle and ground observation
Photo, etc.	Continuous motion picture and TV coverage of suit and AMU utilization
Direct transmit	Open line, real time commentary by subject and observer
Record	Log record of observations and display readouts
Experiment 1502	
Setup, periodic	EVA (see approach)
Teardown, periodic	EVA (see approach)
Apply equipment, self	Maneuver, attitude control, ECS control of suit, AMU, safety lines
Observe, self	Systematic self-test of maneuverability and suit ECS control
Observe, other	Monitor performance and status of EVA Crew members
Observe, display	Monitor suit parameters and AMU displays
Subject	Coordinate suit and AMU with observer vehicle; ground observation
Photo, etc.	Continuous motion picture and TV coverage of suit, AMU, and safety-line utilization

Table 209-16. Crew Experiment Function Description (Cont)

Function	Description
Direct transmit	Open line, real time commentary by subjects and observer
Record	Log record of observations and display readouts
Experiment 1503	
Setup, periodic	EVA (see approach)
Teardown, periodic	EVA (see approach)
Apply equipment, self	Maneuver, attitude control, suit ECS control, airlocks, AMU, safety lines
Apply equipment, other	Attach test devices for simulated handling of injured crew member
Observe, self	Systematic observation of self carrying out above functions
Observe, other	Systematic observation of other crew members carrying out above functions
Observe, direct, man-man	Observe inflatable airlocks and test satellite
Observe, display	Monitor suit parameters and AMU displays
Subject	EVA subject for intravehicular observer
Photo, etc.	Continuous coverage of EVA events
Direct transmit	Open line communication between all crew members and ground log record of observations and display readouts

FLIGHT 211: HUMAN RESEARCH AND MAPPING SYSTEM TECHNOLOGY

1. EXPERIMENTAL PROGRAM

Flight 211 will be launched into a 200 nautical mile, circular, Earth orbit with an inclination of 28.5 degrees. It will carry a three-man crew for a scheduled 30-day mission duration. The mission has the dual objectives of evaluating the effects of space environment on man for a 30-day period and of testing and validating the Lunar Mapping and Survey System prior to the Apollo exploration missions. Experiments performed during this mission are listed below.

Standard Group

0101-0120	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

0904	Lunar Mapping System Test (Sector I Installation)
1401	Personal Hygiene and Food Technology (abbreviated-shower/washing system not included)

2. MISSION OBJECTIVES

Because this will be the first mission in the AES Program that is of a duration greater than 14 days, a complete series of biomedical and behavioral experiments is desired. They will be essentially the same as those performed on Flight 209. However, some of the experiments may be modified with respect to frequency and/or crew time, based upon results of the previous flight.

Operation of the Lunar Mapping and Survey System checkout will approximate the sequence of events that would be followed in a lunar mission. The operating time, number of on and off events, and total amount of data collected will be essentially the same as would be required during a lunar

mapping and survey mission. Selection of surface targets, pointing of vehicle and sensors, photography, unloading/stowage of film cassettes, and observation of the critical subsystems operation will comprise the activities during the test periods. Extra-vehicular activity will be required for film retrieval and stowage in the command module at the end of the test.

Because problems of sanitation, personal hygiene, and eating are expected to become more critical in longer duration flights, pertinent systems development tests of new equipment will be included in the human experiment program. These tests are aimed at verifying methods of providing comfort and sustenance to the astronaut in extended space flight. Observations of methods of food preparation, eating, cleansing, personal ablutions, and waste disposal will be made throughout the flight. The radiation monitoring experiment will also be continued on this mission.

3. BASIC EXPERIMENT REQUIREMENTS

A summary of weight volume, crew time, EPS, and SCS requirements are listed in Table 211-17.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

The characteristics of the individual experiments are presented in Table 211-18. A general discussion of the details of the table and the significance of the various factors enumerated are in Flight 209.

5. DATA MANAGEMENT REQUIREMENTS

The standardized data management subsystem discussed in the Approach, is applicable for this flight. All data collected in Experiment 0904 (Lunar Mapping System Test) will be photographic, while Experiment 1401 (Personal Hygiene and Food Technology) has no requirement for data processing. As indicated in Table 211-19, the experiments will accumulate a maximum of 525 feet of tape per experiment. The transmission of data collected from all experiments selected for the mission totals 562.8 minutes for 30 days, or an average of 18.8 minutes per day. These requirements are compatible with the capabilities of the standardized data management subsystem.

The data management requirements for Experiment 1401 require voice recording only. Experiment 0904 will require return of film cassettes to Earth, but not data transmittal. Data management profiles for the radiation monitoring, biomedical, and behavioral experiments are included in an earlier flight.

Table 211-17. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0120, 0201-0203)	728.4	12.8	9.0	44.5	314.9	0.0	170.0	3.4	
Radiation monitor (0501) Sensors Spectrometers Film packs Dosimeters	50.0	1.0	1.0	3.81	2.0	0.0	1.0	0.01	
Personal hygiene and food technology (1401) Food Pads, bags, shaver Toilet						0.0	0.0	0.0	All requirements accounted for in SC operation
LMS checkout (0904)	1500.0	SEC-TOR I		80.1	24.8	23.4	125.0	2.0	
TOTAL	2278.4	13.8	10.0	128.4	341.7	23.4	296.0	5.4	

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min▲	7.0
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min▲	-
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min▲	-
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-

Table 211-18. Flight 211 Experiment Parameters (Sheet 1 of 2)

ORED OLUME U. FT.	REMARKS
0.6	*0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
1.8	
-	
-	
1.0	
-	
-	
9.0	
-	
0.25	
1.5	
-	
-	
0.05	
-	
-	
2.1	
-	
-	
0.01	
-	
-	
-	Lab work for 0113
0.25	
-	Schedule on 3 successive days
-	*Minimum rotation
-	
2.0	
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Start 7 days after 011743
0.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

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PRIORITY

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STORI VOLU CU. F
011907	0119	1061	1/2 Days				30			10	30							
511907	0119	1062	1/7 Days				30			10	30							
011207	0120	1071	1/14 Days				20			10	15							
511207	0120	1072	1/14 Days				20			10	15							
611207	0120	1073	1/14 Days				20			10	15							
										5								
										5								
FREEZER (LYOPHILIZER AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.							
020161	0201	1091	1/6 Days	82			33			30	26.						75.0	3.1
020152	0201	1092	1/6 Days		82		33			30	26							
020143	0201	1093	1/6 Days			82	33			30	26							
520161	0201	1094	1/6 Days	32			8			30	26							
520152	0201	1095	1/6 Days		32		8			30	26							
520143	0201	1096	1/6 Days			32	8			30	26							
020261	0202	1081	1/3 Days	63			14			105	50							
020252	0202	1082	1/3 Days		63		14			105	50							
020243	0202	1083	1/3 Days			63	14			105	50							
020361	0203	1101	1/6 Days	100						160	75							
020352	0203	1102	1/6 Days		100					160	75							
020343	0203	1103	1/6 Days			100				160	75							
520361	0203	1104	1/6 Days	40						160	15							
520352	0203	1105	1/6 Days		40					160	15							
520343	0203	1106	1/6 Days			40				160	15							
050101	0501	1191	1/3 Days	4						5.3	Cont				12,500	1 sec	50	2
050102	0501	1192	1/3 Days		4						For				per	per		
050103	0501	1193	1/3 Days			4					14 Days				orbit	orbit		
090407	0904	0035	1/4 Orbits				50	30	310	800	50	Towards earth		50			1500	Secto
090412	0904	0036	1/Mission	45	45					200	25			10				
1401xx	1401																	

Table 211-18. Flight 211 Experiment Parameters (Sheet 2 of 2)

D	REMARKS
ME	
T.	
	Schedule during 1st 2 days only
	Start 7 days after 01197
3	
	Schedule 3 days after 020161
	Schedule 3 days after 020152
	Schedule 3 days after 020143
	Schedule 3 days after 020361
	Schedule 3 days after 020352
	Schedule 3 days after 020343
r I	Schedule day side of orbit during first 7 days only (LMS checkout)
	Schedule after 7th day during daylight (EVA)
	Do not schedule - time accounted for in fixed times

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Table 211-19. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	90	
0103, 0107	Analog	1	1/Day	15	75	30	
0104	Analog	3	1/Day	15	225	90	
0105	--	--	--	--			None
0106	Analog	2	1/6 Days	15	150	90	
0108		4	2/Days		300	240	
0109, 0110		4	3/7 Days		300	51.4	
0111	Analog	1	6/7 Days	15	75	25.7	
0112	--						None
0113	Analog	2	3/7 Days	15	150	25.7	
0114-0121	--						
0201-0203	--						
0501	3	Cont					Multiplexed with Other Exps
0904							
1401							None

6. POWER PROFILES

Operating power profiles for Experiment 0904 are shown in Figures 211-8 and 211-9. The profiles for the radiation monitoring, biomedical, and behavioral experiments are included in an earlier flight. Experiment 1401 power is accounted for in Life Support System requirements.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

Requirements for RCS and SPS propellants as a function of the experiments are shown in Table 211-20.

Table 211-20. RCS and SPS Propellant Requirements

Experiment	Maneuvers	Propellant Per Maneuver (pounds)	Number Operations	Propellant (pounds)
RCS REQUIREMENTS				
0904	Attitude hold maneuvers		23.3 (hrs) 112	28.4 52.6
0101-0102	Spin profile	88	12	1060.0
	Linear accelerations	13	4	52.0
TOTAL				1193.0
SPS REQUIREMENTS				
0101	10 sec each - 4 cycles	700	4	2800.0

8. CONTROLS AND DISPLAYS

The integrated control and display panel will be modified by deleting the digital read-out as none of the experiments require this component.

9. CREW FUNCTIONS

Crew operation times are presented in Table 211-21. For this flight, all crew operations are generally similar to Flight 209 for system management

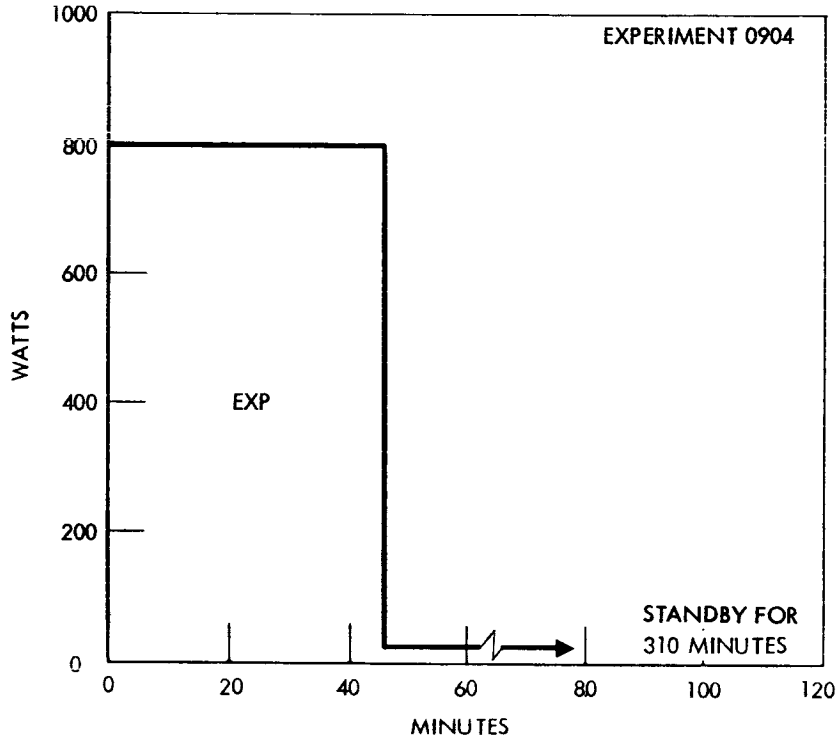

Figure 211-8. Operating Power Profiles, Data Collection

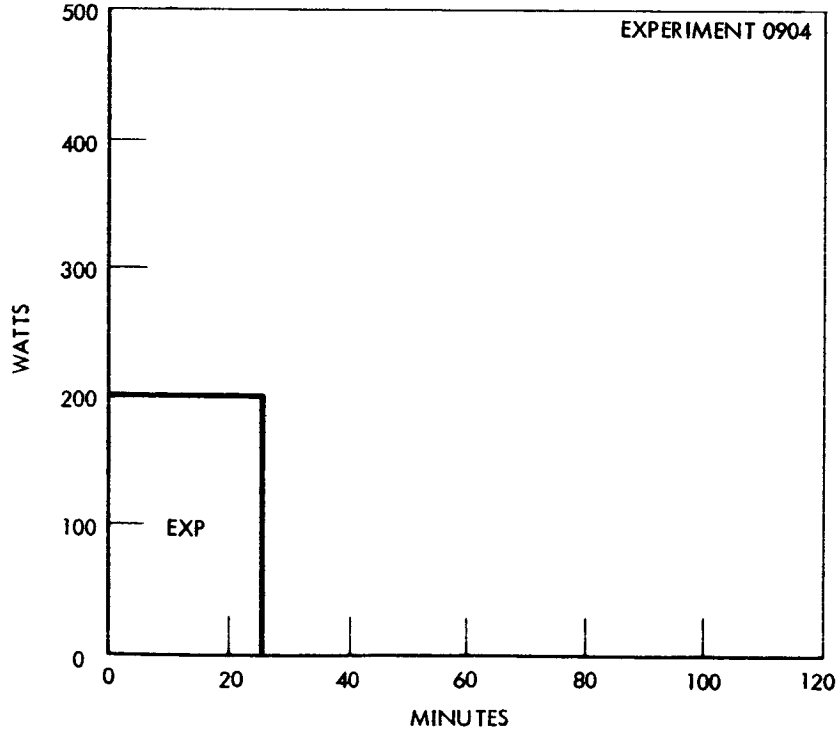

Figure 211-9. Operating Power Profiles, Data Retrieval

with an additional requirement for turning on fuel cells after 14 days. All crew experiment operations for this flight are described in Flight 209 except for Experiment 0904 described in Table 211-22, and 1401, which is simply an observation of standard crew hygiene and food technology.

Table 211-21. Crew Times

Exp	Specific Time (min)				Total (hrs)	Remarks
	C-1	C-2	C-3	Any C		
0904				50	24.8	Camera tending and monitor
0904	45	45				EVA camera tending
1401				0	0.0	Personal hygiene and food preparation
0501					2.0	For details see Flight 209
0100-0200					314.9	For details see Approach
TOTAL					341.7	

Table 211-22. Crew Experiment Function Description

Function	Description
Experiment 0904	
Setup, periodic	Checkout camera, warmup
Align	Visual alignment of camera with target area
Plot	Spacecraft orientation and attitude hold during runs
Observe, direct, non-man	Optical or direct visual observation of mapping target
Observe, display	Monitor camera operation displays
Process data	May utilize polaroid type film processing
Record	Record observations of equipment performance
EVA*	EVA operations in collection camera loading steps a-f and h-n
*EVA steps as shown in Approach	

10. SUMMARY OF MISSION ACCOMPLISHMENT

Flight 211 is the first 30-day mission oriented toward human research. However, 100 percent accomplishment of the experiment goals will not be achieved with existing RCS propellant limitations. It is necessary to delete seven of the twelve spin-ups suggested for Experiment 0102.

The linear accelerations (SPS firings) required by Experiment 0101 should be reduced to two to save weight by reducing the amount of SPS propellant required for the mission.

An objective of this flight is the checkout of Lunar Mapping System (LMS) equipment, which results in several specific mission characteristics. While the stabilization and control requirements are within Apollo accuracy capabilities, the uncertainty of the guidance and navigation reliability restricts mapping operations to the first seven days. LMS equipment qualifications will, therefore, be accomplished on each fourth orbit for 50 minutes on days two through seven. The LMS experiment will generate 125 pounds of film that will be retrieved manually from Sector I of the service module and returned to Earth in the command module.

FLIGHT 507: REMOTE EARTH SENSING AND ELECTROMAGNETIC RESEARCH

1. EXPERIMENTAL PROGRAM

This flight will be placed in a 200-nautical-mile, Earth-polar orbit for 14 days, with a crew of three men.

The following experiments will be flown:

Standard Group

0101-0120	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

0901	Multispectral Target Characteristics
0902	Synoptic Earth Mapping
1201	Measurement of Radio Frequency Radiation
1202	Wide-Bandwidth Transmission in Space
1405	Orbital Test of a Large Solar Cell Array (Mechanism and Deployment Testing Only)

2. MISSION OBJECTIVES

Biomedical and behavioral experimentation will not be emphasized in this flight. At this point, it will be known with certainty that man can survive and perform adequately in space for 30 days. Because the earlier concern in physiological and behavioral areas will have been reduced, proportionately more emphasis will be given to basic mission and systems technology.

This flight will provide the first manned Earth polar orbit, allowing a number of observations of natural communications manifestations as well as realistic checkout of equipment and techniques for surface mapping and sensing missions. In the area of subsystems test, the first check of large solar array deployment vital to prolonged duration future missions will be carried out.

The primary experiment programmed for the mission is the synoptic mapping of the Earth surface (0902). During the mission, stereocartographic photos of 20-foot resolution will be taken in such a manner that topographic maps of the desired height resolution may be prepared. Simultaneously, multicolor photography at a coarser resolution will permit reconstitution of subsequent full-color and modified false-color photos. During the mapping periods, additional surface characteristics will be obtained by reception of broad band VHF pulses; these pulses will indicate surface moisture conditions and passive reception of the Earth's microwave emission with a radiometer. Results of this experiment will be correlated later with the 14-day result of Flight 215 and the 45-day results of Flight 518.

A closely related experiment (0901) provides for the high-resolution examination of areas of the Earth's surface with a multispectral sensor, recording its surface infrared images and spectra as well as microwave imaging. The multispectral examination will utilize a 16-inch telescope for high resolution, and record images at selected points in the ultra-violet and infrared spectrum range. Spectra of selected targets in this frequency range may also be collected through the telescope. The crew's task will be to point the vehicle and/or sensor to see the desired targets adequately. In addition, images of the same surface areas in the infrared and microwave regions of the spectrum will be gathered by appropriate passive imaging sensors. This 14-day version of experiment 0901 will form the basis for later correlation with the same experiment of a 45-day duration (Flight 518) and 14-day duration (Flight 215).

Two other experiments will furnish experimental data closely related to the problem of Earth reconnaissance. The first of these (1201) will record the amplitude and spectral distribution of man-made radio frequency emissions from the Earth in the 100 mc to 15 kmc region. Measurement of these signals (or background noise) will be correlated with geographic position during the mission. The second experiment (1202) will require the spacecraft to make broad bandwidth data transmissions to selected ground station periodically; these transmissions will determine the effectiveness of

transmitters, data coding and modulation techniques, antennas, etc., in the high-frequency, very high frequency, and millimeter wavebands. It is possible that some portion of the data generated by the other high data rate experiments on this mission may be telemetered by this experiment.

In combination, the Radio Frequency Radiation and the Wide Bandwidth Transmission experiments provide a two-way communications path capable of high data transmission rates. The Synoptic Earth Mapping experiment and the Surface Mapping and Exploration experiment will generate large quantities of photographic data and magnetic tape recordings. With wide-band transmission capability aboard the same flight, it may be desirable to transmit some or all photomapping data via a video link to Earth for video tape recording. This approach will serve the dual purpose of testing wide band, high power transmitting systems and reducing data storage requirements imposed on the spacecraft.

An additional commonality of experimental requirements exists with regard to stabilization, attitude control and orbital characteristics. Stabilization and attitude control requirements of the Synoptic Earth Mapping experiment are the most stringent and, if these can be satisfied, stabilization requirements for all other experiments will be met. In order to obtain as complete a mapping of the Earth surface as possible, a polar orbit is necessary. The high inclination orbit will also provide a more complete coverage of radio frequency radiation and a wider range of targets for spectral measurements. To minimize transmission variables and to simplify the data recording system, it is also desirable that the orbit be circular. The Multispectral Target Characteristics experiment favors a low inclination orbit for ground site corroboration—an objective which will be accomplished on a subsequent flight of lower orbit inclinations. While a polar orbit affords optimum global coverage, the duration of this mission is not adequate for a complete global mapping. While the polar region may be mapped comprehensively, it is estimated that only 30 percent of the equatorial area can be mapped in 14 days. Subsequent polar orbit missions of 45-day duration will permit completion of the global mapping experiments.

A mechanical/operational test to determine the physical feasibility of deploying, pointing, and using a large solar cell array is embodied in experiment 1405. A mechanism similar to that which will be carried in the same experiment on Flight 518 will be used, but with a smaller solar array. The purpose of this test will be to photo record the ability of the crew to deploy and orient the array to the sun.

Special interface problems were encountered during experiments 0901 and 0902. These will require mounting on a stable platform. The infrared spectrometer and multispectral camera can be combined optically with the

telescope. The spectrometer requires a dewar and must be oriented towards Earth. For all cameras which require a change of film, the backs and side must be accessible to the astronaut. Thermal control is required for the equipment.

In the case of Experiments 1201 and 1202, the deployable antennas may be stored outside the rolls. The monopole, dipole and dish antennas must be oriented towards the ground when in operation.

Because of its large volume, the Solar Cell Array experiment must be stored in the unpressurized area of the rolls. The solar panels must be erected externally by means of extendable mechanical members.

It is required that the solar array be oriented with respect to the sun, and that the panels do not interfere with the field of view of other experiments.

3. BASIC EXPERIMENT REQUIREMENTS

The weight, volume, crew time, EPS, and SCS requirements of the experiments are listed in Table 507-23.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Pertinent parameters of the experiments conducted on this mission are shown in Table 507-24. The data formed the basic input to the automatic experiment scheduling program. Reference may be made to paragraph 4, Flight 209, for detailed description of the parameters presented in the table.

5. DATA MANAGEMENT REQUIREMENTS

As indicated in Table 507-25, Experiments 0901 and 0902 will be conducted simultaneously at a total data acquisition rate of 1137 bits per second for a period of 30 minutes. These experiments will be repeated three times per 11 orbits. The standardized data management subsystem will process this data readily in the low bit rate mode at a tape speed of 3-3/4 ips, with a tape accumulation of 563 feet per acquisition period. Experiment 1405 is processed in a similar manner while Experiments 1201 and 1202 require no data handling. The balance of the experiments listed will be processed by the standardized data management subsystem and recorded at the 15 ips tape speed. Total transmission time required for all experiments selected for Flight 507 is 330.3 minutes for the 30-day mission, or an average of 23.6 minutes per day.

Table 507-23. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0120, 0201-0203)	728.4	12.8	9.0	19.7	155.0	0.0	87.0	1.7	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	1.8	1.0	0.0	1.0	0.01	
RF radiation and transmission (1201, 1202) Antennas Transmitter Amplifier Receiver	414.0	0.0	14.0	7.9	1.33	0.0	10.0	0.2	
Surface mapping and exploration (901, 902) 16 inch optical telescope IR spectrometer IR image Multispectral camera Microwave imager	2593.0	0.0	96.0	30.0	46.5	64.0	757.0	15.5	
Subsystem development and test (1405) Solar array	262.0	0.0	41.0	0.0	2.98	0.0	4.5	0.1	Solar cell array
TOTAL	4047.4	13.8	161.0	59.4	207.6	64.0	857.5	17.5	

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STO VOLU CU.
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min▲	7.0	0
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min▲	-	
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-		7 min A	7 min▲	-	
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6	1
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-	
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-	
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0	1
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-	
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-	
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473	9
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-	
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0	0
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0	1
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-	
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-	
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2	0
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-	
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-	
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8	2
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-	
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-	
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6	0
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-	
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-	
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-	
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5	0
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-	
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-	
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-	
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9	2
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-	
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-	
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-	
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-	
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-	
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-	
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8	0
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-	

Table 507-24. Flight 507 Experiment Parameters (Sheet 1 of 2)

RED UME FT.	REMARKS
6	* 0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
8	
-	
-	
0	
-	
-	
0	
-	
25	
5	
-	
-	
05	
-	
-	
1	
-	
-	
.01	
-	
-	
-	Lab work for 0113
.25	
-	Schedule on 3 successive days
-	*Minimum rotation
-	
0	
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Start 7 days after 011743
0.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

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[redacted] PRIORITY

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STO VOL CU
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-	
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-	
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.	-	-	-	-	-	-	
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0	3
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-	
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-	
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-	
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-	
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-	
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-	
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-	
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-	
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-	
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-	
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-	
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-	
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-	
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-	
090107	0901, 2	32	1/11 Orbits				30			360	30	Towards earth		30	2.6×10^6	51 sec	2953	96
590107	0901, 2	33	1/11 Orbits				30			360	30	Towards earth		30	2.6×10^6	51 sec	-	
690107	0901, 2	34	1/11 Orbits				33			360	33	Towards earth		33	2.6×10^6	51 sec	-	
790107	0901, 2	1701	1/3 Days				15				-	-	-	-	-	-	-	
050101	0501	1201	1/3 Days	4						5.3	Cont.	-	-	-	-	-	50	2
050102	0501	1202	1/3 Days		4					-	For	-	-	-	12,500/	1 sec/	-	
050103	0501	1203	1/3 Days			4				-	14 Days	-	-	-	orbit	orbit	-	
140507	1405	35	3/Mission				45			-	-	Solar panel		-	-	-	262	41
640507	1405	36	11/Mission				4			-	-	Towards sun		-	-	-	-	
120107	1201-1202	37	4/Mission				20			83	1440	Towards earth		1440	*	*	414	14

Table 507-24. Flight 507 Experiment Parameters (Sheet 2 of 2)

RED UME FT.	REMARKS
-	Schedule during 1st 2 days only
-	Start 7 days after 011907
-	
-	
-	
-	
13	
-	
-	
-	Schedule 3 days after 020161
-	Schedule 3 days after 020152
-	Schedule 3 days after 020143
-	
-	
-	
-	
-	
-	
-	Schedule 3 days after 020361
-	Schedule 3 days after 020352
-	Schedule 3 days after 020343
-	Schedule immediately after 090107 } Peak power 460W for 1 sec
-	Schedule immediately after 590107 }
-	Maintenance and changing film
-	
-	
	Schedule starting in middle of daylight on 1st, 7th, and 14th days only
-	Schedule during daylight on 2nd, 3rd, 4th, 5th, 6th, 8th, 9th, 10th, 11th, 12th and 13th days
	* Uses 120L recorder and 1202 transmitter. Peak power 8KW for 5 min.

Table 507-25. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	42	
0103	Analog	1	1/Day	15	75	14	
0104	Analog	3	1/Day	15	225	42	
0105	--	--	--			--	None
0106	Analog	2	1/6 Days	15	150	4.7	
0108	↓	4	2/Day	↓	300	112	
0109, 0110		4	3/7 Days		300	24	
0111	Analog	1	6/7 Days	15	75	12	
0112	--	--	--			--	None
0113	Analog	2	3/7 Days	15	150	12	
0114 - 0121	--	--	--			--	None
0201-0203	--	--	--			--	None
0901, 0902	37	30	3/11 Orbits	3-3/4	563	57.3	
0501	3	Cont			--		Multiplexed with Other Exper
1405	5	30	11/Mission	3-3/4	563	10.3	
1201, 1202	--				--		None

Experiment 1202 requires an up-voice channel for verification. Experiment 1201 requires a tape recorder. Operating profiles for 0901-0902 and 1405 are shown in Figure 507-10.

6. POWER PROFILES

Figure 507-11 contains the operating power profile for each experimental task that has not appeared in a previous flight.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

The RCS and SPS propellant requirements are listed in Table 507-26

8. CONTROLS AND DISPLAYS

The integrated control and display panel is modified by the addition of a circular indicator and toggle switches for this flight.

Table 507-26. SPS and RCS Propellant Requirements

Experiment	Maneuvers	Propellant per Maneuver (lb)	Number Operations	Propellant (lb)
RCS REQUIREMENT				
0101-0102	Spin profile	88.0	6	530
	Linear acceleration	13.0	2	26.0
1405	Maneuvers		14	12.9
1202	Maneuvers	1.4	4	5.6
1201	Maneuvers	1.4	4	5.6
0901-0902	Maneuvers		60	112.0
	Attitude Hold		31.5 (hr)	91.4
TOTAL WEIGHT				896.5
SPS PROPELLANT REQUIREMENT				
0101	10 sec firing	700.0	2.	1400.0

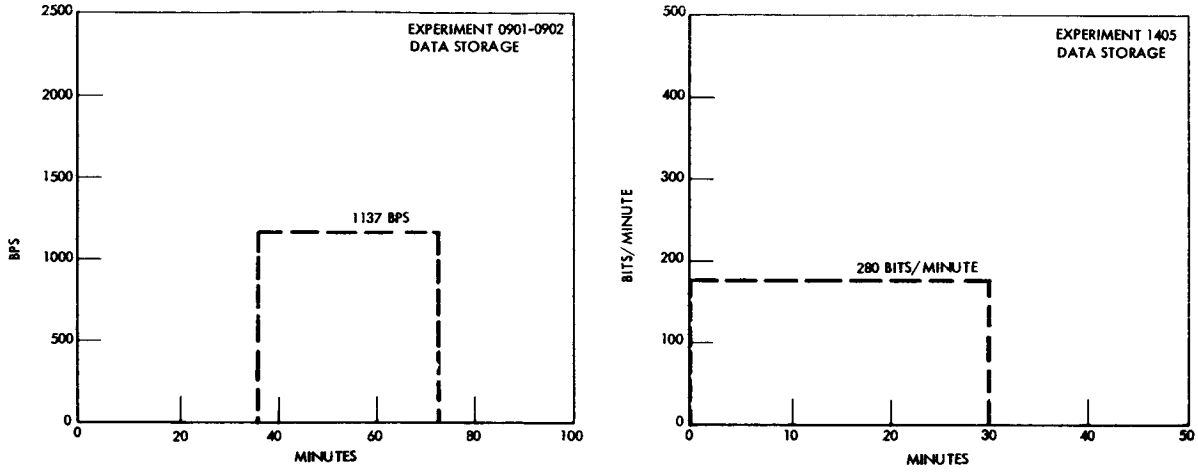

Figure 507-10 Operating Profiles

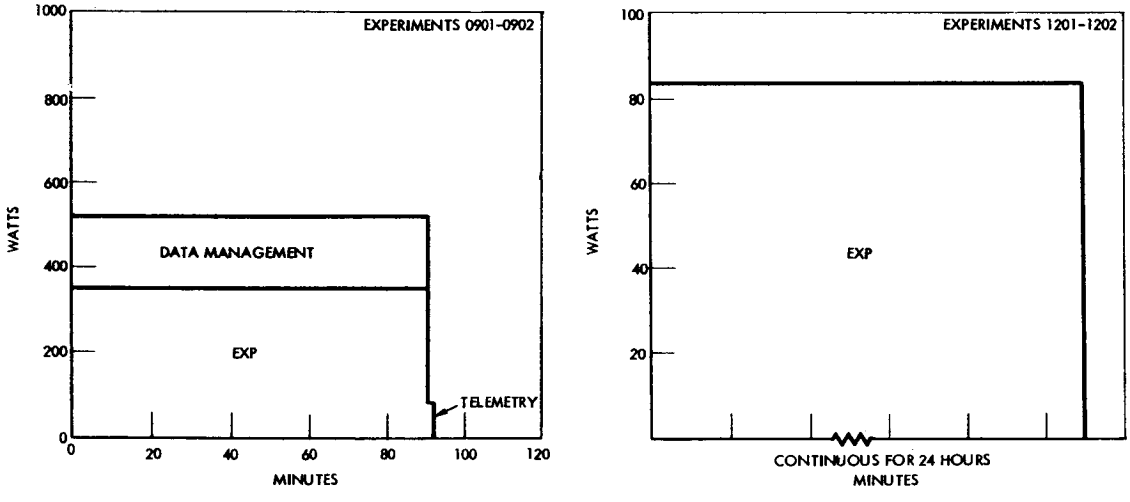

Figure 507-11 Operating Power Profiles

9. CREW FUNCTIONS

Table 507-27 summarizes crew times for this flight. For experiments not described previously, these times are shown as specific to certain crew members or referable to any crew member; for previously described experiments, these times are summarized as totals for the flight.

Table 507-27. Crew Times

Experiment	Specific Time (min)				Flight Total (hr)	Remarks
	C-1	C-2	C-3	Any C		
0901, 2				30	46.5	General sensor selection; Earth target selection; monitor
0901, 2				30		
0901, 2				33		
1201, 2				20	1.3	Mainly communication channel monitoring
1405				4	3.0	Mainly external structure observation
1405				45		
0100-0200					155.8	
0501					1.0	
TOTAL					207.6	

Crew system management operations for Flight 507 are essentially the same as those in Flight 209. Crew experiment operations for those experiments not previously described on other flights are generally concerned with earth target sensing and communication procedures. Table 507-27 describes the crew operations involved in the experiments not previously described.

Table 507-28. Crew Experiment Function Description

Function	Description
EXPERIMENT 0901	
Set-up, periodic	Select sensors, checkout equipment, warm-up
Tear down final	Store film for earth return
Calibrate	Calibration utilizing calibration feature of equipment
Align	Intra sensor alignment, e.g., via optical scopes
Pilot	Altitude orientation and hold during measurements
Observe, direct, non-man	Visual and optical selection of target area
Observe, display	Monitor sensor data, e.g., on CRT
Photo	Possibly activate film exposure
Process	Screen and discard data
Direct transmit	Coordinate with ground support
Record	Log record of data and observations
EXPERIMENT 0902	
Set-up, initial	Remove camera from storage and position for use, probably remote control positioning
Set-up, periodic	Load film, frame ground area in view finder, turn on camera, check out camera
Tear down, periodic	Remove and store film, secure camera

Table 507-28. Crew Experiment Function Description (Cont)

Function	Description
Pilot	Set up attitude orientation, may be manual or by programming computer
Observe, direct, non-man	Visual inspection of area to be photographed
Observe, display	Monitor camera operation displays (1 man) and attitude control (1 man)
Photo, etc.	See above
Direct, transmit	Coordination of photography with ground
Record	Log photo control parameters and comments on visual inspection of ground area
EXPERIMENT 1201	
Set-up, periodic	Select frequency scan segments, check equipment, set-up for photography
Teardown, periodic, N-CDM	Teardown camera set-up, turn-off equipment
Calibrate	Calibration of equipment before each test, probably calibrate of control and display panel.
Pilot	May require gross orientation of vehicle before each or some tests
Observe, display	Monitor equipment operation and reception parameters during test
Photo	Polaroid photo of oscillograph
Direct transmit	Coordinate test runs with appropriate ground stations
Record	Log record experiment plan and significant observations

Table 507-28. Crew Experiment Function Description (Cont)

Function	Description
EXPERIMENT 1202	
Set up, periodic	Select transmitter, signals, variable parameters; turn on and warm up equipment; checkout equipment, all at control and display panel
Calibrate	May be required as part of setup.
Observe display	Monitor equipment performance and reception indicator parameters as provided for in display design.
Direct transmit	Coordinate signal selection, etc., with ground stations.
Record	Log record parameters observed from display panel; also, any unusal events connected with equipment functioning, etc.
EXPERIMENT 1405	
Set-up, initial	Manual control of servomotors for deployment
Calibrate	Calibration will be from control and display panel
Alignment	See Calibration (above)
Pilot	May require ΔV and attitude control for drag, etc. Also measures possible attitude control for orientation.
Observe	Observation of deployment and status of structure
Observation, display	Monitor deployment, calibration, alignment, performance, status displays

Table 507-28. Crew Experiment Function Description (Cont)

Function	Description
Photo	Photographic and TV coverage of deployment and structural status
Direct transmit	Open-line communication between all crew members and ground during deployment
Record	Log record of observations noted above

10. SUMMARY OF MISSION ACCOMPLISHMENT

This flight is the first in a series of flights to be launched into polar orbit. As such, it has several unique characteristics. In order to achieve the polar orbit, a yaw steering boost program is required. Several inhabited islands lie along the proposed flight path; therefore, special consideration must be given to the location of booster impact.

This flight will include the following: deployment tests of the solar array, RF radiation measurement and transmission studies, the Earth-mapping experiment, etc. In order to accomplish the scheduled experiments and ensure mission duration, additional batteries will be required in the experiments rack. Deletion of two of the six spin-ups required in experiment 0102 will be necessary due to RCS propellant limitations. To alleviate the guidance and navigation reliability problem, minor modifications of the stabilization and control system will be considered.

FLIGHT 509: ADVANCED SPACE OPERATIONS AND TECHNIQUE

1. EXPERIMENTAL PROGRAM

Flight 509 will be placed in a synchronous equatorial orbit for 14 days. It will carry a two-man crew due to the volume requirement in the Command Module for return of the Syncom III satellite. The synchronous orbit will require an altitude of 19, 300 nautical miles. Experiments will consist of the following:

Standard Group

0101-0120	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

1603	Recapture of Syncom III
1302	Deployment of RF Reflective Structures
1303	Extendable Rod Performance Tests
1304	Operation of Solar Sailing Passive Communications Satellite
1306	Large Aperture Space Erectable Antenna (30-ft diameter)
1601	Orbital Maneuvering and Docking (Phase I and Phase II)
0801	Conjugate Aurora and Airglow
0705B	Radio Astronomy 1-5 MXPS Range (Using Extendable Rod as Antenna)

2. MISSION OBJECTIVES

Flight 509 will include more complex maneuvers than have been previously attempted. The Apollo spacecraft will be placed in a synchronous orbit for the first time, and will there engage in complex operations relative to other orbiting objects. Deployment and performance of large antennas, rendezvous and docking with an unmaneuverable satellite (Syncom III) and other precise maneuvers will be attempted.

Four experiments (1302, 1303, 1304, and 1306) are concerned with the deployment of unwieldy or bulky external devices, including fibrous rf reflective expandable structures, extendible or inflatable long rods or tubes, large diameter erectable antennas, or inflatable solar sail structures. These experiments may be conducted during the early stages of the mission as desired. Deployment will take place external to the vehicle, and once an experiment is completed, the deployed device will be cast off to make way for the next device under test. Experiment 1302 will require ground-based evaluation of passive rf return of ground signals, whereas Experiment 1306 will receive either ground signals or galactic radio sources for tests of side tubes, tracking and foresight errors, etc.

Data return on the mechanical deployment experiments 1302, 1303, 1304, 1306 will consist of photos and comments on the physical aspects of the deployment of rf-reflective expandable structures, extendible rods, solar rail shapes, and large-aperture rf antennas. Ground stations will determine the reflective characteristics of the first items while on board, records of the latter devices rf directive characteristics will be made.

At synchronous altitudes, a good view of the conjugate aurora can be obtained, and Experiment 0801 will record this phenomenon by photography, spectral data, ionized particle counts, etc.

The mapping of galactic rf noise in the 1 to 5 mc range of frequencies will be accomplished by Experiment 0705B. A tunable V antenna with legs 1000 to 2000 feet long will be formed from extendible rods or tapes of the type used in Experiment 1303. The synchronous orbit altitude will minimize atmospheric drag and gravity-gradient distortion of the antenna arms during the experiment. Records of galactic noise levels, directions, source, sizes, etc., will be made.

Near the end of the mission, a series of orbital maneuvering and rendezvous tests will be performed (Experiment 1601) using visual and radar tracking of the target. The target against which the test will be performed is the Syncom III satellite. A final approach and capture of this target with subsequent return of the device to Earth in the Command Module is the aim of Experiment 1603. An attempt to recover Syncom III for Earth

inspection will provide a test of acquisition and return of sizable weights and volumes. To achieve an equatorial orbit at 19,300 nautical miles necessitates traveling through the portion of the Van Allen belt with the highest density radiation. Once in orbit, the test crew members will be subject to possible hazard due to radiation from solar flares.

Biomedical and behavior experimentation will continue to study in depth untoward reactions observed in earlier flights and will emphasize the search for preventive measures and countermeasures for deleterious effects of space flight. On the assumption that man has been demonstrated to remain relatively unimpaired in space, his capability to accomplish more complex tasks will be studied.

Special Interface Problems:

Because this flight has many large erectable, extendible, or inflatable structures to deploy from the rack, only one at a time will be deployed so that there will be no danger of one device interfering with another. The first experiment to be performed is the first part of the Extendible Rod Performance Test, 1303. A 200-foot extendible rod will be deployed from the rack, observed, and then discarded. The next experiment to be carried out is 1302, Deployment of RF Reflective Structure. For this experiment a 50-foot diameter balloon, stowed in a rack, will be deployed on a tether. This experiment is jettisoned at its conclusion. Experiment 0705B, Radio Astronomy with "V" Antenna, is conducted with the extendible rods of Experiment 1303. The first 2000-foot rod must be extended from the rack to various lengths and checked. Then the second 2000-foot rod is extended full length and the antenna experiment conducted. The rods are jettisoned at the conclusion of the experiment before the balloon for the solar sailing experiment, 1304, is released. This experiment is jettisoned before Experiment 1306 is initiated. The antenna must be stowed in a canister at the bottom of the rack on the booster, because its size does not allow it to be stowed in any of the rack sectors. The antenna must be deployed from the stowed canister and jettisoned after the experiment is complete so that there are no large appendages on the CSM and rack while performing the last experiment, 1603, The Capture of Syncom III.

After rendezvousing with Syncom III, a telescopic boom with a net is extended from the rack. The rotating satellite must be despun using the net and a braking mechanism on the boom. After the satellite is despun, the telescoping boom brings it into the unpressurized portion of the rack where the antennas are removed with metal cutters; at the same time a shaped charge with a guard is placed on the engine nozzle. The satellite must again be extended out on the boom where the charge is fired to sever the nozzle. The two components must then be brought back to the rack and taken into the CM through the airlock and stored.

Experiment 0801, Conjugate Aurora and Airglow, must be located partly in the airlock and partly in the unpressurized section of the rack. The optical systems must be stored in the airlock and assembled on the door when in use. The magnetometer must be extended out of the rack by means of a motor-driven storable tape element, while the plasma probes remain attached to the rack.

3. BASIC EXPERIMENT REQUIREMENTS

The weight, volume, crew time, EPS, and SCS requirements are given in Table 509-29.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Pertinent parameters of the experiments carried on this mission are shown in Table 509-30. This data formed the basic input to the automatic experiment scheduling program. Reference may be made to Paragraph 4, Flight 209, for detailed definition of the parameters presented.

5. DATA MANAGEMENT REQUIREMENTS

The data management requirements for Flight 509 are summarized in Table 509-31. The figure indicates a maximum tape footage requirement of 1125 feet (1/2 reel), a total transmission time per mission of 296 minutes, and an average transmission time per day of 21.1 minutes. Hence, the data management subsystem described under "Approach," is capable of performing the data management functions required by Flight 509. It should be noted that the experiment frequency is altered by the utilization of the two-man crew rather than the three-man crew considered for other flights.

Figure 509-12 shows the data processing profiles for Experiments 0705-B, 0801, and 1313. Other technical experiments will not require data processing in quantity. Reference can be made to Paragraph 6, Flight 209, for data processing profiles for the biomedical/behavioral series.

6. POWER PROFILES

Figure 509-13 contains the operating power profile for each experimental task that has not appeared in a previous flight.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

Table 509-32 specifies the amount of RCS and SPS propellants required to support the technical experiments for attitude-hold and maneuvering during this flight.

Table 509-29. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0100-0200)	728.4	12.8	9.0	18.8	114.9	0.0	57.0	1.0	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	1.17	0.66	0.0	0.7	0.0	
Recapture of syncom III (1601, 1603) Capture net	16.0	0.0	1.2	0.3	4.0	2.0	96.0	5.8	Data return including syncom III
Deployment of RF structure (1302, 1303) Large deployable structure Tether system Power supply and receiver	300.0	0.0	17.0	0.10	4.0	6.0	4.0	0.1	
Evaluation of solar sailing satellite (1304) Large inflatable balloon Tether system Power supply and receiver	100.0	0.0	4.2	0.15	3.0	15.0	2.0	0.0	
Large aperture space erectable antenna (1306) Unfurling mechanism Mechanical support structure	525.0	0.0	204.0	8.7	2.0	14.5	2.0	0.0	
Radioastronomy-galactic noise mapping (0705B) Large unfurlable "V" antenna	75.0	0.0	3.0	0.16	2.9	7.1	10.0	0.1	
Conjugate aurora and airglow sensing (0801) Spectrographic photometers Telescope	105.0	0.0	6.5	0.35	2.3	0.0	10.0	0.1	
TOTAL	1899.0	13.8	245.9	29.9	133.8	44.6	181.7	7.1	

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PRIORITY

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
010221	0101,0102	1141	1/7 Days	40	40					40	30	-	-	See Remarks	7 min A	7 min▲	7.0
010212	0101,0102	1142	1/7 Days	40	40					40	30	-	-	See Remarks	7 min A	7 min▲	-
010321	0103,0107	1001	1/3 Days	50	50					6	40	-	-	-	1 min A	1 min	33.6
010312	0103,0107	1002	1/3 Days	50	50					6	40	-	-	-	1 min A	1 min	-
010421	0104	1021	1/3 Days	20	20					6	15	-	-	-	3 min A	3 min	5.0
010412	0104	1022	1/3 Days	20	20					6	15	-	-	-	3 min A	3 min	-
010521	0105	1151	1/7 Days	10	80					25	60	-	-	-	-	-	10.0
010612	0106	1011	1/6 Days	30	30					8	30	-	-	-	2 min A	2 min	-
010821	0108	1031	2/1 Days	25	5					5	15	-	-	-	4 min A	4 min	3.0
010921	0109,0110	1041	1/7 Days	35	35					56	10	-	-	-	4 min A	4 min	30.0
010912	0109,0110	1042	1/7 Days	35	35					56	10	-	-	-	4 min A	4 min	-
011121	0111	1111	2/7 Days	15	15					15	5	-	-	-	1 min A	1 min	3.2
011112	0111	1112	2/7 Days	15	15					15	5	-	-	-	1 min A	1 min	-
011221	0112	1044	1/7 Days	5	5					10	5	-	-	-	-	-	36.8
011212	0112	1045	1/7 Days	5	5					10	5	-	-	-	-	-	-
011321	0113	1121	1/7 Days	40	40					5	40	-	-	-	2 min A	2 min	0.6
011312	0113	1122	1/7 Days	40	40					5	40	-	-	-	2 min A	2 min	-
011304	0113	1123	1/7 Days			60				5	60	-	-	-	-	-	-
011404	0114	1131	2/7 Days			10				4.5	10	-	-	-	-	-	0.5
011501	0115	1161	3/14 Days	10						1	10	-	-	See Remarks	-	-	-
011502	0115	1162	3/14 Days		10					1	10	-	-	See Remarks	-	-	-
011621	0116	1171	1/14 Days	30	160					5	160	-	-	-	-	-	47.9
011721	0117	1051	1/2 Days	5	5					-	-	-	-	-	-	-	-
011712	0117	1052	1/2 Days	5	5					-	-	-	-	-	-	-	-
511721	0117	1053	1/7 Days	5	5					-	-	-	-	-	-	-	-
511712	0117	1055	1/7 Days	5	5					-	-	-	-	-	-	-	-
011804	0118	1054	1/2 Days			23				10	15	-	-	-	-	-	12.8
511804	0118	1058	1/7 Days			23				10	15	-	-	-	-	-	-
011904	0119	1061	1/2 Days			30				10	30	-	-	-	-	-	-
511904	0119	1062	1/7 Days			30				10	30	-	-	-	-	-	-
012004	0120	1071	1/14 Days			20				10	15	-	-	-	-	-	-
512004	0120	1072	1/14 Days			20				10	15	-	-	-	-	-	-
FREEZER (LYOPHILIZER) & REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont						

Table 509-30. Flight 509 Experiment Parameters (Sheet 1 of 2)

TORED OLUME U. FT.	REMARKS
0.2	0, 3, 6, 9, 6, 3, 0 RPM Fire SPS
	▲Also real time TV or cine-camera for 25 min/exp
-	
1.8	
-	
1.0	
-	
0.03	
-	
0.25	
1.5	
-	
0.05	Peak Power 25 watts 2 min
-	
2.1	Peak Power 500 w 5 sec
-	
0.01	
-	
-	Lab work for 0113
0.25	
-	Minimum rotation, schedule on 3 successive days
-	
2.0	
-	During first 2 days only
-	
-	Start 7 days after 011721
-	Start 7 days after 011712
0.11	During first 2 days only
-	Start 7 days after 011804
-	During first 2 days only
-	Start 7 days after 011904
-	
-	
	The watts are average and consider intermittent-operation

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PRIORITY

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
020121	0201	1091	1/6 Days	82	33					30	26	-	-	-	-	-	75.0
020112	0201	1092	1/6 Days	33	82					30	26	-	-	-	-	-	-
520121	0201	1093	1/6 Days	32	8					30	26	-	-	-	-	-	-
520112	0201	1094	1/6 Days	8	32					30	26	-	-	-	-	-	-
020221	0202	1081	1/3 Days	63	14					105	50	-	-	-	-	-	-
020212	0202	1082	1/3 Days	14	63					105	50	-	-	-	-	-	-
020301	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-
020302	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-
520301	0203	1103	1/6 Days	40						160	15	-	-	-	-	-	-
520302	0203	1104	1/6 Days		40					160	15	-	-	-	-	-	-
130304	1303	35	1/Mission			60				10	60	-	-	60	-	-	150
130204	1302	33	1/Mission			120				10	120	-	-	120			150
630304	1303	36	1/Mission			60				10	60	-	-	60	-	-	-
070504	0705B, 1303	34	1/Mission			120				160	10	Away from earth		10	10^7	195 sec	75
570504	0705B	41	1/6 Orbits			10				160	10	Away from earth		10	10^7	195 sec	-
130404	1304	37	1/Mission			60				10	60	-	-	60	-	-	100
630404	1304	39	1/8 Orbits			30				10	30	-	-	30	-	-	-
130604	1306	38	1/Mission			60				600	30	Towards earth		30			525
630604	1306	42	1/Day			10				600	60	Towards earth		60	-	-	-
160321	1601,1603	32	1/Mission	120	120					200	90	-	-	120	-	-	16.0
050101	0501	43	1/2 Days	4						5.3	cont for 14 days	-	-	-	12,500/ Orbit	1 sec/ Orbit	50.0
050102	0501	44	1/2 Days		4					-		-	-	-			-
080104	0801	40	1/2 Days			20				50	60	Towards earth		60	-	-	105

Table 509-30. Flight 509 Experiment Parameters (Sheet 2 of 2)

STORED VOLUME CU. FT.	REMARKS
3.13	
-	
-	Schedule 3 days after 020121
-	Schedule 3 days after 020112
-	
-	
-	
-	
-	Schedule 3 days after 020301
-	Schedule 3 days after 020302
7	Schedule 1st day only; 200 ft rod
10	Schedule 2nd day only; 200 ft rod
-	Schedule 3rd day only; 500 ft rod
3	Schedule 4th day only; 2-2000 ft rods
	Schedule after 070504 and on 5th and 6th days only
-	Schedule 6th day only
4.2	Schedule after 130404 and on 7th and 8th days only
-	Schedule 9th day only
204	Schedule after 130604 and on 9th, 10th, 11th, 12th, & 13th days only
-	Schedule 14th day only
1.2	
2.0	
-	
6.5	Schedule during night side of orbit

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Table 509-31. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	2/7 Days	15	525	28	
0103, 0107	Analog	1	2/3 Days	15	75	9.3	
0104	Analog	3	2/3 Days	15	225	28	
0105	--	--	--		--	--	None
0106	Analog	2	1/6 Days	15	150	4.7	
0108		4	2/Day		300	112	
0109, 0110		4	2/7 Days		300	16	
0111	Analog	1	4/7 Days	15	75	8	
0112		--	--		--	--	None
0113	Analog	2	2/7 Days	15	150	8	
0114-0120	--	--	--		--	--	None
0201-0203	--	--	--		--	--	None
1303	528	60	4/Mission	3-3/4	1125	8	
1302	--	--	--		--	--	Video Only
0705B	50K	10	6/Mission	15	750	60	
1304	--	--	--		--	--	None
1306	--	--	--		--	--	None
1601, 1603	--	--	--		--	--	None
0501	3	Cont	--		--	--	Multiplex with Other Exps
0801	420	60	1/2 Days	3-3/4	1125	14	

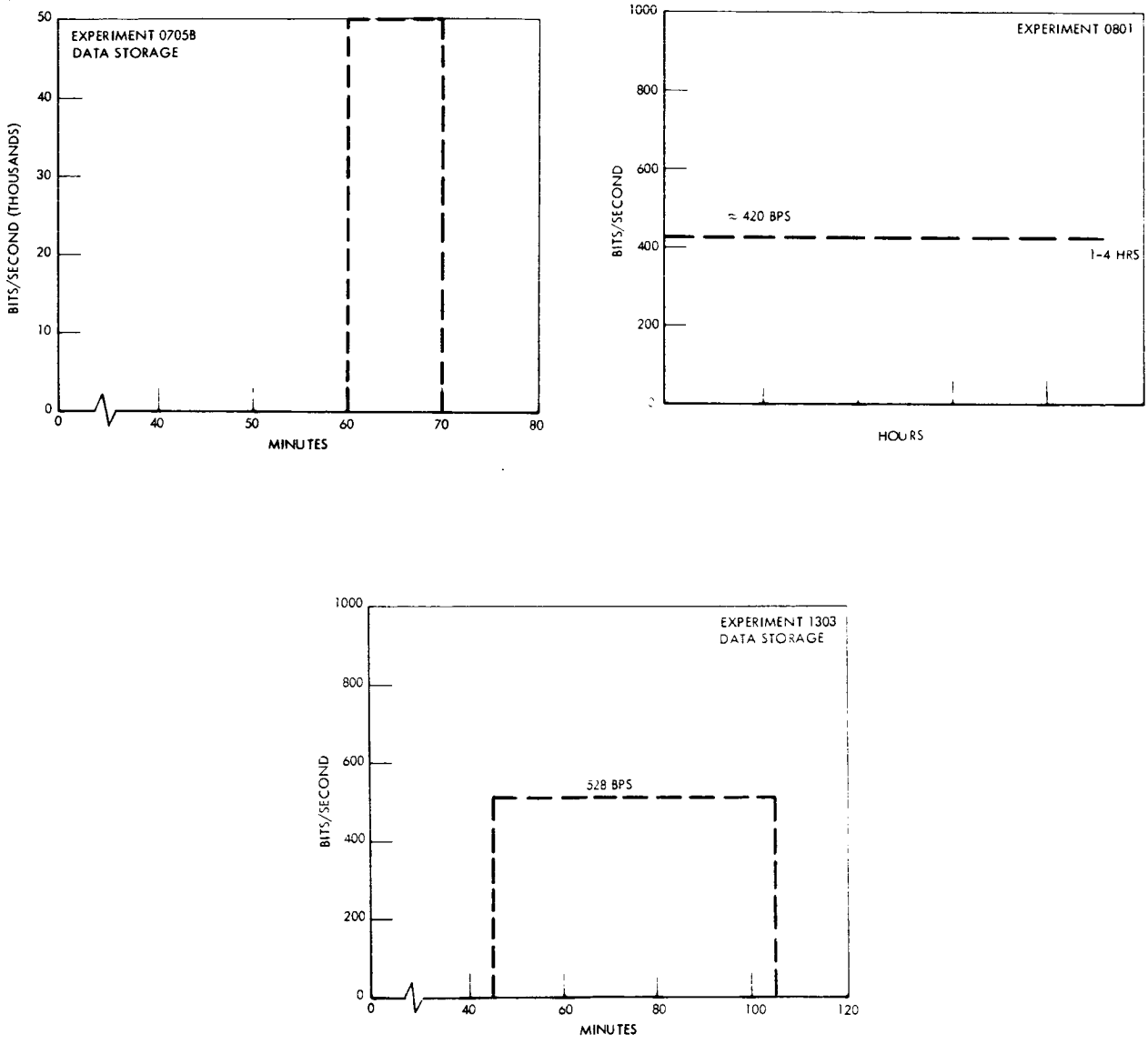


Figure 509-12. Data Processing Profiles

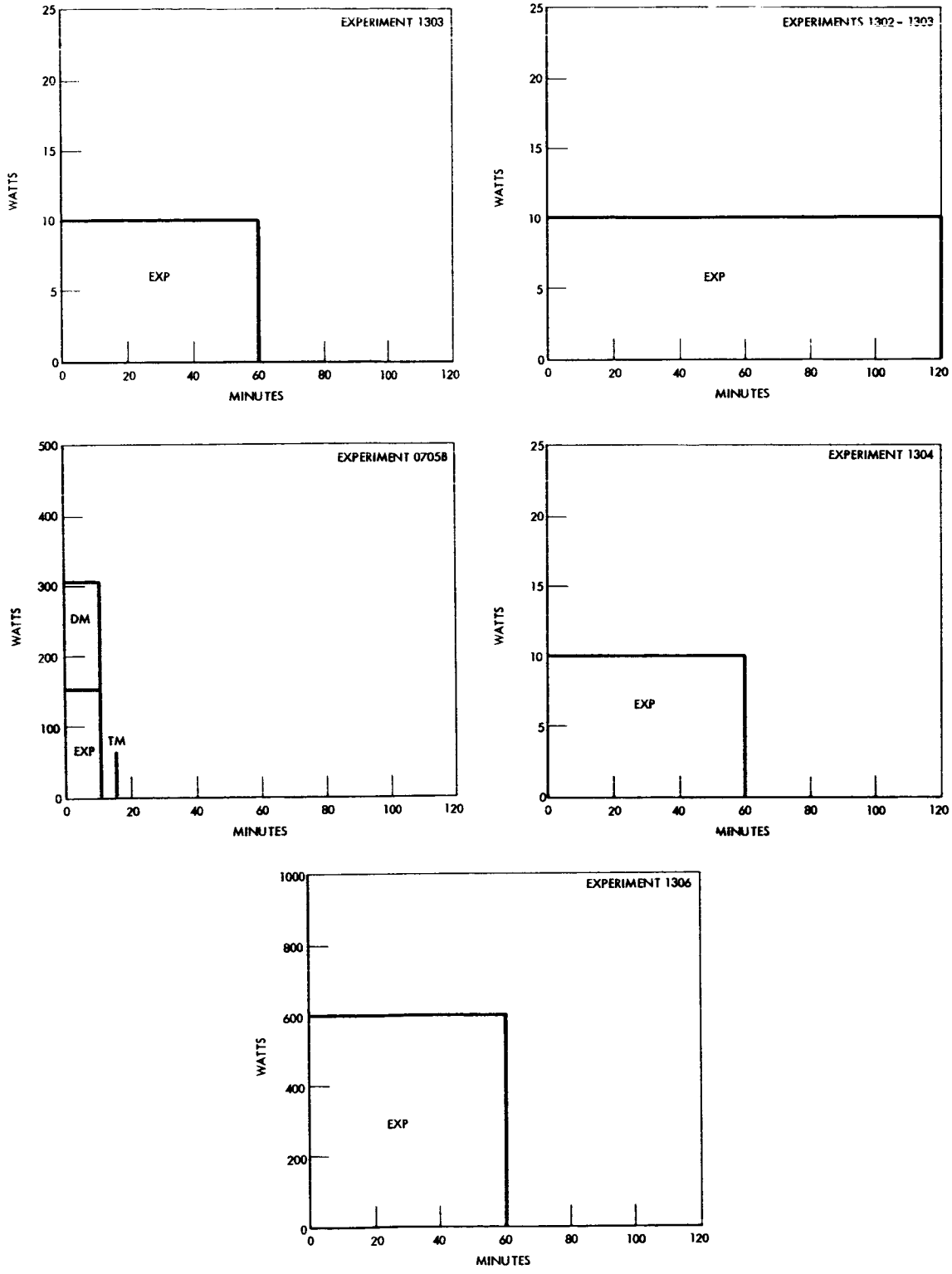
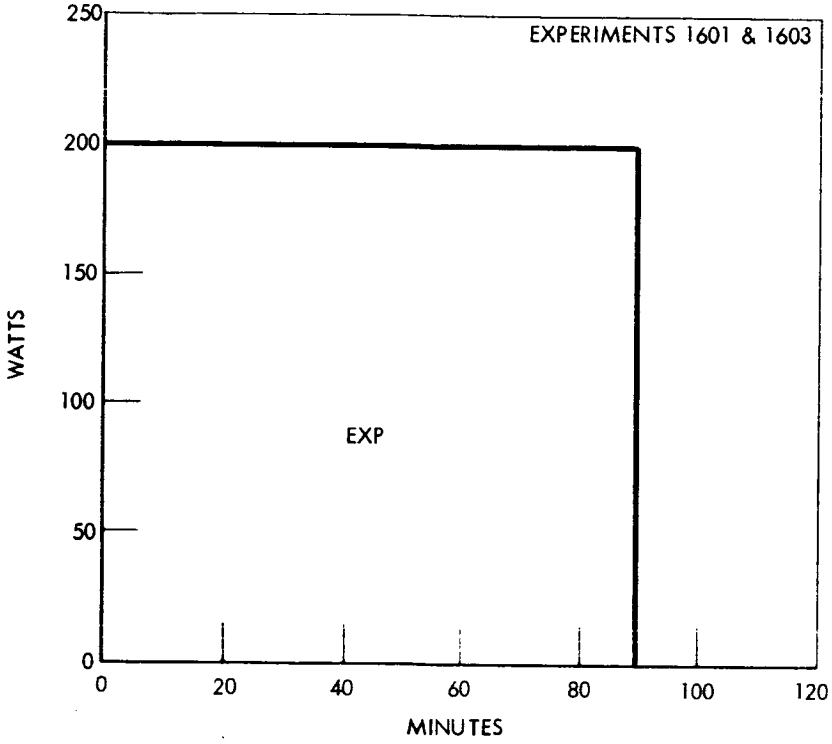


Figure 509-13. Operating Power Profiles (Sheet 1 of 2)



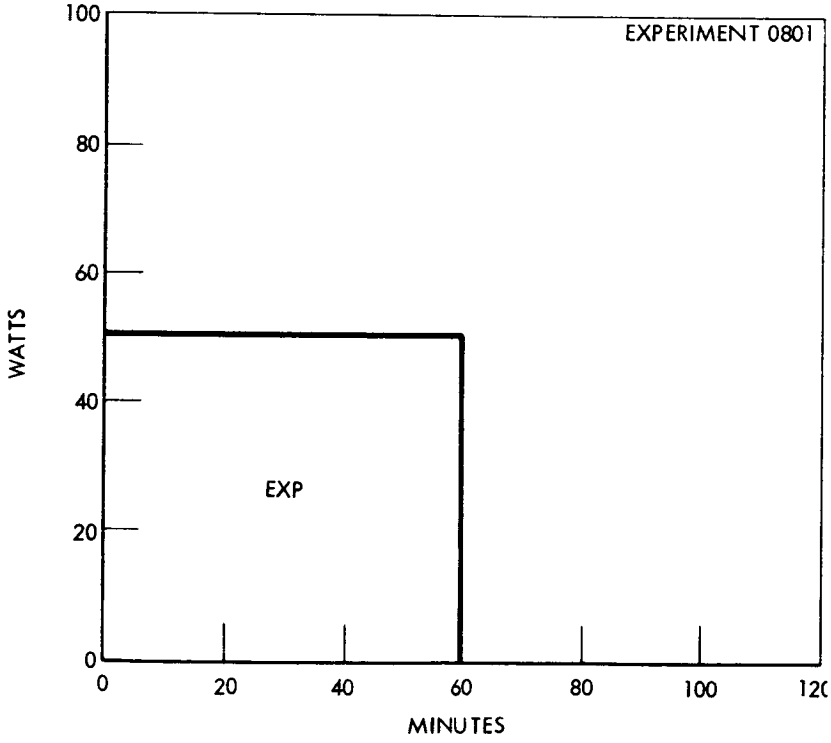


Figure 509-13. Operating Power Profiles (Sheet 2 of 2)

Table 509-32. SPS and RCS Propellant Requirements

Experiment	Maneuvers	Number of Operations	Propellant (lb)
RCS PROPELLANT REQUIREMENTS			
0101-0102	Spin Profile	4	524.0
	Linear Accelerations	2	26.0
0801	Maneuvers	14	21.2
	Attitude-Hold	7 (hrs)	11.3
1601-1603	Maneuvers	6	15.0
1306	Maneuvers	13	23.5
1304	Maneuvers	12	30.0
1302-1303	Maneuvers	6	15.0
0705B-1303	Maneuvers	1	1.8
0705B	Maneuvers	5	8.8
TOTAL WEIGHT			676.6
SPS PROPELLANT REQUIREMENTS			
0101	10-sec firing	2	1400.0

8. CONTROLS AND DISPLAYS

Changes required to the basic configuration described under "Approach" are the addition of a circular meter, a semicircular meter, and sequencing switches.

9. CREW FUNCTIONS

Experiment crew times are presented in Table 509-33 for this flight. For experiments not previously discussed these crew times are shown as specific to a crew member or as referable to any crew member. Crew times previously discussed are shown as totals in order to arrive at a total crew time for the flight.

Table 509-33. Crew Times

Experiment	Specific Time (min)			Flight Total (hr)	Remarks
	C-1	C-2	Any-C		
1303			60	4.0	Primarily control and observation of deployed objects.
1302, 1303			120		
0705B, 1303			120	2.9	
0705B			10		
1304			60	3.0	
1304			30		
1306			60	2.0	
1306			10		
1601, 1603	120	120		4.0	Rendezvous and dock Syncom III Capture and Storage
0801			20	2.3	Aurora observed via sensor
0100-0200				114.9	
0501				0.7	
TOTAL				133.8	

The basic systems management operations for Flight 509 are essentially the same as those for Flight 209, although divided between two rather than three men. The experiments assigned to Flight 509 are all such as may be carried out by two men. In general the crew operations required for these experiments fall into three categories: initiation and activation of object deployment, radio-astronomical technician activities, and rendezvous and docking techniques, with some extra-vehicular activity. The rendezvous and docking operations add some work load of navigation duties to the basic systems management operations. The crew functions required by the experiments are described in Table 509-34.

Table 509-34. Crew Experiment Function Description

Function	Description
EXPERIMENT 0705B	
Setup, periodic	Extend and vary angle of antennas by inflation controls
Teardown, final	Discard antennas
Pilot	Attitude control for selection of area of survey and for stabilization during antenna tuning
Observe, direct, non-man	Visual observation of deployment and separation
Observe, display	Monitor antenna angle, and reception displays
Photo	Photography of deployment, lengthening, and angle
Record	Log visual observations and displayed data
	EXPERIMENT 0801
Setup, periodic	Checkout equipment
Alignment	Align equipment via optical and other devices
Pilot	Control attitude orientation and attitude hold during observation
Observe, direct, non-man	Observation visual selection and observation of auroral events
Observe, display	Monitor equipment operation and displayed data

Table 509-34. Crew Experiment Function Description (Cont)

Function	Description
Process	Selective interpretation of data
Record	Log data and observations
	EXPERIMENT 1302
Observe, display	Monitor pressurization and other possible indicators of structure status
Photo	Photo, TV coverage of deployment and status of structure
Direct transmit	Open wire communication between members and ground
Record	Log-record observations and data readouts
	EXPERIMENT 1303
Setup, initial	Inflate, checkout balloon and sensors; deploy balloon
Setup, periodic	Reel in, redeploy balloon
Pilot	Control spacecraft attitude during deployment and reel-in and observation period
Observe, direct, non-man	Observe deployment and balloon sensor data
Observe, display	Monitor spacecraft attitude and balloon sensor data
Photo	Photograph deployment and reel-in; balloon status
Record	Log attitude observations, balloon sensor data, other observations

Table 509-34. Crew Experiment Function Description (Cont)

Function	Description
EXPERIMENT 1304	
Setup, initial	Deploy and inflate sphere; check out sphere attitude control
Teardown, final	Disengage sphere
Pilot	Spacecraft orientation for sphere deployment and observation; sphere attitude control via rf link
Observe	Optical observation of sphere attitude and position
Photo	Photo record of sphere deployment, inflation and status
Record	Log observations and optical data
EXPERIMENT 1306	
Setup, initial	Deploy and inflate antenna; deploy TV camera on arm; both by control-display panel
Setup, periodic	Position antenna; position TV camera
Align	Compare TV alignment with antenna alignment to ground areas. Maintain fine boresight by transmission to ground and comparison with up-link data display
Pilot	Roll spacecraft
Observe, direct, non-man	Observe deployment and photogrammetric characteristics of antenna via TV
Observe, display	Monitor frequency, impedance, power variables, etc. via display panel

Table 509-34. Crew Experiment Function Description (Cont)

Function	Description
Direct transmit	Coordinate tests with ground station and comment on deployment
Record	Log observations, especially TV photogrammetric, and display ratings
EXPERIMENT 1601	
Observe, direct, non-man	Direct visual and optical observation of satellite consequent upon rendezvous, dock, despin, release
Observe, display	Monitor flight displays, sensor displays, computer readouts
Pilot	Control manually in three axes and ΔV; visual judgment of closure rate
Process data	Enter data into computer; compute by slide rule relevant rendezvous, dock, and satellite spin parameters
Photo	Cover procedures with photo and TV
Direct, transmit	Open-line communication between crew and ground
Record	Log observations and test evaluations
EXPERIMENT 1603	
Setup, initial	Don suits and pressurize, depressurize cabin, remove hatch; check out and deploy capture device
Pilot	Rendezvous to capture distance of syncom, stabilize attitude
Special equipment-operation	Utilize capture device and pull in syncom; remove antenna and place shaped charge; deploy syncom; fire charge; bring in syncom

Table 509-34. Crew Experiment Function Description (Cont)

Function	Description
Teardown, final	Store syncom; replace hatch; pressurize cabin; doff space suits
Transmit	Open-line communication between crew and ground
Record	Log observations

10. SUMMARY OF MISSION ACCOMPLISHMENT

Acquisition and tracking of the nonmaneuvering Syncom III will precede a rendezvous and docking operation. In order to provide adequate space in the command module for stowage of the captured satellite, one crewman must be deleted from this flight. The Syncom will also be dismantled as may be necessary for the return flight.

Biomedical experiments require four spacecraft spin-ups. One of these spin-ups will be deleted in order to remain with in RCS propellant capacities. Additional power capability, in the form of batteries stored in the rack, will be required in order to achieve the proposed flight duration.

Numerous external sensors and structural extensions will be tested on this mission. These will include the deployment of rf reflective structures (50-foot diameter sphere), an extension rod to capture the Syncom III, a solar sail and a 30-foot erectable antenna. Sensors include equipment necessary for observing aurora. Auroral observations are scheduled once per day on the night side of an orbit.

FLIGHT 215: REMOTE EARTH SENSING AND SYSTEM TECHNOLOGY

1. EXPERIMENTAL PROGRAM

Flight 215 will be placed in a 200 nmi orbit at an inclination of 50 degrees. This will provide additional surface coverage for the mapping system experiment. Three men will be carried for 14 days. Experiments will consist of the following:

Standard Group

0101-0120	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

0301	Artificial Gravity by Rotating Station (Limited test of mechanism only)
0901	Multispectral Target Characteristics
0902	Synoptic Earth Mapping

2. MISSION OBJECTIVE

The objectives of this flight are to further evaluate and test the earth sensing equipment and techniques in a 50-degree inclination orbit. This will provide variation in target availability and equipment operating cycles, and test the mechanism of providing artificial gravity by rotating the spacecraft. Observations will be made of agricultural, forestry, geological, oceanographical and geographical ground-truth sites as well as selected uncharted regions. The first test of use of the S-IVB as a counterweight in a rotating artificial gravity system will be conducted.

The first day in orbit will be concerned with testing the deployment, spin-up, de-spin, and retraction of the artificial G mechanism between the spacecraft and the S-IVB. This test extends from the second through the

twelfth orbit; it is planned that the increase and decrease of "G" shall be gradual. Details of G levels for orbit sequence are as follows: 1/6G will be maintained for the first three orbits; 0.6 G for two orbits; 1 G for one orbit; 0.6 G for two orbits; and 1/6 G for three orbits. Results of this test will be applicable to the 45-day artificial G experiment of the subsequent Flight 221.

The remainder of the flight is to be devoted to mapping and observation of the Earth's surface. This flight is orbital at an inclination of 50 degrees; consequently, coverage of the Earth will differ from that of the polar orbit stipulated in Flight 507. Nevertheless, correlation between data collected during both missions should be possible.

During this mission, stereocartographic photos of 20-foot resolution will be taken in such a way to facilitate the preparation of topographic maps of the desired height resolution. Simultaneously, multicolor photography of coarser resolution will permit reconstitution of subsequent full-color and modified false-color photographs. During the mapping periods, additional Earth surface characteristics will be obtained by broad band VHF pulses which will indicate surface moisture condition. Passive reception of the Earth's microwave emission will be accomplished with a radiometer.

In addition, the surface will be examined with a high-resolution multispectral sensor, its infrared images and spectra will be recorded, and microwave imaging data acquired. The multispectral examination, utilizing a 16-inch telescope for high resolution, will record images at selected points in the ultraviolet to infrared spectrum range. Spectra of selected targets may also be collected through this sensor. The crew's task will be to point the vehicle and/or sensor to see the desired targets adequately. In addition, images of the same surface area in the infrared and microwave regions of the spectrum will be gathered by an appropriate passive imaging sensor.

The photomapping experiment requires that the camera be directed vertically downward at all times, and spectral measurements will be also made on targets along or near the ground trace.

Independent gimbaling systems will be required to perform the Synoptic Earth Mapping experiment and the Spectral Measurements experiment simultaneously. This will permit adjustment of vehicle attitude to accommodate spectrometer sensors while the photomapping experiment is in progress or vice-versa.

The biomedical, behavioral and radiation monitoring experimental program will continue as in previous flights. The emphasis will continue

to be on psychophysiological relationships and countermeasures. At this point the precursors to impairment should be identified, also, the mechanisms that underlie observed changes as well as prediction of rate of change over time will be studied.

Special Interface Problems :

The experiment 0301, Artificial G by Station Rotation, must be performed by separating the CSM and rack from the S-IVB stage by extendable devices capable of carrying end and torsion loads. Rotation of this configuration about its center of rotation is necessary to develop the required gravitational forces in the CSM rack. The tubes must be capable of resisting compression forces, but tension cables may also be required between the modules. These cables will resist bending couples carried by the firing of the SM Reaction Control System engines when initiating system rotation.

3. BASIC EXPERIMENT REQUIREMENTS

The weight, volume, crew time, electrical power system (EPS) and reaction control system (RCS) requirements are tabulated in Table 215-35.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Pertinent parameters of the experiments carried on this mission are shown in Table 215-36. This data formed the basic input to the automatic experiment scheduling program. Reference may be made to paragraph 4, Flight 209, for detailed description of the parameters presented in the table.

5. DATA MANAGEMENT REQUIREMENTS

As indicated in Table 215-37, experiments 0901 and 0902 will be conducted simultaneously at a total data acquisition rate of 1137 bits per second for a period of 45 minutes. This period will be repeated eight times per day. The standardized data management subsystem described in Section 2, Approach, will readily process this data in the low bit rate mode at record tape speed of 3-3/4 ips with a tape accumulation of 843.8 feet per data acquisition period. During transmission of this data to Earth, the tape playback speed will be 120 ips—requiring a total mission transmission period of 157.5 minutes for these two experiments. The balance of the experiments listed will be processed by the standardized data management subsystem and recorded at 15 ips tape speed. Total transmission time required for all experiments selected for Flight 215 is 420.2 minutes for the 14-day mission, or an average of 30 minutes per day.

Table 215-35. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0120, 0201-0203)	728.4	12.8	9.0	19.7	155.8	0.0	85.0	1.7	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	1.8	1.0	0.0	1.0	0.0	
Remote sensing of the earth's surface (0901, 0902) 16 inch telescope IR spectrometer IR imager Map and survey camera Multispectral camera Microwave radiometer Microwave imager VHF pulse	2953.0	0.0	96.0	56.7	20.0	168.0	757.0	15.5	
Creation of artificial gravity (0301) Mechanisms	151.0	0.0	2.0	0.2	4.0	0.0	0.0	0.0	
TOTAL	3882.4	13.8	108.0	78.4	180.8	168.0	843.0	17.2	

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STORED VOLUM CU. FT.
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min	7.0	0.6
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min	-	-
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min	-	-
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6	1.8
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-	-
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-	-
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0	1.0
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-	-
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-	-
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473	9.0
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-	-
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0	0.25
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0	1.5
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-	-
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-	-
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2	0.05
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-	-
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-	-
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8	2.1
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-	-
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-	-
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6	0.0
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-	-
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-	-
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-	-
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5	0.2
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-	-
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-	-
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-	-
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9	2.0
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-	-
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-	-
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-	-
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-	-
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-	-
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-	-
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8	0.1
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-	-

Table 215-36. Flight 215 Experiment Parameters (Sheet 1 of 2)

REMARKS
0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
▲Also real time TV or cine-camera for 25 min/exp
Lab work for 0113
Schedule on 3 successive days
*Minimum rotation
Schedule during 1st 2 days only
Schedule during 1st 2 days only
Schedule during 1st 2 days only
Schedule during 1st 2 days only
Start 7 days after 011761
Start 7 days after 011752
Start 7 days after 011743
Schedule during 1st 2 days only
Start 7 days after 011807

[redacted]

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	ST VO CU
011907	0119	1061	1/2 Days				30			10	30							
511907	0119	1062	1/7 Days				30			10	30							
011207	0120	1071	1/14 Days				20			10	15							
511207	0120	1072	1/14 Days				20			10	15							
611207	0120	1073	1/14 Days				20			10	15							
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.							
020161	0201	1091	1/6 Days	82			33			30	26						75.0	3
020152	0201	1092	1/6 Days		82		33			30	26							
020143	0201	1093	1/6 Days			82	33			30	26							
520161	0201	1094	1/6 Days	32			8			30	26							
520152	0201	1095	1/6 Days		32		8			30	26							
520143	0201	1096	1/6 Days			32	8			30	26							
020261	0202	1081	1/3 Days	63			14			105	50							
020252	0202	1082	1/3 Days		63		14			105	50							
020243	0202	1083	1/3 Days			63	14			105	50							
020361	0203	1101	1/6 Days	100						160	75							
020352	0203	1102	1/6 Days		100					160	75							
020343	0203	1103	1/6 Days			100				160	75							
520361	0203	1104	1/6 Days	40						160	15							
520352	0203	1105	1/6 Days		40					160	15							
520343	0203	1106	1/6 Days			40				160	15							
090107	0901, 2	33	1/4 Orbits				10			360	45	Towards earth		45	2.6×10^6	51 sec	2953	96
590107	0901, 2	34	1/4 Orbits				10			360	45	Towards earth		45	2.6×10^6	51 sec		
790107	0901, 2	35	1/3 Days				10											
030177	0301	32	1/1 Orbit				10/10										151	2
050101	0501	1191	1/3 Days	4						5.3	Cont				12,500	1 sec	50	2
050102	0501	1192	1/3 Days		4						for				per	per		
050103	0501	1193	1/3 Days			4					14 days				orbit	orbit		

Table 215-36. Flight 215 Experiment Parameters (Sheet 2 of 2)

ORED LUME . FT.	REMARKS														
	Schedule during 1st 2 days only														
	Start 7 days after 011907														
			in missions less												
.13															
	Schedule 3 days after 020161														
	Schedule 3 days after 020152														
	Schedule 3 days after 020143														
	Schedule 3 days after 020361														
	Schedule 3 days after 020352														
	Schedule 3 days after 020343														
	Schedule day side of orbit starting with 2nd day								Peak	Power	460W	For	1 Sec		
	Schedule during night side of same orbit as 090107 is scheduled								Peak	Power	460W	For	1 Sec		
.0	Schedule 1st day only														
.0															

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Table 215-37. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	42	
0103, 0107	Analog	1	1/Day	15	75	14	
0104	Analog	3	1/Day	15	225	42	
0105	--	--	--	--		--	None
0106	Analog	2	1/6 Days	15	150	4.7	
0108		4	2/Days		300	112	
0109, 0110		4	3/7 Days		300	24	
0111	Analog	1	6/7 Days	15	75	12	
0112	--	--	--	--			None
0113	Analog	2	3/7 Days	15	150	12	
0114, 0121	--	--	--	--			None
0201, 0203	--	--	--	--			None
0901, 0902	1137	45	8/Day	3-3/4	843.8	157.5	
0301	--						None
0501	3	Cont					Multiplexed with Other Exper

6. POWER PROFILES

Figure 215-14 contains the operating power profile for each experimental task that has not appeared in a previous flight.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

The required propellant expenditures for the experiments conducted on this flight are listed in Table 215-38.

8. CONTROLS AND DISPLAYS

The integrated control and display panel will be modified by adding a circular indicator, additional toggle switches, and six additional status indicators.

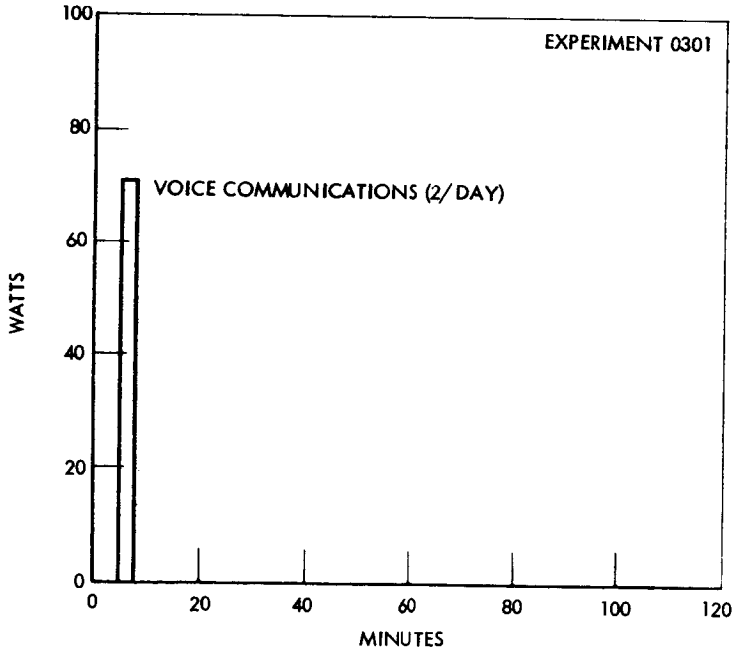

Figure 215-14. Operating Power Profile

Table 215-38. SPS and RCS Propellant Requirements

Experiment	Maneuver	Number Operations	Propellant (lb)
RCS REQUIREMENTS			
0901N-0902N	Attitude hold	78 (hr)	191
	Maneuvers	62	93
0101-0102	Spin profile	6	118
	Linear acceleration	2	26
0301	Artificial G	1	789
TOTAL WEIGHT			1217
	SPS REQUIREMENTS		
0101	Linear acceleration	2	1400

9. CREW FUNCTIONS

Experiment 0301 requires a cooperative effort of any two crew members for 10 minutes to initiate and terminate artificial gravity, i.e., spinning. Spinning will require a total of four hours time during the flight. Other flight experiment times, previously enumerated, are:

0100-200	155.8 hours
0501	1.0 hour
0901, 2	20.0 hours

Total scheduled crew experiment time for the mission is 180.8 hours.

This flight resembles Flight 209 in the basic systems management requirements. However, the introduction of spinning may complicate systems management activities either in scheduling or performance; this factor may also have a direct and/or indirect effect upon personal functions. Generally, the experiment 0301 introduced on this flight requires the crew to initiate and terminate spinning and to observe the effects thereof upon their own status. The spinning effect may interact with crew performance of medical and behavioral experiments. Table 215-39 summarizes the crew operations for Experiment 0301.

Table 215-39. Crew Experiment Function Description

Function	Description
EXPERIMENT 0301	
Set-up, initial	Assume seat and other restraints (all), release clamps, initiate extension by activating servo-motor or spacecraft propulsion (1); release restraints (all)
Teardown, final	Assume seat and other restraints (all); separate from rods and S-IVB (1); release restraints (all). Store film for Earth return (1)
Pilot	Assume seat and other restraints (all); initiate spin and monitor build-up (1); de-spin and monitor de-spin (1); release restraints (all)
Observe, self	Self-observation of spin effects
Observe, other	Observation of effects on other crew members
Observe, direct, non-personnel	Direct or optical device observation of extension and status of rods
Observe, display	Periodic monitoring of spin and equipment parameters as displayed on panel
Subject	Cooperation with observation by others
Photo, etc.	Camera and TV coverage of deployment and separation status
Direct transmit	Real time commentary on deployment, spin, de-spin and other critical events
Record	Log book recording of observations

10. SUMMARY OF MISSION ACCOMPLISHMENT

The Earth mapping and sensing experiments scheduled for every fourth orbit on this mission will provide a wide range of data from orbits of high inclination. With this in mind, a 50-degree orbit was selected.

Mapping experiments are initiated on the second day. This will permit testing the artificial gravity experiment on the first day of the mission. Since the artificial gravity experiment requires rotation of the spacecraft, it may not be conducted simultaneously with the mapping experiments which require a stable vehicle attitude.

In order to reduce weight, all spin-ups required for experiments 0101 and 0102 have been deleted. Linear accelerations have also been deleted to minimize propellant weight. Additional weight saving may be derived by deleting batteries from the rack; however, this will occasion an associated reduction in mission duration. This loss in mission duration may be minimized if a lower inclination (lower than 50 degrees)orbit is selected.

FLIGHT 513: ADVANCED SPACE MANEUVERS AND OBSERVATION

1. EXPERIMENTAL PROGRAM

Flight 513 will be placed in a 200-nautical-mile orbit at an inclination of 81.5 degrees, coplanar with the Echo II satellite. A change to approximately a 630-nautical-mile orbit will be undertaken late in the mission to observe Echo II. Three men will be carried on the flight for 14 days. Experiments will consist of the following:

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series

Mission Group

0502	Study of Magnetic Field Lines
0503	Generation and Analysis of Comet-Like Particulate Clouds
1507	Extravehicular Assembly Operations
0802A	Operation of High-Resolution Infrared Radiometer (HRIR) Detectors Experiment
0802B	Test of an Infrared Scanning Spectrometer
0802C	Test Calibration and Evaluation of a Microwave Spectrometer
0802D	Test of a Prototype Star-Tracker

2. MISSION OBJECTIVE

Flight 513 is the first flight on which scientific investigations and observations or development of sensing equipment for such observations will play a major role in determining overall mission objectives. Nevertheless, the primary objective remains operational rather than scientific. Complex extra-vehicular tasks will be continued and will be based on experience gained during earlier flights, particularly Flight 209. A major flight profile advance will be involved in achieving an 81.5-degree orbit (coplanar

with the Echo II satellite) and a late-mission orbital deviation to an elliptical profile allowing maximum operation in the vicinity of the orbiting Echo II satellite (about 630 nautical miles).

Secondary objectives include a series of studies of the space environment, involving radiation, magnetic fields, and the spectral nature of artificially generated particle clouds.

The biomedical experimentation for this flight will be less broad in scope than in earlier flights. Operational human experimentation will be emphasized. Extra-vehicular assembly operations will be studies involving safety monitoring as well as technique assessment. There also will be studies that involve the measurement of human performance associated with complex maneuver operations.

Experiment 0502 is devoted to injecting packets of electrons into the Earth's magnetic field when the auroral impact of these discharge at the conjugate points may be observed by ground station. This experiment requires a near-polar inclination for the orbit to cross all field lines and permit electron injection at specific locations. Data collection for the magnetic field in Experiment 0502 will be made from ground observation stations.

Another scientific investigation, Experiment 0503, is concerned with expelling clouds of chemical particles from the spacecraft and observing the growth and dissipation of the cloud and its chemical changes by means of direct photography and reflected sunlight spectra.

The evaluation of various methods of handling and assembly of structures, tanks, and mechanisms in extra-vehicular operations is the subject of Experiment 1507. Various task boards, sets of structural members, plumbing, tankage, and sets of special tools will be used by the test subject to determine the problem that may develop in actual operational use of these assembly techniques in space.

The spacecraft will initially be placed in a 81.5-degree, 200-nautical-mile orbit. The extra-vehicular assembly operations experiment must be performed at this low altitude to minimize the radiation hazards to the astronauts when they are outside the vehicle. This experiment will be modified somewhat to fit the mission. Its requirement for 13 operational periods 48 hours apart cannot be satisfied in the 14-day mission. Either the number of operational periods must be lowered or the interval between them shortened. Extra-vehicular activity data in Experiment 1507 will be in the form of photos and comments on the actual test assembly operation.

Experimental products of the Earth sensing series (Experiments 0802A, 0802B, 0802C, and 0802D) will be performance records, comments, and photographic records of the experimental devices under test. Correlation between the various test sensors while viewing the same area of the Earth's surface will be an important result.

A star tracker (Experiment 0802A) will accurately determine the refraction of stellar images as the star occult through the visible atmospheric bank. Two scanning spectrometers, one IR and the other the microwave (Experiments 0802C and 0802D), will procure spectral distributions of radiation from various points on the Earth's surface in certain frequency bands. An IR radiometer (Experiment 0802B) will generate IR emission data that can be correlated with photos and can be reconstituted into cloud cover images.

At the end of this mission, it is expected that a flyby of the Echo II balloon may be made so that photos can be taken of its physical condition and correlation made with simultaneous Earth-based radar reflection data. The design of the mission orbit inclination and launch data will be such that minimum orbital changes will be required for the task. Echo II observations will be in the form of photos and ground-based rf reflectivity tests. The command-service module (CSM) will separate from the rack and the SPS will be used to establish an elliptic orbit. The CSM will achieve an apogee altitude of 630 nautical miles approximating the orbit altitude of the Echo II satellite. At apogee, another SPS maneuver will be made to affect a gross rendezvous with the satellite so that photographs may be taken.

A short time later, the SPS will again be used to initiate a Hohmann transfer to an orbit altitude below the high radiation areas. This low-altitude orbit will be maintained until recovery can be initiated.

Special interface problems encountered during the experiments are as follows:

Experiment 0802A—IR Radiometer: This experiment requires a Dewar for cryogenic supply. The radiometer can be mounted in an open unpressurized bay of the rack and must point towards Earth. A CRT and still camera which operate in conjunction with the Earth survey viewfinder are required.

Experiment 0802B—IR Spectrometer: This experiment is also stored in an open bay of the rack and must point to Earth. The CRT is used for display.

Experiment 0802C—Microwave Spectrometer: This experiment requires three antennas that are mounted externally. Astronauts must have a view in the direction the antennas are pointed. This may be accomplished by either the spacecraft window or by using the Earth survey viewfinder. This device is a telescope that can be used by the astronaut directly or in conjunction with a still camera. To minimize RF losses, it is essential that the spectrometer be located adjacent to the antennas.

Experiment 0802D—Star Tracker: This experiment requires a gyro-stabilized stable platform. The star trackers must be oriented towards the target star and the reference star, and its view must be unobstructed by other experiments.

Experiment 0502, Study of Magnetic Field Lines: This experiment requires a gimbaled electron beam gun that must be attached to the air lock wall. Controls for this device must go through the air lock wall and are to be operated by the astronaut inside. A magnetometer must be extended.

Experiment 0503, Cloud Generation: This experiment requires a chemical dispersing system that will expel the chemicals into free space so they may be observed from a distance. It is important that these chemicals are not dispersed too close to the spacecraft, because incorrect readings may result due to spacecraft coating.

Experiment 1507, EVA Assembly Operation: All equipment used in this experiment must be easily accessible to the astronaut in the rack, and the external experiment must be visible to another astronaut.

Experiment 1602: This experiment must take place after the rack is jettisoned, prior to orbit change.

3. BASIC EXPERIMENT REQUIREMENTS

The weight, volume, crew time, Electrical Power System (EPS), and Stabilization Control System (SCS) requirements are summarized in Table 513-40.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Table 513-41 lists the most pertinent characteristics of the experiments carried on the flight from the standpoint of experiment scheduling. Reference should be made to Flight 209 for explanations of the meanings of the various parameters.

5. DATA MANAGEMENT REQUIREMENTS

As indicated in Table 513-42, Experiment 1507 will require transmission of real time TV. Experiments 0802A-D, 0502, and 0503 all have acquisition data rates less than 1600 bits per second and therefore can be processed in the low bit rate mode of the standardized data management subsystem described in this volume in Approach. The data for these experiments will be recorded at the 3-3/4 ips tape speed and played back at 120 ips for transmission to Earth. The balance of the experiments listed will be processed by the standardized data management system. Total transmission time required for all analog and digital measurements of experiments for Flight 513 is 357.3 minutes for the 14-day mission or an average of 25.5 minutes per day.

Profiles for data management requirements for the pertinent technical experiments on this flight are shown in Figure 513-15. Additional data management profiles for the biomedical/behavioral experiments may be found under Flight 209.

6. POWER PROFILES

Figure 513-16 contains the operating power profile for each experimental task that has not appeared in a previous flight.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

The required expenditure of propellants for attitude hold and space maneuvering is shown in Table 513-43 for the experiments concerned.

8. CONTROLS AND DISPLAYS

The integrated display and control panel is modified by deleting the digital readout component which is not required for this mission.

9. CREW FUNCTIONS

Crew operation times for this flight are summarized in Table 513-44 for individual test sessions with reference to crew times specific to a given crew member and crew times referable to any crew member. Total crew times for the mission also are indicated.

System management operations on this flight are essentially the same as those for Flight 209. A number of new experiments introduced for Flight 513 involve the following general crew function emphasis. The Experiment 0500 series center around crew observation of artificially induced extended particles and clouds. The Experiment 0800 series emphasize observation

Table 514-40. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0120, 0201-0203)	728.4	12.8	9.0	19.7	155.0	0.0	87.0	1.7	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	1.8	1.0	0.0	1.0	0.0	
Extra-vehicular operations (1507) AMU Airlock Repair task units, tools Structures to be assembled	143.0	0.0	18.0	3.5	24.0	12.0	8.0	0.1	
Meteorological techniques (0802-A, B, C, D) Telescope IR radiometer IR spectrometer Microwave spectrometer	766.0	0.0	18.0	2.83	54.87	53.7	55.0	0.8	
Study of space environment Spectrometer Electron accelerator	59.0	0.0	2.5	1.4	11.5	7.0	0.0	0.0	
Physical science (0503) Particulate cloud generator Spectrographic camera Photometer Camera	105.0	0.0	9.5	0.016	6.0	5.0	2.0	0.0	
Observation of Echo II (1602) Camera	12.0	0.5	0.0	0.0	4.0	2.0	2.0	0.0	Echo II observation
TOTAL	1712.4	14.3	58.0	29.3	257.0	79.7	154.0	2.6	

[redacted]

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont	-	-	-	-	-	-
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-
050101	0501	42	1/3 Days	4						5.3	Cont for	-	-		12,500	1 Sec	50
050102	0501	43	1/3 Days		4					-	14 Days	-	-		per	per	-
050103	0501	44	1/3 Days			4				-					orbit	orbit	-
080207	0802A	38	4/1 Day				20	15	5	25	20	Towards Earth		20	-	-	98
580207	0802B	39	6/1 Day				20	10	5	60	20	Towards Earth		20	-	-	390
680207	0802C	40	2/1 Day				15			90	16	Towards Earth		15	-	-	68
780207	0302D	41	7/Mission				10			5	7	Towards Star		1	-	-	60
050207	0502	36	2/1 Day				25			200	15	*		15	-	-	59
050307	0503	37	3/Mission				120			3.1	100	*		100	-	-	105

Table 513-41. Flight 513 Experiment Parameters (Sheet 1 of 3)

ORED LUME J. FT.	REMARKS
.6	* 0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
.8	
-	
-	
.0	
-	
-	
.0	
-	
.25	
.5	
-	
-	
.05	
-	
-	
.1	
-	
-	
.01	
-	
-	
-	Lab work for 0113
.25	
-	* Schedule on 3 successive days
-	*Minimum rotation
-	
.0	
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011743
.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

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[redacted]

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
150761	1507	33	2/Mission	120			120			350	100	-	-	100	-	-	140
150752	1507	34	2/Mission		120		120			350	100	-	-	100	-	-	-
150743	1507	35	2/Mission			120	120			350	100	-	-	100	-	-	-
160277	1602	32	1/Mission				120/120			-	-	Towards Earth		60			10.5

Table 513-41. Flight 513 Experiment Parameters (Sheet 2 of 3)

STORED VOLUME CU. FT.	REMARKS
-	Schedule during 1st days only
-	Start 7 days after 011907
-	
-	
-	
-	
3.13	
-	
-	
-	Schedule 3 days after 020161
-	Schedule 3 days after 020152
-	Schedule 3 days after 020143
-	
-	
-	
-	
-	
-	
-	
-	Schedule 3 days after 020361
-	Schedule 3 days after 020352
-	Schedule 3 days after 020343
2	
-	
-	
4	
10	
5	
3.5	
2.5	* See experiment
9.5	* See experiment

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[redacted]

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	ST VO CU
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min▲	7.0	0
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min▲	-	
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min▲	-	
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6	1
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-	
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-	
010461	0104	1021	1/3 Days	20			20			6	15	--	-	-	3 min A	3 min	5.0	1
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-	
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-	
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473	0
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-	
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0	0
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0	1
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-	
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-	
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2	0
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-	
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-	
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8	2
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-	
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-	
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6	0
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-	
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-	
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-	
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5	0
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-	
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-	
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-	
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9	2
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-	
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-	
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-	
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-	
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-	
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-	
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8	0
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-	

Table 513-41. Flight 513 Experiment Parameters (Sheet 3 of 3)

STORED VOLUME CU. FT.	REMARKS
18	Schedule day 1 and 7
-	Schedule day 3 and 9
-	Schedule day 5 and 11
1.0	Schedule 14th day

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Table 513-42. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	42	
0103, 0107	Analog	1	1/Day	15	75	14	
0104	Analog	3	1/Day	15	225	42	
0105	--	--	--	--		--	None
0106	Analog	2	1/6 Days	15	150	4.7	
0108	↓	4	2/Day	↓	300	112	
0109, 0110	↓	4	3/7 Days	↓	300	24	
0111	Analog	1	6/7 Days	15	75	12	
0112	--	--	--			--	None
0113	Analog	2	3/7 Days	15	150	12	
0114-0121	--	--	--	--		--	None
0201-0203	--	--	--	--		--	
0501	3	Cont		--	--	--	Multiplexed with Other Exper
0802A	35	20	4/Day	33/4	375	35	
B	1365	10	6/Day	↓	187.5	26.2	
C	1444	15	2/Day	↓	281.3	13.1	
D	160	1	7/Mission	↓	18.8	0.2	
0502	3	10	2/Day	↓	187.5	8.8	
0503	100	120	3/Mission	33/4	2250	11.3	
1507							Video & Voice
1602							

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont	-	-	-	-	-	-
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-
050101	0501	42	1/3 Days	4						5.3	Cont for	-	-		12,500	1 Sec	50
050102	0501	43	1/3 Days		4					-	14 Days	-	-		per	per	-
050103	0501	44	1/3 Days			4				-					orbit	orbit	-
080207	0802A	38	4/1 Day				20	15	5	25	20	Towards Earth		20	-	-	98
580207	0802B	39	6/1 Day				20	10	5	60	20	Towards Earth		20	-	-	390
680207	0802C	40	2/1 Day				15			90	16	Towards Earth		15	-	-	68
780207	0302D	41	7/Mission				10			5	7	Towards Star		1	-	-	60
050207	0502	36	2/1 Day				25			200	15	*		15	-	-	59
050307	0503	37	3/Mission				120			3.1	100	*		100	-	-	105

[redacted]

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
150761	1507	33	2/Mission	120			120			350	100	-	-	100	-	-	140
150752	1507	34	2/Mission		120		120			350	100	-	-	100	-	-	-
150743	1507	35	2/Mission			120	120			350	100	-	-	100	-	-	-
160277	1602	32	1/Mission				120/120			-	-	Towards Earth		60			10.5

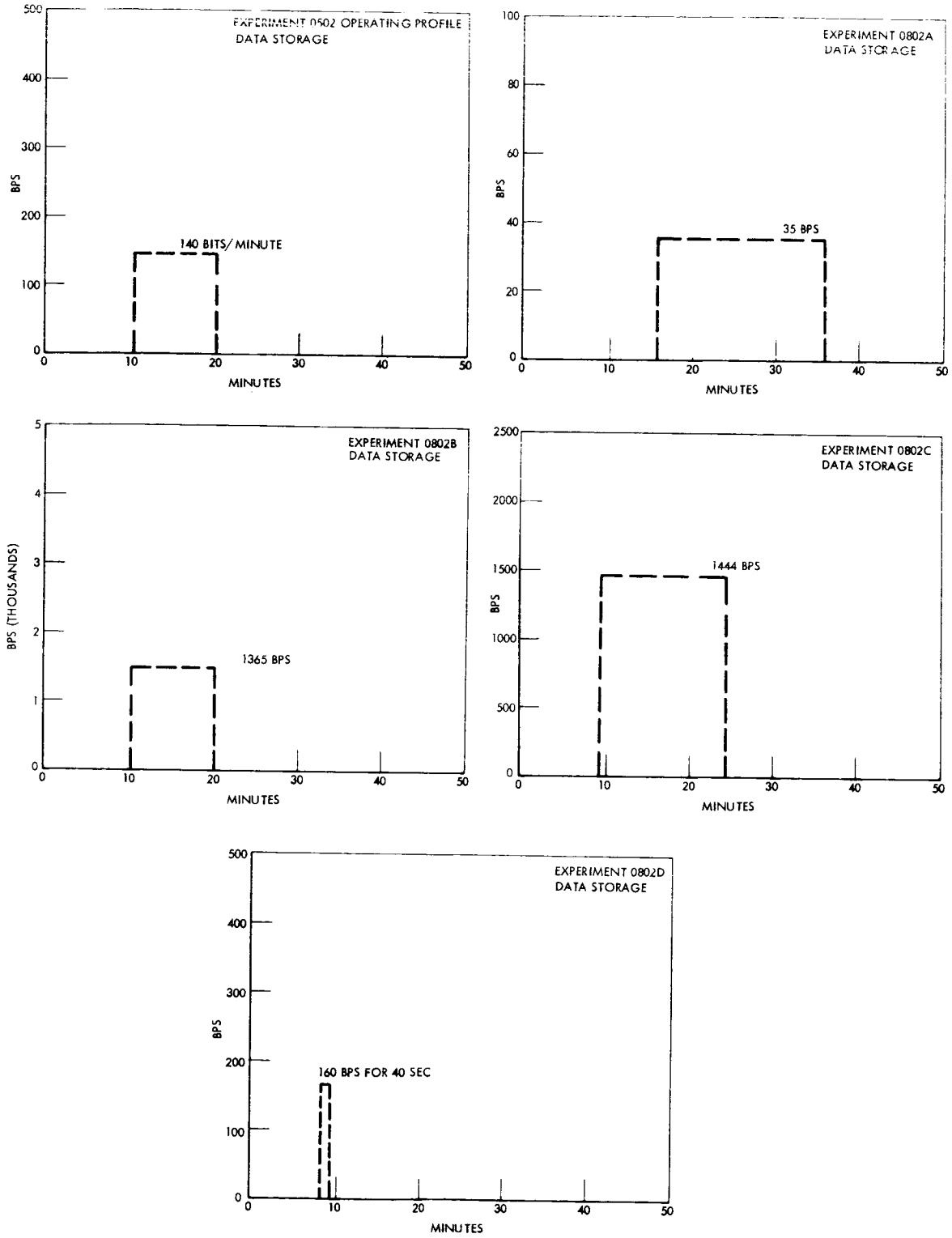


Figure 513-15. Profiles for Data Management Requirements

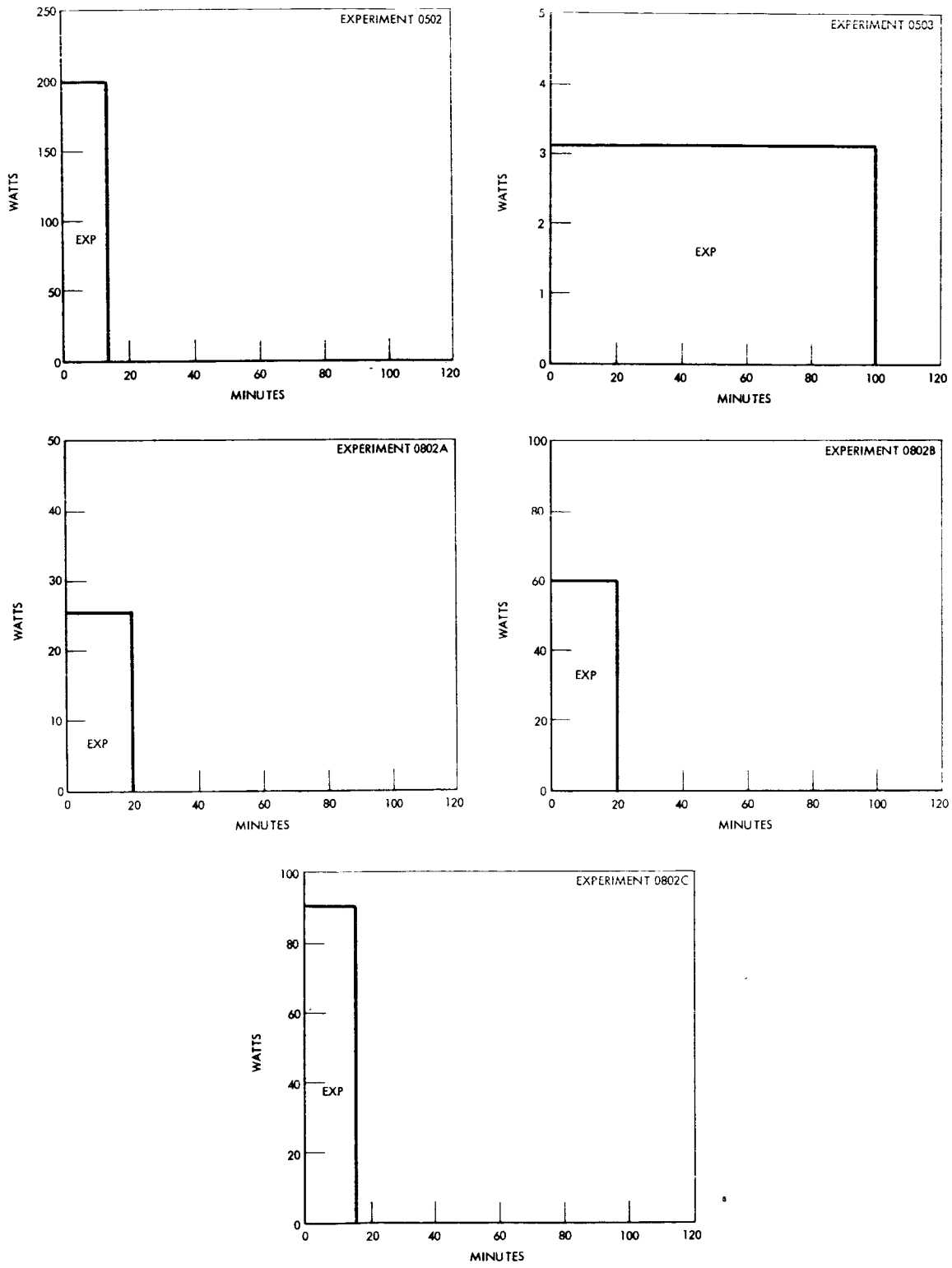
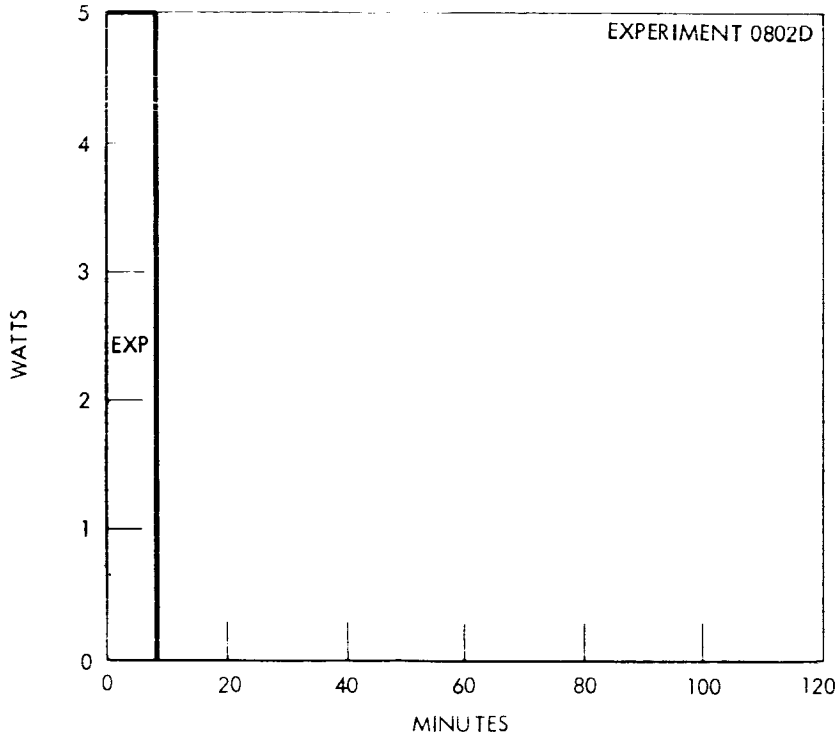


Figure 513-16. Operating Power Profiles (Sheet 1 of 2)



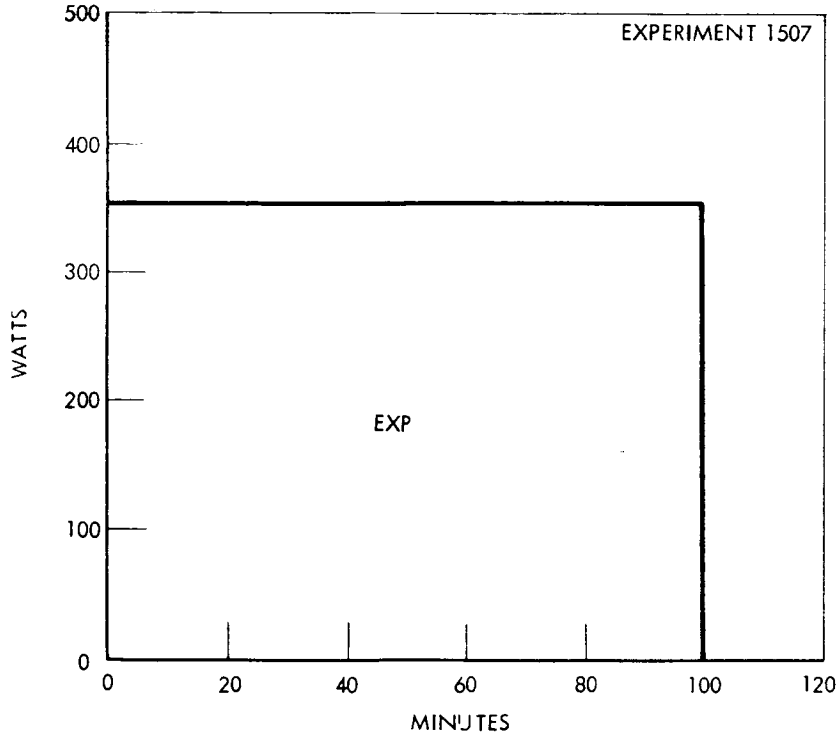


Figure 513-16. Operating Power Profiles (Sheet 2 of 2)

and interpretation of spectral data. Experiment 1507 further explores man's extra-vehicular maneuvering capability, while Experiment 1602 empasizes his flyby inspection performance. All experiment crew operations are described or referred to in Table 513-43.

Table 513-43. SPS and RCS Propellant Requirements

Experiment	Maneuver	Operations	Propellant (lb)
RCS REQUIREMENTS			
0101-0102	Spin profile	6	516
	Linear accelerations	2	26
0802	Attitude hold	53 (hr)	72
	Maneuvers	343	396
0502	Maneuvers	3	4
0503	Maneuvers	28	25
	Attitude hold	7 (hr)	6
1507	Maneuvers	40	56
	Attitude hold	10 (hr)	7
1602	Maneuvers	4	5
TOTAL WEIGHT			1113
SPS REQUIREMENTS			
0101	10-second firing	2 cycles	1400
1602	Rendezvous with Echo II	1	8650

Table 513-44. Crew Times

Experiment	Specific Time (min.)				Flight Total (hr)	Remarks
	C-1	C-2	C-3	Any C		
0802A				20	18.7	Observation and interpretation of spectral data
0802B				20	28.0	
0802C				15	7.0	
0802D				10	1.2	
0502				25	11.3	Ejection and observation of particles and clouds
0503				120	6.0	
1507	120			120	24.0	EVA
1602	120			120	4.0	Flyby observation
0100-0200					155.8	
0501					1.0	
TOTAL					257.0	

Table 513-45. Crew Experiment Function Description

Function	Description
EXPERIMENT 0502	
Setup, periodic	Adjust accelerator, checkout, activate
Pilot	Align spacecraft
Observe, direct, non-man	Track particle with camera or radar
Observe, display	Monitor radar displays
Photo	Photograph auroral spot
Transmit	Correlate tests with ground
Record	Log record observations

Table 513-45. Crew Experiment Function Description (Cont)

Function	Description
EXPERIMENT 0503	
Setup, periodic	Prepare cameras for observation; initiate release of chemicals
Pilot	Stabilize spacecraft
Observe, direct, non-man	Visually observe status of cloud
Observe, display	Photometric data, if displayed
Photo	Photo of cloud
Record	Log record observations
EXPERIMENT 0802A	
Setup, initial	Initiate servomotor deployment of telescope on platform
Calibrate	Check electronic display and recording by built-in light source—probably a C-D panel operation
Pilot	Attitude hold during sequence
Observe, direct, non-man	Visually observe deployment; boresight acquisition of star
Observe, display	Monitor displayed readout of pointing direction
Record	Log record of displayed readout
EXPERIMENT 0802B	
Setup, periodic	Select target and initiate measurement sequence
Calibrate	Periodic calibration of equipment utilizing built-in calibration facilities
Pilot	Spacecraft orientation

Table 513-45. Crew Experiment Function Description (Cont)

Function	Description
Observe, direct, non-man	Visual observation for target selection
Observe, display	Monitor and interpret CRT display
Photo	Still photos of target in conjunction with sensor star
Process	Data interpretation
Record	Log record of data and interpretation
EXPERIMENT 0802C	
Setup, periodic	Select target, initiate sequence
Calibrate	Select source of known characteristics; calibrate sensor by built-in calibration equipment with reference to calibration source. Confer with ground support on calibration
Pilot	Initial spacecraft orientation
Observe, direct, non-man	Target selection
Observe, display	Monitor and interpret CRT display of spectral data
Photo	Still photos of target in conjunction with sensor scan
Process	Data interpretation and evaluation
Record	Log record of data and interpretation
EXPERIMENT 0802D	
	Crew operations for this experiment are similar to the experiments above but with a wider requirement for selection of measurement techniques and technical evaluation of data

Table 513-45. Crew Experiment Function Description (Cont)

Function	Description
EXPERIMENT 1507	
Setup, periodic	EVA steps a through f, position for task and remove or release equipment to be assembled
Teardown, periodic	EVA steps h through n
Apply equipment, self	Utilize tools, etc., in assembly task
Observe, self	Systematic observation of own task performance
Observe, other	Visual and TV observation of subject
Subject	Cooperation with observer
Photo	Photo coverage of task performance
Record	Log record of observations and evaluations
EXPERIMENT 1602	
Setup, initial	Check out photo and other remote measuring equipment; calculate flight data for flyby
Pilot	Attitude orientation and ΔV for flyby
Observe, direct, non-man	Direct visual and optical observation of satellite
Observe, display	Possible displayed data on satellite status
Photo	Photo of satellite
Data process	Interpretation of visual and optical data on satellite
Transmit	Voice description of observations
Record	Log record data and observations

10. SUMMARY OF MISSION ACCOMPLISHMENT

This mission is unique in that an 81.5-degree circular orbit will be extended into an elliptical orbit (200-nautical-mile perigee, 630-nautical-mile apogee) during the last mission day for intersection with the Echo II flight path. The mission will be designed (within transfer window limitations) to permit maximum time within a 1- to 10-mile range of the Echo II satellite. Radiation hazards to the crew members because of high orbital altitudes must be considered. The initial orbit of 81.5-degree inclination also will present problems concerning booster impact area. A programmed yaw steering boost phase is required.

Special consideration must be given to the G&N reliability uncertainty in final scheduling of the mission. The extended EVA's (2 hours duration) for each crewman twice during the flight are not expected to prove unusual problems.

Scheduled experiments include magnetic field observations, sensing system tests, and the release of chemicals for generation of comet-like clouds. The only deviation from the specified experimental program is the deletion of all spin-ups required for the biomedical Experiments 0101 and 0102 caused by RCS propellant limitations.

FLIGHT 218: BIOSCIENCE/PHYSICAL SCIENCE LABORATORY

1. EXPERIMENTAL PROGRAM

This mission is launched to an altitude of 200 nautical miles in an orbital inclination of 28.5 degrees. Its duration is 45 days, carrying a three-man crew. Experiments are listed below. There was no experiments integration by S&ID; experiments are listed for information only and to provide interface factors pertinent to Flight 219, which docks with Flight 218.

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

0401	Genetic Effects in Microorganisms (DNA Mutation Rate, and Phage Production)
0204	Effects of Space on Morphology, Growth, and Gas/Liquid Separation in Microorganisms, Unicellular Organisms and Animal Tissue Cells
0403	The Effects of Weightlessness on Cardiovascular and Respiratory Functions; Hormone, Mineral, and Water Metabolism; ANS, CNS, and Brain Mechanisms, Operant Behavior and Biorhythms in the Primate
0404	Limb Regeneration and Wound Healing During Weightlessness
0405	Effects of Drugs on Mammalian Behavior in Space Flight
0406	Soft Capture, Innumeration, and Identification in Space-Borne Microorganisms

1504	Development of Personnel and Cargo Transfer Operations
1505	Maintenance and Repair Techniques
0601	Capillarity Studies
0602A	Kinetics and Dynamics of Vapor/Gas Bubbles in Free-Fall
0602B	Liquid Drop Dynamics Studies
0603A	Pool Boiling in Long-Term Zero-G Environment
0603B	Nucleate Condensation of Fluids in Zero Gravity
0604	Density Gradient of a Fluid at a Near-Critical State
0605	Crystallization Studies
0606	Cosmic Ray Emission

2. MISSION OBJECTIVE

This first 45-day flight has a wide variety of experimental objectives which constitute the requirement for the establishment of a true bioscience/physical science space laboratory. Because of the increase in duration to 45 days, and because at least one astronaut may remain on board through the succeeding rendezvous flight, biomedical and behavioral measures again take precedence. Also, this is the first flight of sufficient duration to include Experiment 0121. The human experimental program will represent a comprehensive survey of critical functions related to prolonged space flight. The measures will most likely be the same as those utilized in earlier flights, but comprehensive coverage to include extension of data points is fundamental. There will be continued study of complex task performance.

Bioscience studies will be predominantly with microorganisms, although the effects of weightlessness on primates will also be studied. This will be the first manned flight allowing detailed investigation of space effects on living organisms other than man.

Experimental observations and basic studies in zero-gravity dynamics are secondary purposes.

3. BASIC EXPERIMENT REQUIREMENTS

The estimated weight, volume, crew time, Electrical Power System (EPS), and Stabilization Control System (SCS) requirements are presented in Table 218-46.

Table 218-46. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0121, 0201-0203)	747.4	14.5	9.0	67.2	471.8	0.0	255.0	4.6	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	5.7	3.0	0.0	3.0	0.1	
Study of living organisms (0401-0406) Centrifuge, incubator Refrigerator, microscope Cages and animals Physiological equipment	1072.5	29.5	0.0	286.3	407.5	0.0	24.0	0.3	
Study of liquid, gas and solids behavior (0601-0606) Test surface, storage Stereo camera and microscope Collision chamber, bomb tank Bomb cell optics, oven, centrifuge	287.5	20.1	0.0	4.0	111.5	296.8	71.0	0.8	
Extra-vehicular operations (1504-1505) Propellant, tanks, fuel transfer system Cargo and cargo transfer equipment	540.0	0.0	6.5	5.7	78.0	28.5	20.0	0.3	
TOTAL	2697.4	65.1	16.5	368.9	1071.8	325.3	373.0	6.1	

FLIGHT 219: BIOSCIENCE/PHYSICAL SCIENCE LABORATORY EXTENSION

1. EXPERIMENTAL PROGRAM

Flight 219 will be launched into a 200-nautical-mile, circular, Earth orbit with an inclination of 28.5 degrees. It will carry a three-man crew for a scheduled 45 days. Experiments to be carried are listed below:

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Extended Group

This flight will rendezvous with Flight 218. Experiments from Flight 218 that require extended duration will be continued if operationally feasible.

New Mission Group

1407	Performance Assessment of On-Board Guidance and Navigation System and Components
1501	Evaluation of Advanced Space-Suit Assemblies
1502	Development of Manned Locomotive and Maneuvering Capability
1503	Emergency Techniques, Equipment, and Procedures for Rescue Operations
1504	Development of Personnel and Cargo Transfer Operations (joint experiment with Flight 218)
1505	Maintenance and Repair Techniques
0302	On-Board Centrifuge (this experiment will be integrated with the laboratory module configuration only)

2. MISSION DESCRIPTION

This flight represents a major milestone in the long term program of enhancing man's operational efficiency for space flights of more extended duration. It will rendezvous with Flight 218 and will provide a means of continuing the duration of many of the Flight 218 experiments and of one astronaut to the 90-day level. The basic biomedical/behavioral experiments for two of the crewmen will continue in consonance with the program derived from earlier flights. However, the astronaut from Flight 218 who remains for an additional 45 days will be assessed in depth at regularly recurring intervals on all critical physiological functions and on a comprehensive sample of performance.

This flight will be the first in which personnel have participated in rendezvous and crew transfer. The transfer of personnel and supplies at the time of rendezvous with Flight 218, subsequent extended tests with tether lines, mechanical systems, and powered AMU operations will be performed in Experiment 1504.

A repeat of the testing of spacesuits and extravehicular operational techniques of Experiments 1501, 1502, and 1503 from Flight 209 will be made, as well as maintenance/repair techniques investigations (Experiment 1505) and personnel/cargo transfer operations at rendezvous (Experiment 1504).

During this mission, Experiments 1501 through 1505 are scheduled twice with test times of 80 and 100 minutes each. Experiment 1505, Maintenance/Repair, is scheduled additionally four more times at 30 minutes each. Operations both inside the rack airlock and outside the vehicle are required in order to continue the testing of advanced spacesuits, extravehicular powered and unpowered movement, personnel/cargo transfer, and in-space maintenance and repair. Two crewmen will be required in much of the testing, one crewman outside the spacecraft and the second crewman observing from the inside. Testing of spacesuits (Experiment 1501) will involve manned operation of the suits in many work environments. Extended series of extravehicular (EVA) activities will be performed in Experiment 1502, including use of a powered AMU thrusting unit. Emergency rescue, use of inflatable airlocks, and evaluation of various failure detection devices will be performed in Experiment 1503.

Experiment 1505 will entail the application of various tools and repair techniques to certain maintenance task boards that contain typical equipment in the propulsion, electrical, electronics, and stability/control categories. The operation will be performed both inside the airlock (with and without pressure suits) and outside the airlock.

Test and checkout of a prototype on-board navigation system in Experiment 1407 will entail observation of landmarks and stellar objects, orientation of the vehicle, and sightings through the sextant or telescope. The horizon sensor and altimeter will furnish additional data to the guidance computer. Some degree of orbital maneuvering will enable the effects of such motion on navigation accuracy to be evaluated. Because this mission is a rendezvous mission, the G&N system experiment should be of particular practical importance by aiding in the rendezvous as a backup to the vehicle guidance system.

Special Interface Problems

Experiment 1407, which employs the G&N system, must be provided with additional Earth-oriented antennas which are rotated out of the unpressurized area of the rack.

The basic orbital configuration for Flight 219 has the Apollo CSM docked to the rack. However, this is a rendezvous mission and the Rack of Flight 219 docks with Flight 218. To carry out Experiment 1504 (Personnel and Cargo Transfer Techniques), the astronauts can either transfer from Flight 218 to 219 through the docking hatch at the end of the rack in shirt-sleeve conditions, or can transfer externally by using the side access doors in the rack.

The cargo transfer portion of the experiment may be accomplished in three ways:

1. A mechanism in the Flight 219 rack can transfer cargo from one rack to another with an astronaut in the unpressurized portion of each rack to operate the cargo boom and receive the cargo. This method requires the two configurations to be physically docked.

2. An alternate method of cargo transfer for the experiment may be carried out with the two vehicles separated. A line must be connected between the two configurations and cargo attached to the line and transfered from one to the other using pulleys and a driving mechanism. Again, the astronauts will be required to be in the unpressurized portion of the racks to send and receive the cargo.

3. Another method of transfer consists of having the astronaut physically carry cargo containers from one configuration to another externally.

The equipment required for Experiment 1505 must be stored in the airlock and the unpressurized portion of the rack.

3. BASIC EXPERIMENT REQUIREMENTS

A summary of weight, volume, crew time, and other requirements is presented in Table 219-46.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Pertinent parameters of the experiments carried on this mission are shown in Table 219-48. This data formed the basic input to the automatic experiment scheduling program. Reference may be made to paragraph 4, Flight 209, for detailed description of the parameters presented in the table.

5. DATA MANAGEMENT REQUIREMENTS

As indicated in Table 219-49, Experiment 1407 will acquire data at the ratio of 865 bits per second for period of 95 minutes, repeated 12 times per mission. The standardized data management subsystem will readily process this data in the low-bit rate mode. The balance of the experiments listed will be managed as in Flight 209. Total transmission time for all experiments of Flight 219 is 868.8 minutes for the 45-day mission or an average of 19.3 minutes per day.

Figure 219-17 shows the data management profile for Experiment 1407 on this flight. For profiles of the biomedical/behaviorial experiments and Experiments 1501, 1502, 1503, see paragraph 5, Flight 209. Other experiments on this flight do not require data management

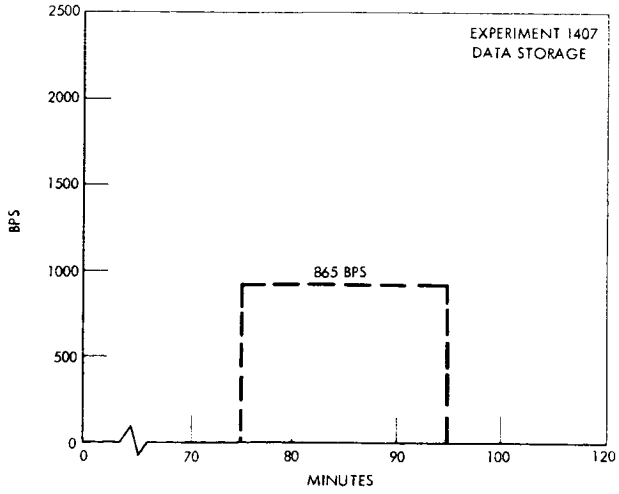


Figure 219-17. Data Management Profile

Table 219-47. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0121, 0201-0203)	0.0	0.0	0.0	67.2	471.8	0.0	255.0	4.6	From 218
Radiation monitor (0501)	0.0	0.0	0.0	5.7	3.0	0.0	3.0	0.4	From 218
Extra-vehicular operations (1501-1505) Dynamic test rigs Airlock Advanced space suits AMU Emergency equipment Cargo mechanisms, cargo	800.0	0.0	154.0	7.2	70.1	27.2	90.0	1.0	250 lb AMU fuel included
Subsystem development and test (1407) Antennas Computer Sensors	160.0	0.0	5.0	4.9	9.0	9.0	25.0	0.3	
Living organisms (0401-0406) Incubator, refrigerator Microscope, centrifuge Cages and animals Physiological equipment	205.0	6.5		286.3	407.5	0.0	24.0	0.3	From 218
Liquid/gas and solids behavior (0601-0606)	79.1	1.0		4.0	111.5	296.8	71.0	0.8	From 218
TOTAL	1244.1	7.5	159.0	375.3	1072.9	333.0	468.0	7.1	

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STO VOL CU
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 Min ▲	7.0	0.6
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 Min ▲	-	-
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min ▲	-	-
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6	1.8
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-	-
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-	-
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0	1.0
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-	-
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-	-
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473	9.0
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-	-
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0	0.2
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0	1.5
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-	-
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-	-
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2	0.0
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-	-
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-	-
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8	2.
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-	-
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-	-
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6	0.0
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-	-
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-	-
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-	-
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5	0.
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-	-
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-	-
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-	-
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9	2.0
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-	-
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-	-
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-	-
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-	-
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-	-
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-	-
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8	0.
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-	-

Table 219-48. Flight 219 Experiment Parameters (Sheet 1 of 3)

RED	REMARKS
JME	
FT.	
*	0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
*	▲Also real time TV or cine-camera for 25 min/exp
25	
5	
05	
1	
01	
	Lab work for 0113
25	
	Schedule on 3 successive days
	*Minimum rotation
	Schedule during 1st 2 days only
	Schedule during 1st 2 days only
	Schedule during 1st 2 days only
	Start 7 days after 011761
	Start 7 days after 011752
	Start 7 days after 011743
1	Schedule during 1st 2 days only
	Start 7 days after 011807

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STO VOLU CU.
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-	
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-	
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
012107	0121	1181	1/14 Days				35	-	-	5	1440	-	-	-	-	-	19.0	1
512107	0121	1182	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
612107	0121	1183	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.	-	-	-	-	-	-	
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0	3
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-	
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-	
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-	
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-	
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-	
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-	
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-	
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-	
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-	
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-	
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-	
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-	
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-	
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-	
150161	1501,1502	32	2/Mission	120			120			200	95	-	-	95	-	-	800	154
150152	1503,1504	33	2/Mission		120		120			200	95	-	-	95	-	-	-	
150143	1505	34	2/Mission			105	105			200	95	-	-	95	-	-	-	
650161	1504	35	2/Mission	120			120			200	95	-	-	95	-	-	-	
650152	1504	36	2/Mission		120		120			200	95	-	-	95	-	-	-	
650143	1504	37	2/Mission			105	105			200	95	-	-	95	-	-	-	
750161	1501,1502	38	2/Mission	80			80			200	60	-	-	60	-	-	-	
750152	1503,1504	39	2/Mission		80		80			200	60	-	-	60	-	-	-	
750143	1505	44	2/Mission			80	80			200	60	-	-	60	-	-	-	
150501	1505	45	4/Mission	30						-	-	-	-	-	-	-	-	
150502	1505	46	4/Mission		30					-	-	-	-	-	-	-	-	

Table 219-48. Flight 219 Experiment Parameters (Sheet 2 of 3)

RED UME FT.	REMARKS
-	Schedule during 1st 2 days only
-	Start 7 days after 011907
-	
-	
-	
.7	Start after 30 days
-	
-	
-	
.13	
-	
-	
-	Schedule 3 days after 020161
-	Schedule 3 days after 020152
-	Schedule 3 days after 020143
-	
-	
-	
-	
-	
-	
-	Schedule 3 days after 020361
-	Schedule 3 days after 020352
-	Schedule 3 days after 020343
	Tethered Schedule day 1 & 19 1505 performed EVA equip for
-	Tethered Schedule day 3 & 21 1505 performed EVA 1504 & 1505
-	Tethered Schedule day 5 & 23 1505 performed EVA in orbit
-	Boom Schedule day 7 & 25
-	Boom Schedule day 9 & 27
-	Boom Schedule day 11 & 29
-	AMU Schedule day 13 & 31 1505 performed EVA
-	AMU Schedule day 15 & 33 1505 performed EVA
-	AMU Schedule day 17 & 35 1505 performed EVA
-	1505 performed in pressurized area
-	1505 performed in pressurized area

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
150503	1505	47	4/Mission			30				-	-	-	-	-	-	-	-
050101	0501	48	1/3 Days	4						5.3	Cont	-	-	-	12,500	1 sec	-
050102	0501	49	1/3 Days		4					-	for	-	-	-	per	per	-
050103	0501	50	1/3 Days			4				-	45 days	-	-	-	orbit	orbit	-
040207	0402	1201	2/1 Day				30			125	Cont	-	-	-	-	-	-
540207	0402	1202	1/1 Day				60			-	for	-	-	-	-	-	-
640207	0402	1203	1/1 Day				30			-	45 days	-	-	-	-	-	-
040407	0404	1301	8/Day				15			5	Cont	-	-	-	-	-	17
540407	0404	1302	3/Day				20			5	Cont	-	-	-	-	-	-
040507	0405	1401	4/Day				45			125	Cont	-	-	-	-		108
040607	0406	1501	8/Mission				15			-	-	-	-	-	-	-	-
040107	0401	1601	6/Mission				10			125	5	-	-	-	-	-	-
040307	0403	1701	3/Day				10			10	Cont	-	-	-	-	-	80.0
140707	1407	40	3/Mission				45			540	45	Towards earth		45	350	-	160
640707	1407	41	3/Mission				45			540	45	Towards earth		45	350	-	-
740707	1407	42	3/Mission				45			540	45	Towards earth		45	350	-	-
840707	1407	43	3/Mission				45			540	45	Towards earth		45	350	-	-
060107	0601	1803	1/Day				20			10	15	-	-	10	-	-	5
560107	0601	1804	1/Day				11			250	5	-	-	5	-	-	-
060207	0602A	1901	1/4 Day				135	50	15	133	120	-	-	120	-	-	3
560207	0602B	1902	1/2 Day				60	100	30	101	15	-	-	15	-	-	5
060307	0603A	1903	10/Mission				60	100	30	150	15	-	-	15	-	-	50
560307	0603B	1904	5/Mission				120	50	30	100	90	-	-	-	-	-	10.1
060407	0604	1905	2/Mission				150	40	30	200	120	-	-	120	-	-	1
060507	0605	1906	1/2 Days				90			-	-	Towards sun		30	-	-	-
060607	0606	1907	1/Mission				30			130	3	Towards earth		10 days	-	-	5
560607	0606	1908	1/Mission				30			50	90	-	-	-	-	-	-

Table 219-48. Flight 219 Experiment Parameters (Sheet 3 of 3)

TORED OLUME CU. FT.	REMARKS
-	1505 performed in pressurized area
-	
-	
-	
-	12 hours ± 1 hour between exp. E. Coli
-	Pseudomonas
-	Paramecium and Hela Cells
0.06	4 hours ± 1 hour between exp. Planaria
-	8 hours ± 2 hours between exp. Newts
4.0	6 hours ± 1 hour between exp.
-	
-	
2.5	
5	Schedule day side orbit ± 10 min
-	Schedule day side orbit ± 10 min 1st orbit after 140707
-	Schedule night side orbit ± 10 min same orbit as 140707
-	Schedule night side orbit ± 10 min same orbit as 640707
0.05	
-	
0.16	Peak power 200W 20 min
0.1	Peak power 150W 5 min
0.25	
0.2	Peak power 200W 20 min
0.01	
-	
0.35	Schedule before 30th day
-	Schedule 10 days after 060607

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Table 219-49. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	135	
0103, 0107	Analog	1	1/Day	15	75	45	
0104	Analog	3	1/Day	15	225	135	
0105	--	--					None
0106	Analog	2	1/6 Days	15	150	15	
0108	Analog	4	2/Day	15	300	360	
0109, 0110	Analog	4	3/7 Days	15	300	78	
0111	Analog	1	6/7 Days	15	75	39	
0112	--	--					None
0113	Analog	2	3/7 Days	15	150	33	
0114	--	--					None
0201-0203	--	--					None
1501	250	95	4/Mission	3-3/4	1781	11.9	
1502-1505	--	--					None
0501	3	Cont			--		Multiplexed with Other Exper
1407	865	45	12/Mission	3-3/4	844	16.9	
0401-0406	--						None
0601-0606	--						None

6. POWER PROFILES

Figure 219-18 contains the operating power profiles for each experimental task that has not appeared in a previous flight. Note that the 0400 series of experiments are carried over from Flight 218, the flight with which Flight 219 will rendezvous.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

Table 219-50 defines the RCS propellant requirements for the experiments carried on this flight. SPS propellants for Experiment 0101 and the rendezvous with Flight 218 are also included.

8. CONTROLS AND DISPLAYS

The Integrated Control and Display is modified by adding on alphanumeric read-out component.

9. CREW FUNCTIONS

Crew operational times for this flight are summarized in Table 219-51. Many of these crew times must be specifically assigned to specific crew members with the assistance of any of the other crew members.

System management operations in this flight will require activation of fuel cells after 14 days and the navigation and pilot duties associated with rendezvous and docking with Flight 218. There will also be some crew transfer operations. The experiments aboard this flight which have not been discussed previously will generally require the crew to tend and observe living organisms in the 0400 experiment series, further develop man's extravehicular performance capabilites on the 1500 experiment series, and offer an opportunity to test on-board guidance and navigation procedures in Experiment 1407. Crew functions in these experiments are described in Table 219-52. In addition to the above, the crew may be required to study liquid, gas, and solid behavior through the use of on-board tanks, etc. in the 0600 experiments series.

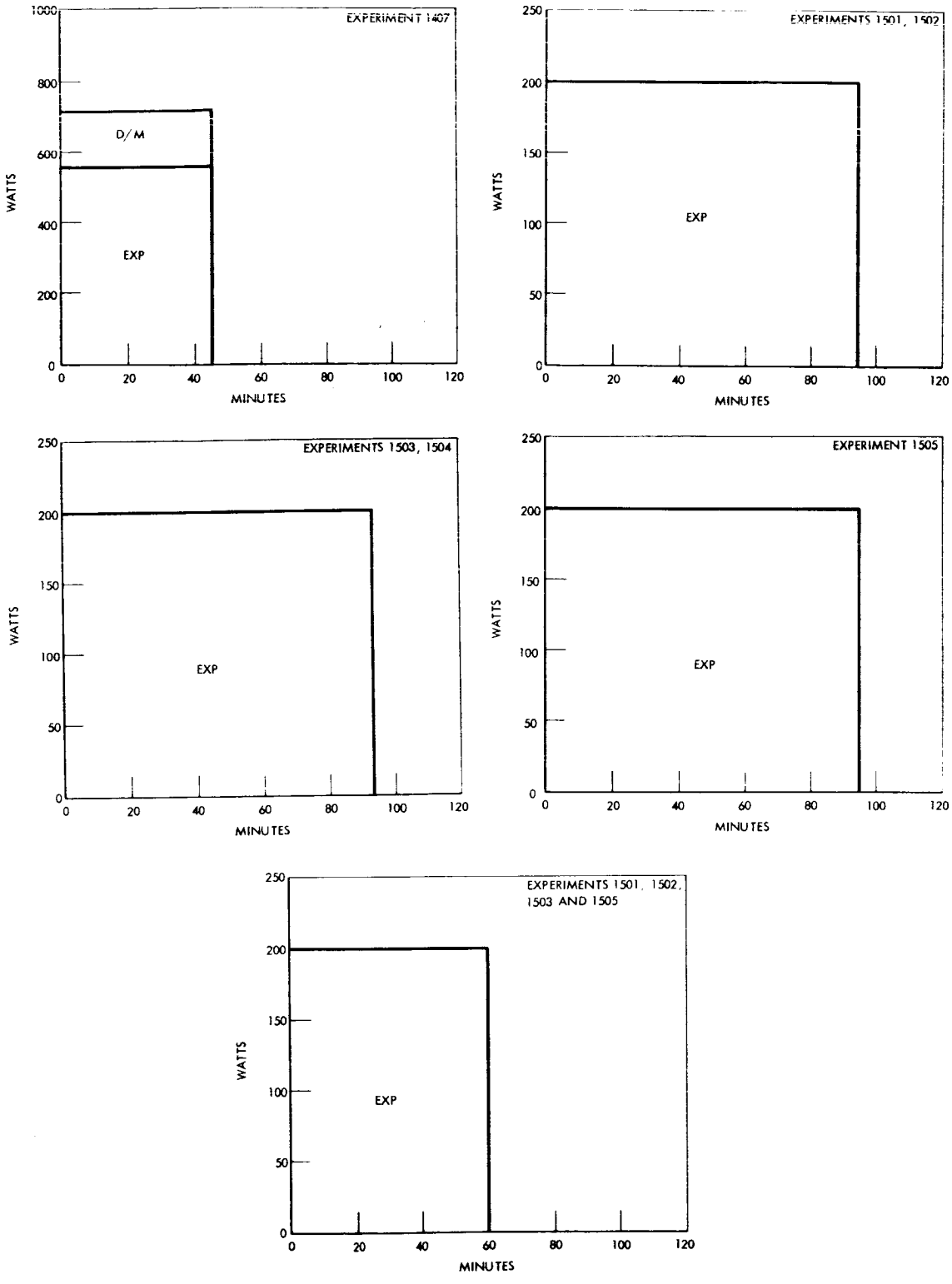

Figure 219-18. Operating Power Profiles
(Sheet 1 of 2)

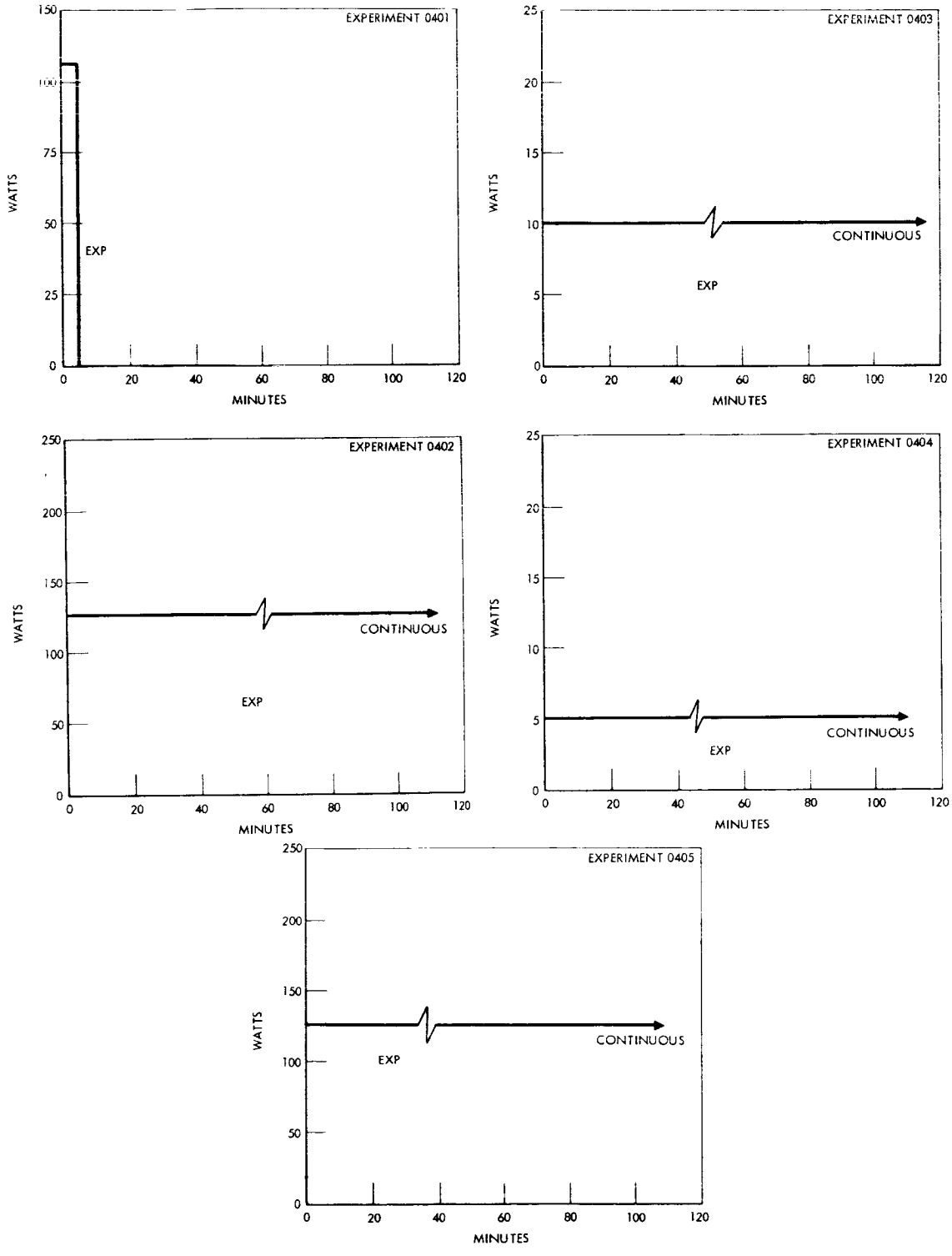

Figure 219-18. Operating Power Profiles
(Sheet 2 of 2)

Table 219-50. SPS and RCS Propellant Requirements

Experiment	Mancuvers	Operations	Propellant (lb) Conf C	Propellant (lb) Conf D
RCS REQUIREMENTS				
0101-0102	Spin profile	19	1824.0	2375.0
	Linear accelerations	6	78.0	78.0
1501-1502	Maneuvers	40	40.0	48.0
	Attitude hold	5 (hrs)	4.5	5.5
1503-1504	Maneuvers	40	40.0	48.0
	Attitude hold	5 (hrs)	4.5	5.5
1505	Maneuvers	40	40.0	48.0
	Attitude hold	5 (hrs)	4.5	5.5
1504	Maneuvers	76	72.0	92.0
	Attitude hold	10 (hrs)	8.0	9.0
1407	Maneuvers	42	84.0	105.0
	Attitude hold	9 (hrs)	10.0	11.0
1505	Maneuvers	22	44.0	55.0
	Attitude hold	11 (hrs)	12.0	13.0
		Total Weight	2266.0	2898.0
SPS REQUIREMENTS				
0101 Rendezvous with 218	10 sec firing	6	4200.0	
	rendezvous	-	650.0	

Table 219-51. Crew Times

Experiment	Specific Time (min)				Flight Total (hr)	Remarks
	C-1	C-2	C-3	Any C		
1501, 1502	120			120	70.1	Increasingly sophisticated EVA tests
1503, 1504		120		120		
1505 (EVA)			120	120		
1504	120			120		
1504		120		120		
1504			120	120		
1501, 1502	80			80		
1503, 1504		80		80		
1505 (EVA)			80	80		
1505 (N-EVA)				30		
0401				10	407.5	Plant and small life form laboratory operations
0402				30		
0402				60		
0402				30		
0404				15		
0404				20		
0405				45		
0406				15		
0403				10		
1407				45	9.0	Navigation operations
0100-0200					471.8	
0501					3.0	
0601-0606	(if carried out)				111.5	
TOTAL					1072.9	

Table 219-52. Crew Experiment Function Description

Function	Description
EXPERIMENT 0401	
Set-up, periodic	Transfer organisms to tubes and inject strains
Teardown, periodic	Inject material to halt phage infection and store tubes for Earth return
Observation	Visual observation of phage plaques
Record	Log record times and observations
EXPERIMENT 0402	
Set-up, initial	Check cultures and environment after launch
Teardown, final	Store cultures and slides for Earth return
Observe	Microscopic observations of organisms; measurement of CO_2, culture density
Process	Transfer cultures, freeze, prepare slides, chemical treatment
Bio-Sample	Remove sample cultures
Process data	Convert observations to standard format
Record	Log second observations and data
EXPERIMENT 0403	
Set-up, initial	Check monkeys; set up observation and life support equipment
Set-up, periodic	Instrument monkeys; care and nutrition
Teardown, periodic	De-instrument monkeys, clean up
Teardown, final	Secure monkeys and specimens for reentry
All other	Generally similar to human crew medical and behavioral procedure

Table 219-52. Crew Experiment Function Description (Cont)

Function	Description
EXPERIMENT 0404	
Set-up, initial	Check organisms for post-launch damage and set-up mission environment
Set-up, periodic	Care and nutrition of organisms, set up for surgery
Teardown, periodic	Post-surgical cleanup; sample storage
Observe	Direct and microscopic observation of growth and wound healing
Bio-Sample	Surgical removal of tissue
Process	Preserve samples, make slides
Photo	Photograph organisms
Data process	Convert observation data to recording form
Record	Log record observations and other data
EXPERIMENT 0405	
Set-up, initial	Set up animal systems and checkout
Set-up, periodic	Set up for surgery and injections, care and nutrition of animal colony
Teardown, periodic	Post-surgery cleanup and sample storage
Observe	Visual observation of animal behavior; microscopic and other observation of samples
Bio-Sample	Surgical procedures
Process	Slide preparation; preserve samples
Photo	Photographic coverage of animal behavior and status, including surgical findings

Table 219-52. Crew Experiment Function Description (Cont)

Function	Description
Direct transmit	TV transmission of animal behavior
Data process	Conversion of observations into suitable form for data
Record	Log record of data and observations
EXPERIMENT 0406	
Set-up, periodic	EVA steps, as in Approach Section; attach cartridge to holder; internal attachment of cartridge for observation
Teardown, periodic	EVA steps, as in Approach Section. Remove cartridge and return to interior spacecraft. Store for return
Pilot	Orient spacecraft for maximum collection
Observe, direct	View organisms in cartridge via magnifying installation
Data record	Record counts and other observations
EXPERIMENT 1407	
Set-up, initial	Remove equipment from storage and position, may be control of servo-mechanism for equipment in unpressurized areas; checkout equipment
Set-up, periodic	Acquire star, acquire landmark, or acquire horizon, as case may be
Teardown, periodic	Secure equipment to pre-test position
Align	Inter-align test equipment by non-test equipment for each type of test
Pilot	Orientation and stabilization of spacecraft for sightings and by horizon scanner/altimeter data

Table 219-52. Crew Experiment Function Description (Cont)

Function	Description
Observe, other	Observation of subject crew member's task performance
Observe, direct, non-man	Center stars and landmarks by optical device
Observe, display	Observe computer position, attitude, altitude, position readouts, times, etc.
Data process	Enter star sight and landmark sight data into computer
Direct transmit	Compare on-board navigation values with ground determined values
Record	Log record task performance observations and navigation values
EXPERIMENT 1504	
Set-up, initial	Deploy TV camera; EVA stops a-f; remove conveyor from storage, assemble, secure, secure AMU
Teardown, final	EVA stops h-n
Pilot	Attitude control
Observe, self	Observe own actions during EVA
Observe, other	Monitor buddy and crew members in EVA
Physical transfer of cargo	Release cargo; restrain to conveyor; manually move cargo by AMU or by restraint system
Photo, etc.	Complete TV coverage and possible photos of set-up and transfer
Direct transmit	Open line communication between all crew members and ground
Record	Log record observations

Table 219-52. Crew Experiment Function Description (Cont)

Function	Description
EXPERIMENT 1505	
Set-up, periodic	EVA steps a-f; egress to test station, setup tool kit and task board
	Set up tool kit and task board for non-EVA tests.
Teardown, periodic (EVA)	Secure tool kit and task board for transport; ingress to vehicle with tool kit and task board. EVA steps h-n
	Tear down task boards to pre-test status
Apply equipment, self	Utilize instructions, tool kit, task board items as required by experiment task
Observe, self	Systematic observation of own test performance and problems
Observe, other	Systematic observation of subject test performance by TV, direct vision, etc.
Observe, direct, non-man	Inspect and evaluate test board status after test
Subject	Cooperation with observer during test
Photo, etc.	Pre-test, test, and post-test photo and TV coverage
Record	Log record observations, scores, etc.

10. SUMMARY OF MISSION ACCOMPLISHMENT

A very significant aspect of this flight is the rendezvous and docking with Flight 218 in order to transfer one crew member and assorted cargo. This is the first AES flight which will attempt crew/cargo transfer, thereby extending the in-orbit medical and behavioral experiments data to a 90-day duration. Fewer spin-ups will be conducted in conjunction with Experiments 0101 and 0102, because of RCS propellant limitations. Fewer linear accelerations will be conducted in order to reduce SPS propellant requirements. Because of weight limitations, configuration D will be limited to 33 days.

Numerous experiments, including testing of maintenance and repair techniques, will require extra vehicular activity. Animal life support experiments will be continued from Flight 218. The on-board Block II-A Guidance and Navigation system evaluation will also be conducted on this mission, requiring three 45-minute operations on the day side of the orbit and three 45-minute operations on the night side.

FLIGHT 221: SPACE STATION ARTIFICIAL GRAVITY INVESTIGATIONS

1. EXPERIMENTAL PROGRAM

This mission will be placed in a 200 nautical-mile circular orbit at 28.5 degrees inclination. It will involve three men for 45 days and include the following experiments:

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavior Series
0501	Radiation Environment Monitoring

Mission Group

0301	Artificial Gravity by Rotating Station

2. MISSION OBJECTIVES

The artificial gravity system, as tested on Flight 215 and subsequently developed, will be given a full-scale test of 45 days duration with varied G levels.

The previous mechanical tests of Flight 215 will have proven the capability of maintaining a rotational artificial G condition. Upon establishing orbit, the Command-Service module/rack will be mechanically separated from the S-IVB carcass and a rotation of the combination will be initiated. At the end of the mission period, the system will be de-rotated just prior to Earth-return of the Command Module. This will provide the data for comparison of weightlessness effects with effects over time due to artificial G by station rotation. In order to make this comparison, the full range of biomedical and behavioral functions will be measured. Radiation environment measurement will continue.

3. BASIC EXPERIMENT REQUIREMENTS

A summary of weight, volume, crew time and other requirements is contained in Table 221-53.

Table 221-53. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0121, 0201-0203)	747.4	14.5	9.0	67.2	471.8	0.0	255.0	4.6	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	5.7	3.0	0.0	3.0	0.1	
Creation of artificial gravity (0301) Mechanisms	151.0	0.0	2.0	0.2	5.0	0.0	75.0	0.8	
TOTAL	948.4	15.5	12.0	73.1	479.8	0.0	333.0	5.5	

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Pertinent parameters of the experiments carried on this mission are shown in Table 221-54. This data formed the basic input to the automatic experiment scheduling program. Reference may be made to Section 4, Flight 209, for detailed description of the parameters presented in the table.

5. DATA MANAGEMENT REQUIREMENTS

The data management requirements for Flight 221 are summarized in Table 221-55. Flight 221 carries the standard experiments (0100, 0200, and 0501 plus 0301) which impose normal requirements for data management. Hence, the requirements for 525 feet of tape per acquisition, 840 minutes transmission time per mission, and 18.7 minutes average transmission time per day are easily satisfied by the standard data management subsystem.

6. POWER PROFILES

This section normally contains the operating power profile for each experimental task that has not appeared in a previous flight. All experiments on this flight have already been covered.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

Table 221-56 enumerates the propellant quantities required for maneuvering the spacecraft during this flight.

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min ▲	7.0
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min ▲	-
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min ▲	-
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-

Table 221-54. Flight 221 Experiment Parameters (Sheet 1 of 2)

TORED OLUME U. FT.	REMARKS
0.6	0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
1.8	
-	
-	
1.0	
-	
-	
9.0	
-	
0.25	
1.5	
-	
-	
0.05	
-	
-	
2.1	
-	
-	
0.01	
-	
-	
-	Lab work for 0113
0.25	
-	Schedule on 3 successive days
-	*Minimum rotation
-	
2.0	
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Start 7 days after 011743
0.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	ST VO CU
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-	
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-	
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
012107	0121	1181	1/14 Days				35	-	-	5	1440	-	-	-	-	-	19.0	
512107	0121	1182	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
612107	0121	1183	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.	-	-	-	-	-	-	
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0	
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-	
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-	
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-	
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-	
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-	
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-	
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-	
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-	
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-	
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-	
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-	
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-	
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-	
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-	
050101	0501	1191	1/3 Days	4						5.3	Cont.				12,500	1 sec	50.0	
050102	0501	1192	1/3 Days		4						for				per	per		
050103	0501	1193	1/3 Days			4					45 days				orbit	orbit		
030177	0301	32	15/Mission				10/10			-	-	-	-	*	-	-	151	

Table 221-54. Flight 221 Experiment Parameters (Sheet 2 of 2)

ORED	REMARKS
OLUME	
J. FT.	
-	Schedule during 1st 2 days only
-	Start 7 days after 011907
-	
-	
-	
.7	Start after 30 days
-	
-	
-	
.13	
-	
-	
-	Schedule 3 days after 020161
-	Schedule 3 days after 020152
-	Schedule 3 days after 020143
-	
-	
-	
-	
-	
-	
-	Schedule 3 days after 020361
-	Schedule 3 days after 020352
-	Schedule 3 days after 020343
.0	
.0	Schedule ±2 orbits at beginning of day 1, 6, 11, 21, 26, 31, 36 and middle of day 3, 8, 18, 23, 28, 33, 38, 45

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Table 221-55. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	135	
0103, 0107	Analog	1	1/Day	15	75	45	
0104	Analog	3	1/Day	15	225	135	
0105	--	--					None
0106	Analog	2	1/6 Days	15	150	15	
0108		4	2/Day		300	360	
0109, 0110		4	3/7 Days		300	78	
0111	Analog	1	6/7 Days	15	75	39	
0112	--	--	--				None
0113	Analog	2	3/7 Days	15	150	33	
0114, 0121	--	--	--				None
0201, 0203	--	--	--				None
0501	3	Cont			--		Multiplexed with Other Exper
0301	--						None

Table 221-56. RCS and SPS Propellant Requirements

Experiment	Maneuver	Number Operations	Propellant (lb) Conf C	Propellant (lb) Conf D
RCS REQUIREMENTS				
0301	Artificial G test	2	1578	1578
SPS REQUIREMENTS				
0101	10 sec firing	6	4200	

8. CONTROLS AND DISPLAYS

Changes to the basic control and display panel include two additional items: a circular meter, and a 1G warning signal light.

9. CREW FUNCTIONS

Crew times have been previously discussed in connection with Flights 211 and 215; therefore, only total crew times are included in Table 221-57.

Table 221-57. Crew Times

Experiment	Total (hrs)
0100-0200	471.8
0501	3.0
0301	5.0
Total	479.8

This flight, essentially an extended version of Flight 211 with artificial gravity (spin) operations, does not include the camera duties with which the spin operations might interfere. All experiments on this flight have been discussed in previous flights.

10. SUMMARY OF MISSION ACCOMPLISHMENT

The purpose of this flight will be the full mission testing of the artificial gravity system using the S-IVB as a counterweight to the spacecraft. The S-IVB and spacecraft combination will be rotated continuously in orbit, with variable rotation radius (up to 50 feet) and rpm. This will provide variable artificial gravity conditions up to one G.

The only recommended deviation from the specified experimental program is the reduction of orbital duration to 39 days for configuration D. Special considerations are required only to the extent that the initial spin-up will be accomplished through non-coupled RCS firing.

FLIGHT 516: ASTRONOMY

1. EXPERIMENTAL PROGRAM

This mission is launched into synchronous orbit with a crew of three for 45 days. The experiments aboard this mission, listed below, were not integrated into the spacecraft by S&ID. However, some data were generated for consideration in the overall analysis of the spacecraft and its systems.

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

0401	Genetic Effects in Microorganisms (DNA Mutation Rate, and Phage Production)
0402	Effects of Space on Morphology, Growth, and Gas/Liquid Separation in Microorganisms, Unicellular Organisms and Animal Tissue Cells
0403	The Effects of Weightlessness on Cardiovascular and Respiratory Functions. Hormone, Mineral, and Water Metabolism, ANS, CNS and Brain Mechanisms, Operant Behavior and Biorythms in the Primate
0404	Limb Regeneration and Wound Healing During Weightlessness
0405	Effects of Drugs on Mammalian Behavior in Space Flight
0406	Soft Capture, Innumeration and Identification in Space-Borne Microorganisms
1303	Extendable Rod Performance Tests

1304	Operation of Solar Sailing Passive Communications Satellite
0701	Emission Line Radiometry
0702	Intermediate-Size Reflecting Telescope
0703	Manned Coronagraph
0704	Study of Nearly Solar-Like Stars in X-Rays
0705A	Radio Astronomy 1-5 MCPS Range
0705B	Radio Astronomy 1-5 MXPS Range Using Tunable "V" Antenna
0801	Conjugate Aurora and Airglow
1001	Small Maneuverable Satellite (SMS)

2. MISSION OBJECTIVE

This flight is intended to provide a significant advance in the scientific space laboratory effort. Included is a major series of astronomical observations and associated experimentation. A synchronous orbit for a full 45 days is specified for the first time.

With the astronomical mission, basic space flight development investigations are primary to include such operational problems as extendable member techniques or kinetic energy use in spacecraft control; and such environmental problems as the nature of aurorae and interstellar gases.

Biomedical/behavioral experimentation continues as a progression of the basic programs of earlier 45-day flights. Mammalian studies will be emphasized, with the use of implanted electrodes in primates as the major progression.

3. BASIC EXPERIMENT REQUIREMENTS

The estimated weight, volume, crew time, Electrical Power System (EPS), and Stabilization Control System (SCS) requirements are presented in Table 516-58.

Table 516-58. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0100-0200)	747.4	14.5	9.0	67.2	471.8	0.0	255.0	4.6	Including radioisotope 463 lb
Radiation monitoring (0501)	50.0	1.0	1.0	5.7	3.0	0.0	3.0	0.1	
Study of living organisms (0401-0406) Centrifuge, incubator, refrigerator Microscope, cages and animals Physiological equipment	1072.5	29.5	0.0	286.3	407.5	0.0	24.0	0.3	
Space structures technology (1303-1304) Large deployable structure Tether system Power supply and receiver	200.0	0.0	9.0	0.5	21.0	19.0	3.0	0.1	
Astronomical observations and techniques (0701-0705) Coronograph, camera, image monitoring system, IR interferometer, oscilloscope, telescope, microscope, solar tracking system, antennas, radioastronomy RCVR	4663.0	0.0	105.5	39.5	520.0	507.5	135.0	2.72	
Conjugate aurora and airglow (0801) Spectrographic photometers telescope	105.0	0.0	6.5	1.2	6.9	0.0	30.0	0.3	
Small maneuverable satellite (1001)	782.0	0.0	39.0	6.3	27.3	0.0	50.0	1.0	
TOTAL	7619.9	45.0	170.5	406.7	1457.5	526.5	500.0	9.12	

FLIGHT 518: REMOTE SENSING OF THE EARTH'S SURFACE AND ATMOSPHERE

1. EXPERIMENTAL PROGRAM

This mission will be carried out in a 200-nautical-mile orbit at an inclination of 83 degrees retrograde. It will carry three men for a total duration of 45 days. Experiments to be conducted are as follows:

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

1405	Orbital Test of a Large Solar Cell Array
0802A	Operation of High-resolution Infrared Radiometer (HRIR) Detectors Experiment
0802B	Test of an Infrared Scanning Spectrometer
0802C	Test Calibration and Evaluation of a Microwave Spectrometer
0802D	Test of a Prototype Star-tracker
0901	Multispectral Target Characteristics
0902	Synoptic Earth Mapping
0903	Multifrequency Radar Imagery

2. MISSION OBJECTIVE

The primary purpose of this flight is the direct application and further development of the Earth sensing systems initiated in earlier flights, and the increased accumulation of detailed Earth data. A full complement

of Earth sensing equipment will be installed for the first time with the addition of multifrequency radar imaging capacity to the basic equipment.

The slightly retrograde orbit is designed to maintain the same orbit-Sun-Earth viewing relationships throughout the 45-day mission. During the sunlit phases of the orbits, a large solar cell array will be tested (1405). This array will be about 1250 square feet and produce a maximum of about 10 kw. The power will be utilized to alleviate the demand of the radar experiment (0903). Mechanical problems of deployment will have been tested in the earlier Flight 507. Development of future power systems for prolonged, perhaps interplanetary, missions will be influenced by this mission's test and actual use of the solar cell array.

Four experiments will be concerned with the specialized observation of the Earth's surface and atmosphere. A star tracker (0802A) will accurately determine the refraction of stellar images as the star occult through the visible atmospheric fringe. Two scanning spectrometers, IR and microwave (0802C and D), will procure spectral distribution of radiation from various points on the Earth's surface in certain frequency bands. An IR radiometer (0802B) will generate IR emission data which can be correlated with photos and reconstituted into cloud images.

Observation of the Earth's surface in various modes is the purpose of the 0901, 0902, and 0903 series of experiments. Stereocartographic photos at 20-foot resolution will permit topographic maps of the desired height resolution to be made. Simultaneously, multicolor photos of a coarser resolution will permit reconstitution of subsequent full-color and modified false-color photos. Broad band VHF returns will indicate surface moisture condition; passive reception of the Earth's microwave emission will be accomplished with a radiometer. A radar mapping task (0903) will simultaneously be performed to provide correlated radar maps of the same areas covered by 0901 and 0902. Radar swaths up to about 80 nautical miles at frequencies from 0.5 kmc to 35 kmc at resolutions from 15 to 340 meters will cover most of the Earth's surface during the mission.

A special interface problem was encountered during Experiment 0903, radar mapping. The radar altimeter antenna must be oriented in the direction of the Earth. The parabolic antenna for the side-looking radar must be oriented 35 degrees with respect to the local horizontal. It is imperative that the parabolic antenna be so designed as to assume a proper shape after deployment and unfurling. The equipment box must be mounted in close proximity to the antennas to minimize RF losses. Film storage must be accessible and provided with thermal control. In order to minimize interference, it is desirable that all antennas be provided with separate erection capabilities.

3. BASIC EXPERIMENT REQUIREMENTS

The weight, volume, crew time, EPS, and SCS requirements are presented in Table 518-59.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

The pertinent parameters of the experiments carried on the flight are listed in Table 518-60. This data forms the basic input to the scheduling computer program. Additional definitions of the various parameters are presented in Flight 209.

5. DATA MANAGEMENT REQUIREMENTS

The data management requirements for Flight 518 are summarized in Table 518-61. Flight 518 will conduct the same standard experiments (i.e., 0100, 0020, and 0501) as Flight 209. In addition, experiment 0903 requires 2250 feet (one reel) of tape per acquisition and a total transmission time per mission of 5888 minutes. This is attributable due to high data rate and high frequency of acquisition relevant to the mission. The flight requires a total transmission time of 7236.6 minutes per mission, i.e., an average transmission time of 160.8 minutes per day. Hence, the standard data management subsystem described in Section 2 is adequate. The data management profile for Experiment 0903 is shown in Figure 518-19.

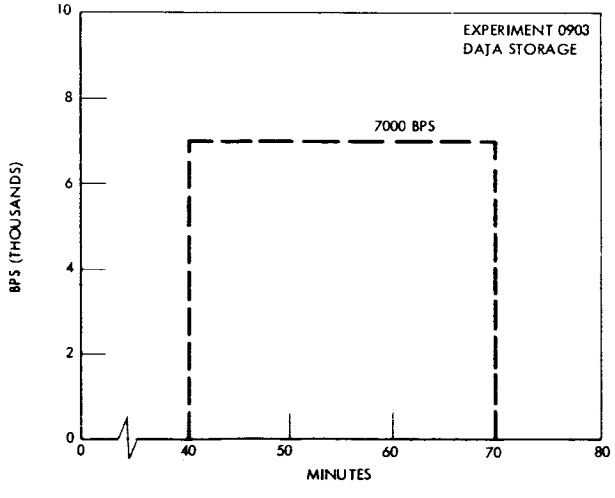

Figure 518-19. Data Management Profile

Table 518-59. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0100-0200)	747.4	14.5	9.0	67.2	471.8	0.0	255.0	4.6	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	5.7	3.0	0.0	3.0	0.1	
Orbital test of large solar cell system (1405) Solar cell array Elect. actuators and motors	2897.0	0.0	305.0		45.0	(2160.0)	13.5	0.3	Solar cell array
Remote sensing of the earth's atmosphere (0802A, B, C, D) IR spectrometer, C.R.T., camera, spectrophotometer, antennas, microwave receivers, theodolite	616.0	0.0	22.5	9.2	173.7	189.1	136.0	2.3	
Remote sensing of the earth's surface (0901-0902-0903) Multispectral camera, IR spectrometer, and imager, side-looking radar, high resolution radar, telescope	4171.0	0.0	150.0	396.0	104.5	292.5	848.5	17.0	
TOTAL	8481.4	15.5	487.5	478.0	798.0	481.6	1256.0	24.3	

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	S V C
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min▲	7.0	
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min▲	-	
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min▲	-	
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6	
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-	
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-	
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0	
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-	
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-	
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473	
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-	
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0	
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0	
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-	
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-	
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2	
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-	
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-	
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8	
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-	
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-	
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6	
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-	
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-	
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-	
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5	
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-	
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-	
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-	
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9	
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-	
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-	
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-	
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-	
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-	
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-	
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8	
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-	

Table 518-60. Flight 518 Experiment Parameters (Sheet 1 of 3)

TORED OLUME U. FT.	REMARKS
0.6	*0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
1.8	
-	
-	
1.0	
-	
-	
9.0	
-	
0.25	
1.5	
-	
-	
0.05	
-	
-	
-	
2.1	
-	
-	
0.01	
-	
-	
-	Lab work for 0113
0.25	
-	Schedule on 3 successive days
-	*Minimum rotation
-	
2.0	
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Start 7 days after 011743
0.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	ST VO C
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-	
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-	
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
012107	0121	1181	1/14 Days				35	-	-	5	1440	-	-	-	-	-	19.0*	
512107	0121	1182	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
612107	0121	1183	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont	-	-	-	-	-	-	
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0	
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-	
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-	
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-	
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-	
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-	
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-	
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-	
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-	
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-	
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-	
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-	
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-	
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-	
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-	
090107	0901, 2, 3	32	1/11 orbits				30			3930	30	Towards Earth		30	3.2×10^6	61 Sec	4171	
590107	0901, 2, 3	33	1/11 orbits				30			3930	30	Towards Earth		30	3.2×10^6	61 Sec	-	
690107	0901, 2, 3	34	1/11 orbits				33			3930	33	Towards Earth		33	3.2×10^6	61 Sec	-	
790107	0901,2, 3	1701	1/3 Days				15			-	-	-	-	-	-	-	-	
050101	0501	1201	1/3 Days	4						5.3	Cont	-	-	-	12,500/	1 Sec/	50	
050102	0501	1202	1/3 Days		4					-	for	-	-	-	orbit	orbit	-	
050103	0501	1203	1/3 Days			4				-	45 days	-	-	-			-	
140507	1405	1501	1/1 Day				30			*	-	Towards Sun		Cont	25,200/	5 Sec/	2517	
640507	1405	1502	1/1 Day				30			*	-	Towards Sun		Cont	orbit	orbit	-	

Table 518-60. Flight 518 Experiment Parameters (Sheet 2 of 3)

ORED	REMARKS
OLUME	
J. FT.	
-	Schedule during 1st 2 days only
-	Start 7 days after 011907
-	
-	
-	
1.7*	Start after 30 days
-	*Do not include in missions less than 30 days
-	
-	
3.13	
-	
-	
-	Schedule 3 days after 020161
-	Schedule 3 days after 020152
-	Schedule 3 days after 020143
-	
-	
-	
-	
-	
-	
-	Schedule 3 days after 020361
-	Schedule 3 days after 020352
-	Schedule 3 days after 020343
150	
-	Schedule immediately after 09017 — Peak power 40,000W 1 min
-	Schedule immediately after 59017
-	Maintenance and changing film
2	
-	
-	
00	* Produces power
-	* Produces power

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	STO VOL CU.
080207	0802A	1601	4/1 Day				20	15	5	25	20	Towards	Earth	20	*		98	4
580207	0802B	1602	6/1 Day				20	10	5	60	20	Towards	Earth	20	*		390	10
680207	0802C	1603	2/1 Day				15			90	16	Towards	Earth	15	*		68	5
780207	0802D	1604	7/Mission				10			5	7	Towards	Star	1			60	3.5

Table 518-60. Flight 518 Experiment Parameters (Sheet 3 of 3)

RED UME FT.	REMARKS
4	* All data collected on film and tape
9	* All data collected on film and tape
5	* All data collected on film and tape
5	

Table 518-61. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	135	
0103, 0107	Analog	1	1/Day	15	75	45	
0104	Analog	3	1/Day	15	225	135	
0105	--				--	--	None
0106	Analog	2	1/6 Days	15	150	15	
0108		4	2/Day		300	360	
0109, 0110		4	3/7 Days		300	78	
0111	Analog	1	6/7 Days	15	75	39	
0112	--				--	--	None
0113	Analog	2	3/7 Days	15	150	33	
0114-0121	--				--	--	None
0201-0203	--				--	--	None
0901, 0902	1137	30	3/11 Orbits	3-3/4	562.5	184.1	
0903	7000	30	3/11 Orbits	15	2250.0	5888.0	(Return Excess to Earth in Tape Form)
0501	3	Cont			--	--	Multiplexed with Other Exper
1405	5	30	2/Day	3-3/4	562.5	84.6	
0802A	35	20	4/Day		375.0	112.8	
B	1365	10	6/Day		187.5	84.6	
C	1444	15	2/Day		281.3	42.3	
D	160	1	7/Mission	3-3/4	18.8	0.2	

6. POWER PROFILES

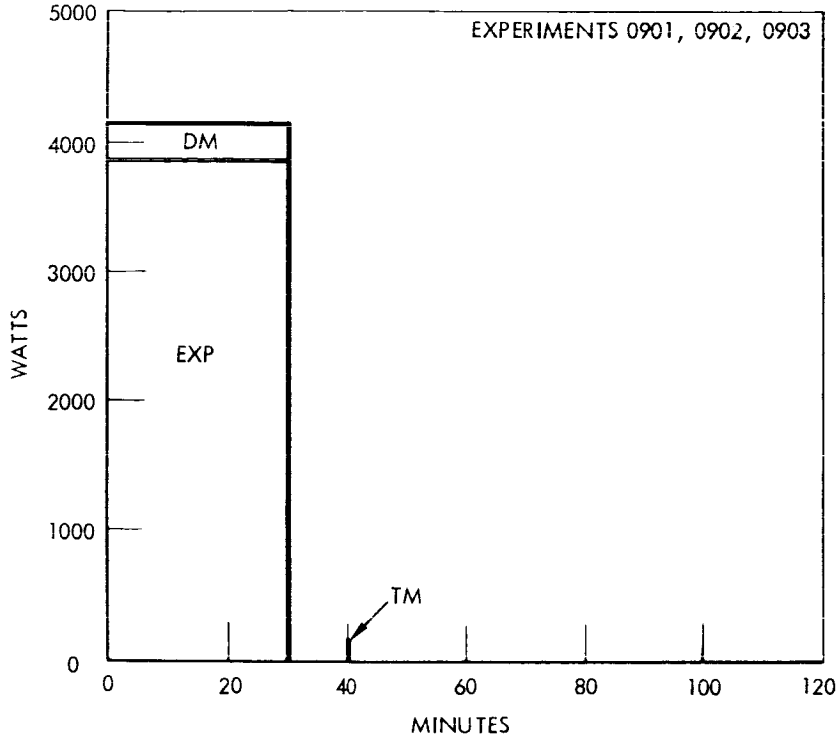
Figure 518-20 contains the operating power profile for each experimental task that has not appeared in a previous flight.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

The required expenditure of Reaction Control System (RCS) and Service Propulsion System (SPS) propellants to support the mission experiments is shown in Table 518-62.

Table 518-62. RCS and SPS Propellant Requirements

Experiment	Maneuver	Operations	Propellant (lb)	
			Conf C	Conf D
RCS REQUIREMENTS				
0101-0102	Spin profile	19	2070	2570
	Linear accelerations	6	78	78
0901	Maneuvers	65	90	113
1405	Maneuvers	342	473	576
0802 (ABC)	Maneuvers	270	372	453
0802 D	Maneuvers	7	11	13
0901-3	Attitude hold	102 (hrs)	239	187
1405	Attitude hold	787 (hrs)	262	254
0802 A	Attitude hold	60 (hrs)	28	21
0802 B	Attitude hold	90 (hrs)	42	32
0802 C	Attitude hold	23 (hrs)	37	29
TOTAL WEIGHT			3702	4326
SPS REQUIREMENTS				
0101	10 sec-firing	6	4200	



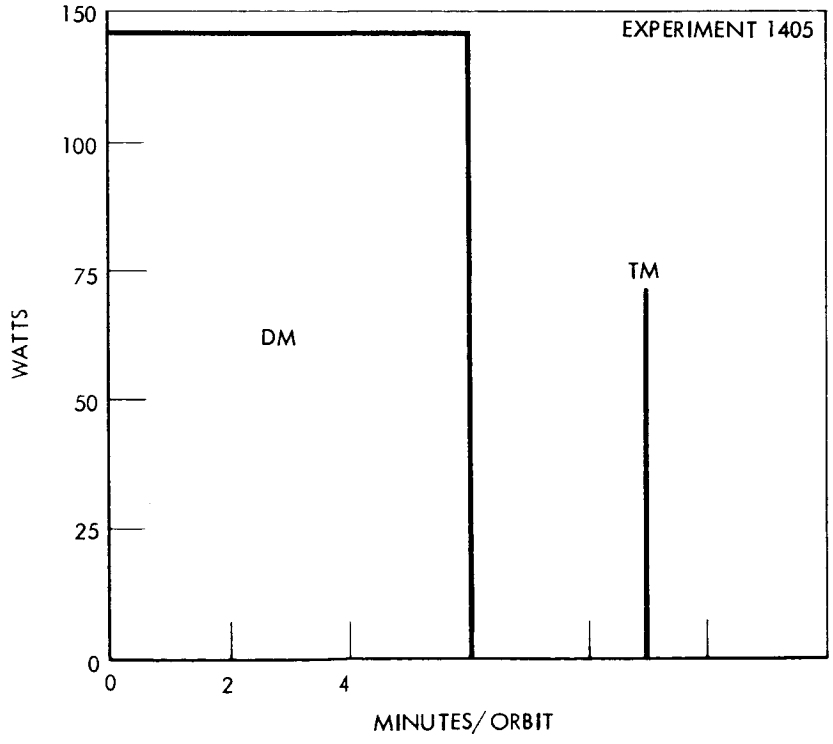


Figure 518-20. Operating Power Profiles

8. CONTROLS AND DISPLAYS

The following changes to the basic control and display panel are required: addition of toggle switches; deletion of digital read-out.

9. CREW FUNCTIONS

With the exception of the addition of Experiment 0903, whose crew time is combined with Experiments 0901 and 0902, no experiments appear on this flight that have not been previously discussed. Therefore, it is only necessary to list total crew times in Table 518-63.

Table 518-63. Crew Times

Experiment	Total (hrs)
0100-0200	471.8
0501	3.0
1405	45.0
0802A	60.0
0802B	90.0
0802C	22.5
0802D	1.2
0901-0903	104.5
TOTAL	798.0

Crew system management functions for this flight are generally standard for a 45-day D configuration. In experiment operations, the flight contains no crew functions not previously discussed—with the exception of extending the 0900 series of experiments into 0903. Crew functions for Experiment 0903 are described in Table 518-64.

Table 518-64. Crew Function Description
Experiment 0903

Function	Description
Set-up, initial	Initiate deployment; initial checkout.
Set-up, periodic	Select channels, ranges, techniques, etc.; select targets; load film.
Calibrate	Periodic calibration of equipment by built-in calibration facilities and in coordination with ground support.
Pilot	Attitude orientation.
Observe, direct, non-man	Observe deployment and status of antenna; visually select targets.
Observe, display	Observe pertinent parameters for various measurement techniques; interpret data.
Photo	Photo coverage of targets in conjunction with radar scan.
Direct transmit	Coordinate data acquisition and transmit with ground support.
Record	Log record displayed data and other observations.

10. SUMMARY OF MISSION ACCOMPLISHMENT

As in all polar orbit launches from Cape Kennedy, a yaw steering boost program is required in this flight. This flight must be launched within a certain time interval to capitalize on optimal Earth lighting for Earth mapping purposes. Test of a radar imaging system will be conducted on this flight in addition to other sensor system tests.

A deployable solar cell array will be utilized to provide 10 kw of power for the radar experiment. Since power generated by the solar array will be directly available only on the Earth's day side, batteries will be provided to permit radar mapping operations of the Earth's night side.

Recommended deviations from the specified experimental program include deletion of spin-ups required for experiments 0101 and 0102. This exception is due to RCS propellant capacity limitations. Fewer experiment 0802B operations will be performed for the same reason.

Special consideration must be given to two factors: selection of the booster impact area and the requirement for approximately 20,000 RCS firings.

FLIGHT 521: SPACE PHYSICS AND SUBSYSTEM DEVELOPMENT

1. EXPERIMENTAL PROGRAM

This flight is launched into synchronous orbit with a crew of three for 45 days. Experiments are listed below. This experimental mission was not integrated by S&ID.

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

0801	Conjugate Aurora and Airglow
1403	Fluid Management Technology for LSS
1404	Radioisotope - Thermoelectric Power System Integration
1406	Optical Technology (Excluding LASER Tracking)
0502	Study of Magnetic Field Lines
0503	Generation and Analysis of Comet-Like Particulate Clouds
1101	Launch of an Unmanned Satellite (OGO)

2. MISSION OBJECTIVES

This flight continues the series of broad scientific investigations begun with Flight 218. Emphasis is on the effects of the space environment on equipment, materials, and structures and further observation of the environment. An operational development phase will be achieved with the launch of an unmanned satellite, perhaps an orbiting geophysical observatory, from the spacecraft. Investigation of advanced subsystems, though highly important, must be considered a secondary mission objective.

3. BASIC EXPERIMENT REQUIREMENTS

Table 521-65 presents a tabulation of estimated equipment weight volume, crew time, and other experiment requirements for this mission.

Table 521-65. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0100-0210)	747.4	23.5	0.0	67.2	471.8	0.0	255.0	4.6	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	0.0	2.0	5.7	3.0	0.0	3.0	0.1	
Remote sensing of the earth's atmosphere (0801) Telescope Image orthicon camera Recorder	105.0	0.0	6.5	1.2	6.9	0.0	30.0	0.3	
Fluid management technology (1403)	35.0	0.0	2.0	6.0	12.0	0.0	0.0	0.0	
Radioisotope system (1404)	440.0	0.0	8.0	0.0	75.0	0.0	0.0	0.0	
Optical technology (1406)	130.0		6.5	0.05	12.0	12.0	5.0	1.0	
Unmanned satellites launch (1101)	500.0		20.0	1.5	15.0	0.0	0.0	0.0	
Magnetic field lines (0502)	59.0		2.5	4.2	33.9	21.0	0.0	0.0	
Physical science (0503) Particulate cloud generator Spectrographic camera Photometer Camera	105.0		9.5	0.0	18.0	15.0	6.0	0.0	
TOTAL	2171.4	23.5	57.0	85.85	646.6	48.0	299.0	6.0	

FLIGHT 523: ASTRONOMY AND PHYSICS

1. EXPERIMENTAL PROGRAM

This flight is launched to an altitude of 200 nm at an orbital inclination of 28.5 degrees. It carries three men for 45 days.

Although the experiments for this mission were not integrated into the spacecraft by S&ID, some data were generated for use in the total analysis of experimental requirements on the spacecraft systems. Knowledge of experiments on the flight has a direct bearing on Flights 229 and 230, which rendezvous with Flight 523 and continue certain experiments to the 90-day and 135-day duration levels. Experiments included on the flight are:

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Mission Group

0401-0406	Physiological and Biological Effects of Space
1301	Effects of Space Environment of Structures
0601-0604	Fluid and Gas Dynamics Studies
0605	Crystallization Studies
0606	Cosmic Ray Emission
0701	Emission Line Radiometry
0702	Intermediate-size Reflecting Telescope
0703	Manned Coronagraph
0704	Study of Nearly Solar-like Stars in X-Rays
0705A	Radio Astronomy 1-5 MCPS Range
1401	Personal Hygiene and Food Technology

2. MISSION OBJECTIVE

The astronomical data obtained on Flight 516 will have been submitted to preliminary analysis. The major purpose of Flight 523 is to continue solar and stellar observations under refinements suggested by earlier studies. Basic studies leading toward improvements in the design and engineering of systems and components are continued, and the latest series of biosciences studies on living organisms is begun, to be continued into later rendezvous Flights 229 and 230.

At this point the effects of the space environment on man should be defined in depth on a time line for body functions and behavior through 45 days. However, two crewmen will be tested extensively, since they will transfer to Flight 229 at the end of 45 days and will remain with that flight for another 45 days. One man may remain with Flight 230 for an additional 45 days. Man's ability to perform operational tasks in space should be known, and techniques and procedures for most operations should be well established. Therefore, human experimentation will be predominantly a matter of hypothesis testing under rigorously controlled conditions. Bioscience studies will now be emphasized and will be accomplished in space laboratories containing customized equipment and utilizing experiment techniques and programs equal to the best of ground laboratory research.

3. BASIC EXPERIMENT REQUIREMENTS

The estimated weight, volume, crew time, Electrical Power System EPS), and Stabilization Control System (SCS) are presented in Table 523-66.

Table 523-66. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0100-0200)	747.4	14.5	9.0	67.2	471.8	0.0	255.0	4.6	Including radioisotope 463 lb
Radiation monitor (0501)	50.0	1.0	1.0	5.7	3.0	0.0	3.0	0.1	
Study of living organisms (0401-0406) Centrifuge, incubator, refrigerator Microscope, cages and animals Physiological equipment	1072.5	29.5	0.0	286.3	407.5	0.0	24.0	0.3	
Study of liquid, gas and solids behavior (0601-0606) Test surface, storage, stereo Stereo microscope and camera Collision chamber, bomb tank Bomb cell optics, oven, centrifuge Emulsion chamber	287.5	20.1	0.0	4.0	111.5	296.8	71.0	0.8	
Personal hygience and food techniques (1401)									All requirements accounted for in S/C oper
Astronomical observation and techniques (0701-0705) Coronagraph, still camera, TV camera Oscilloscope, IR interferometer Telescope, microscope, solar tracking system, image monitoring system, antennas, radio astronomy, RCVR	4663.0		105.5	39.5	520.0	507.5	135.0	2.72	
TOTAL	6820.4	65.1	115.5	402.7	1513.8	804.3	488.0	8.52	

FLIGHT 229: ASTRONOMY LOGISTICS I

1. EXPERIMENTAL PROGRAM

This flight will rendezvous with Flight 523, which is in a 200-nautical-mile, circular Earth orbit with an inclination of 28.5 degrees. The flight will have three crew members and is scheduled for a duration of 45 days. The experiments that are to be performed are as follows:

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Extended Group

Experiments from Flight 523 that require extended duration will be continued if operationally feasible.

New Mission Group

1302	Deployment of RF Reflective Structures
1305	Deployment and Observation of Gravity Gradient Structures
1306	Large Aperture Space Erectable Antenna (30-foot diameter)
1504	Development of Personnel and Cargo Transfer Operations (Joint with Flight 523)
Note:	Experiments begun on Flight 523 will be continued to limits of crew time.

2. MISSION OBJECTIVE

Flight 229 objectives include continuation of the basic experimentation begun on Flight 523, with the addition of major tests on extension and erection of structures such as antennas and balloons.

Two of the original Flight 523 crew will remain in space for another 45 days while the remainder return to Earth in the Flight 523 CM. The various biomedical, behavioral, and scientific studies of Flight 523 will continue to the limits of crew time available. Additional experiments allocated to Flight 229 include several deployment-type mechanical experiments. The deployment and observation of a fibrous rf reflective structure, Experiment 1302, supplements the same test of the earlier Flight 509. Similarly, the deployment, observation and usage of a large diameter erectable antenna (Experiment 1306) repeats and amplifies a previous test in Flight 509.

The feasibility of deployment of a large inflatable lenticular rf reflector device is the task of Experiment 1305. The deployed structure is shaped so that gravity gradient forces stabilize its earth-oriented attitude. Ground radar observations will determine its radio reflective characteristics.

The exchange of the crew member and replenishment of vehicle and experiment expendables at the time of rendezvous will fulfill the transfer requirements of Experiment 1504.

3. BASIC EXPERIMENT REQUIREMENTS

The weight, volume, crew time, EPS, and SCS requirements are listed in Table 229-67.

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Pertinent parameters of the experiments carried on this mission are shown in Table 229-68. This data formed the basic input to the automatic experiment scheduling program. Reference may be made to paragraph 4, Flight 209, for detailed description of the parameters presented in the table.

5. DATA MANAGEMENT REQUIREMENTS

The data management requirements are primarily those imposed by the biomedical, behavioral, and radiation monitoring experiments, which have been discussed in previous flights. The requirements for the mission are listed in Table 229-69.

Table 229-67. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0100-0121, 0201-0203)	0.0	0.0	0.0	67.2	471.8	0.0	255.0	4.6	From flight 523
Radiation monitor (0501)	0.0	0.0	0.0	5.7	3.0	0.0	3.0	0.1	From flight 523
Space structures technology (1302, 1305,1306) Deployable antennas Reflective structures Gravity gradient structures	1925.0	0.0	240.0	4.6	17.8	41.1	11.0	0.1	
Liquid/gas and solids behavior (0601-0606) Test surface, storage, stereo microscope, stereo camera, collision chamber, bomb tank, bomb cell optics, oven-centrifuge, emulsion stack	79.0	1.85	0.0	4.0	111.5	296.8	71.0	0.8	From flight 523
Living organisms (0401-0406) Centrifuge, incubator, refrigerator, microscope, cages, animals, physiological equipment	205.0	6.5	0.0	286.3	407.5	0.0	24.0	0.3	From flight 523
Astronomical observations and techniques (0703) Coronograph Camera Image monitoring system	0.0	0.5	0.0	1.5	20.0	7.5	12.0	0.0	From flight 523
Extra-vehicular operations (1504) Cargo transfer mechanism Cargo Safety equipment	540.0	0.0	6.5	5.7	72.0	28.5	20.0	0.3	
TOTAL	1925.0	7.85	246.5	575.0	1103.6	373.9	396.0	6.4	

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	MIN	OPERATING WATTS	MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	ST VO C
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min ▲	7.0	
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min ▲	-	
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min ▲	-	
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6	
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-	
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-	
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0	
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-	
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-	
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473	
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-	
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0	
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0	
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-	
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-	
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2	
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-	
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-	
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8	
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-	
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-	
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6	
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-	
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-	
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-	
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5	
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-	
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-	
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-	
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9	
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-	
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-	
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-	
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-	
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-	
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-	
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8	
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-	

Table 229-68. Flight Experiment Parameters (Sheet 1 of 3)

ORED OLUME J. FT.	REMARKS
0.6	*0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
1.8	
-	
-	
1.0	
-	
-	
9.0	
-	
0.25	
1.5	
-	
-	
0.05	
-	
-	
2.1	
-	
-	
0.01	
-	
-	
-	Lab work for 0113
0.25	
-	Schedule on 3 successive days
-	*Minimum rotation
-	
2.0	
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Start 7 days after 011743
0.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	S V C
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-	
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-	
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-	
012107	0121	1181	1/14 Days				35	-	-	5	1440	-	-	-	-	-	19.0	
512107	0121	1182	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
612107	0121	1183	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-	
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.	-	-	-	-	-	-	
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0	
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-	
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-	
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-	
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-	
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-	
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-	
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-	
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-	
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-	
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-	
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-	
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-	
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-	
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-	
150461	1504	37	6/Mission	120			120			200	95	-	-	95	-	-	540	
150452	1504	38	6/Mission		120		120			200	95	-	-	95	-	-	-	
150443	1504	39	6/Mission			120	120			200	95	-	-	95	-	-	-	
130507	1305	40	1/Mission				120			-	-	-	-	120	-	-	1250	2
630507	1305	41	1/Day				15			-	-	-	-	15	-	-	-	
130207	1302	42	1/Mission				120			-	-	-	-	120	-	-	150	
130607	1306	43	1/Mission				60			600	30	Towards Earth		30	-	-	525	20
630607	1306	44	1/Day				10			600	60	Towards Earth		60	-	-	-	
040207	0402	1201	2/1 Day				30			125	Cont	-	-	-	-	-	-	
540207	0402	1202	1/1 Day				60				for	-	-	-	-	-	-	
640207	0402	1203	1/1 Day				30				45 Day	-	-	-	-	-	-	

Table 229-68. Flight 229 Experiment Parameters (Sheet 2 of 3)

ORED OLUME U. FT.	REMARKS
-	Schedule during 1st 2 days only
-	Start 7 days after 011907
-	
-	
-	
1.7	Start after 30 days
-	Do not include in missions less than 30 days
-	
-	
3.13	
-	
-	
-	Schedule 3 days after 020161
-	Schedule 3 days after 020152
-	Schedule 3 days after 020143
-	
-	
-	
-	
-	
-	
-	Schedule 3 days after 020361
-	Schedule 3 days after 020352
-	Schedule 3 days after 020343
6.5	Schedule day 1, 9, 17, 25, 33, 41
-	Schedule day 2, 10, 18, 26, 34, 42
-	Schedule day 3, 11, 19, 27, 35, 43
6.2	Schedule on day 4
-	Schedule on day 5 through 20
0	Schedule on day 21
4	Schedule on day 22
-	Schedule after 130604 and on day 22, 23, 24, 25, 26, and 27
-	12 hours ±1 hr between exps. E. Coli
-	Pseudomonas
-	Paramecium and hela cells

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
040407	0404	1301	8/Day				15			5	Cont	-	-	-	-	-	17
540407	0404	1302	3/Day				20			5	Cont	-	-	-	-	-	-
040507	0405	1401	4/Day				45			125	Cont	-	-	-	-	-	108
040607	0406	1501	8/Mission				15			-	-	-	-	-	-	-	-
040107	0401	1601	6/Mission				10			125	5	-	-	-	-	-	-
040307	0403	1701	3/Day				10			10	Cont	-	-	-	-	-	80
050101	0501	1702	1/3 Day	4						53	Cont	-	-	-	12,000	1/Sec	-
050102	0501	1703	1/3 Day		4						for	-	-	-	per	per	-
050103	0501	1704	1/3 Day			4					45 Days	-	-	-	orbit	orbit	-
130177	1301	1705	2/Mission				120/120			200	100	-	-	100	-	-	-
	0701																
	0702																
070307	0703	1706	1/3 Days				65	100	15	200	30	Towards Sun		30	-	-	-
570307	0703	1707	1/8 Days				45	-	-	-	-	-	-	-	-	-	-
	0704																
	0705A																
	1401																
060107	0601	1803	1/Day				20			10	15	-	-	10	-	-	5
560107	0601	1804	1/Day				11			250	5	-	-	5	-	-	-
060207	0602A	1901	1/4 Day				135	50	15	133	20	-	-	120	-	-	3
560207	0602B	1902	1/2 Day				60	100	30	101	15	-	-	15	-	-	5
060307	0603A	1903	10/Mission				60	100	30	150	15	-	-	15	-	-	50
560307	0603B	1904	5/Mission				120	50	30	100	90	-	-	-	-	-	10.1
060407	0604	1905	2/Mission				150	40	30	200	120	-	-	120	-	-	1
060507	0605	1906	1/2 Days				90			-	-	Towards Sun		30	-	-	
060607	0606	1907	1/Mission				30			130	3	Towards Sun		10 Days	-	-	5
560607	0606	1908	1/Mission				30			50	90	-	-	-	-	-	-

Table 229-68. Flight 229 Experiment Parameters (Sheet 3 of 3)

STORED VOLUME CU. FT.	REMARKS
0.6	3 hours ±1 hour between exps Planaria
-	8 hours ±2 hour between exps Newts
4.0	6 hours ±2 hour between exps
-	
-	
2.5	
-	
-	
-	
-	1 At 20 days ±2 days and 1 at 40 days ±2 days (EVA)
	Need not be continued
	Cannot be continued as primary experiment
-	Peak power 250 W 2 min
-	Start scheduling after 070307
	Need not be continued
	Need not be continued
	Do not schedule - time accounted for in fixed times
0.05	
-	
0.16	Peak power 200 W 20 min
0.1	Peak power 150 W 5 min
0.25	
0.02	Peak power 200 W 20 min
0.01	
0.35	Schedule before 30th day
-	Schedule 10 days after 060607

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Table 229-69. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME/MISSION (MINUTES)	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	135	
0103, 0107	Analog	1	1/Day	15	75	45	
0104	Analog	3	1/Day	15	225	135	
0105	--	--					None
0106	Analog	2	1/6 Days	15	150	15	
0108		4	2/Day		300	360	
0109, 0110		4	3/7 Days		300	78	
0111	Analog	1	6/7 Days	15	75	39	
0112	--	--					None
0113	Analog	2	3/7 Days	15	150	33	
0114-0121	--	--					None
0201-0203	--	--					None
1504	--	--					None
1305	--						None
1302	--						5 Min Video
1306	--						None
0401-0406	--						None
0501	3	Cont					Multiplexed with Other Exper
1301	--						Video & Film
0703	--						Film
0601-0606	--						None

Total transmission time of experiment recorded data is 840 minutes for the 45-day mission, or an average of 18.7 minutes per day.

The data management profiles that have not been included in previous flights include:

Experiment 0701: Two hours per day of analog recording interferogram, playback not required. DSE has a total capacity of 48 hours of single channel recording with a frequency response of 25 kc if no simultaneous digital recording is permitted.

Experiment 0405: 50 bps continuous

Experiment 0704: 32 bps from 120 to 150 minutes after test start

Experiment 0705A: 150 bps from 5 to 6.5 hours after test start

Experiment 1301: 63 bps from 40 to 160 minutes after test start

6. POWER PROFILES

Figure 229-21 contains the operating power profile for each experimental task that has not appeared in a previous flight. The experiments that follow use continuous power as indicated:

Experiment 0402 - 125 watts
Experiment 0403 - 10 watts
Experiment 0404 - 5 watts
Experiment 0405 - 125 watts

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

The RCS and SPS propellant requirements are listed in Table 229-70.

8. CONTROLS AND DISPLAYS

The integrated control and display panel is modified by adding two rotary controls and additional toggle switches.

9. CREW FUNCTIONS

Crew times associated with experiment operations on the flight are shown in Table 229-71. These times are listed as specific to certain crew members, referrable to any crew member, and as total mission times.

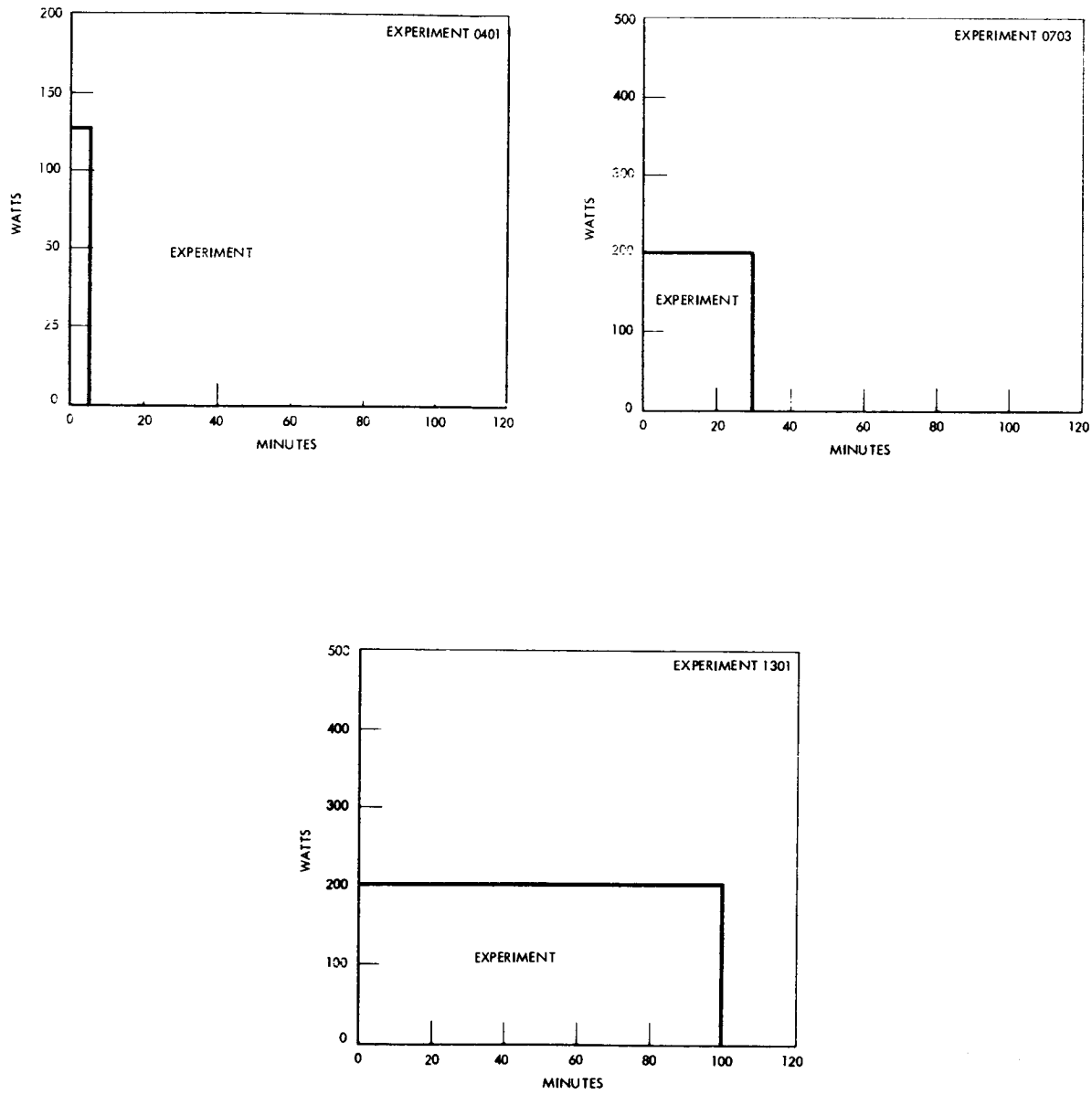

Figure 229-21. Operating Power Profiles

Table 229-70. RCS and SPS Propellant Requirements

Experiment	Maneuver	Requirements		
		Operations	Propellant (lb)	
			Conf C	Conf D
RCS REQUIREMENTS				
0101-0102	Spin profile Linear accelerations	19 6	1890 78	2390 78
1504	Maneuvers Attitude hold	36 29 hr	70 21	88 28
1305	Maneuvers Attitude hold	17 6 hr	33 4	42 5
1302	Maneuvers	8	16	20
1306	Maneuvers Attitude hold	13 6 hr	25 9	32 11
1301	Maneuvers	2	4	5
0703	Maneuvers Attitude hold	15 8 hr	19 8	24 10
0605	Maneuvers Attitude hold	22 11 hr	28 12	35 14
		Total Weight	2217	2782
SPS PROPELLANT REQUIREMENTS				
0101	10 second firings Rendezvous with 523	6 -	4200 650	

Table 229-71. Crew Times

Experiment	Specific to C—(min) C-1	C-2	C-3	Any C (min)	Total (hr)	Remarks
0703				65	20.0	Astronomical observations
1301	120			120	8.0	
1305				120	5.8	Deployment of EV structures
1305				15		
0100-0200					471.8	
0501					3.0	
0401-0406					407.5	
0601-0606					111.5	
1302					2.0	
1306					10.0	
1504					72.0	
TOTAL					1111.6	

Crew operations associated with systems management are generally for a 45-day flight including rendezvous and docking operations with Flight 523. The experiments in which this flight differs from preceding flights involve the general type of crew-equipment operations associated with spectral astronomy (Experiment 0703) and deployment of extra-vehicular structures without an EVA requirement. The crew functions associated with the experiments are described in Table 229-72.

10. SUMMARY OF MISSION ACCOMPLISHMENT

Experiments 0101 and 0102 of the biomedical series will be modified by deletion of several spin-ups due to RCS propellant limitations. Three of 18 spin-ups will be deleted from configuration C, and six of 18 will be deleted from configuration D. No linear accelerations (SPS firings) will be conducted because of weight limitations.

Table 229-72. Crew Experiment Function Description

Function	Description
EXPERIMENT 0703	
Setup, periodic	Install filters; program exposure sequence, including calculating exposure time; check out equipment; initiate target lock; load camera
Align	Visual image alignment
Pilot	Attitude orientation and stabilization
Observe, direct, non-man	Monitor image
Process	Process film
Data process	Evaluate and interpret data
Record	Log record observations
EXPERIMENT 1301	
Setup, initial	Check out equipment; initiate inflation
Observe, direct, non-man	Monitor inflation, direct visual
Observe display	Possible monitoring of leakage, temperature
Tear down, final	May deflate and collect samples for return
Photo	Photo coverage of deployment, inflation, status
Record	Log second observations
EXPERIMENT 1305	
Set-up, initial	Checkout equipment; initiate ejection; initiate unfolding
Observe, direct, non-man	Visual observation of ejection and unfolding
Photo	Photo coverage of above
Record	Log record observations

FLIGHT 230: ASTRONOMY LOGISTICS II

1. EXPERIMENTAL PROGRAM

This flight will rendezvous with Flight 229 which is in a 200-nautical-mile, circular Earth orbit with an inclination of 28.5 degrees. The flight will have three crew members and is scheduled for a duration of 45 days. The experiments that are to be performed are as follows:

Standard Group

0101-0121	Biomedical Series
0201-0203	Behavioral Series
0501	Radiation Environment Monitoring

Extended Group

Experiments from both Flight 523 and Flight 229 that require extended duration will be continued if operationally feasible.

New Mission Group

1506	Propellant Handling Techniques

2. MISSION OBJECTIVES

Transfer of propellants between orbiting spacecraft as a major innovation in space operations and prolonged space environment effects (135 days) on man are the primary purposes of this flight. This mission will permit the investigation of a number of techniques of fluid handling such as bladder expulsion, acceleration expulsion, etc. The propellant handling experiment necessitates extra-vehicular activity, and exposure to space radiation is a concomitant hazard. In this sense, the experiment restricts orbital altitude. Also the Radiation Environment experiment initiated on Flight 523 will be continued and conducted simultaneously with the extra-vehicular activity. Because it is highly desirable that extra-vehicular activity be observable, vehicle attitude control is important, or space activities must be confined to the visual limits of a window or closed circuit TV camera.

In addition, experiments begun on Flights 523 and 229 will be continued insofar as feasible.

One crewman from Flights 523 and 229 will possibly remain with this flight. For him the biomedical/behavioral experiment program will be a continuation of the complete and comprehensive survey of man's response to prolonged exposure to space. For the other crewmen, the human experiment program will be based on requirements indicated from an earlier 45-day experience.

It is reasonable to speculate that the major problems associated with the human aspects of space flight will have been resolved. However, with each incremental increase in time duration of flights, man's response must be studied comprehensively. The further the data points on all human functions can be extended by empirical study, the more reliable will be the extrapolations to space travel of the future.

The Radiation Monitoring experiment (0501) will accumulate long-term data pertaining to the radiation environment at low and synchronous altitudes. Scheduling of these experiments will be such as to extend over the whole mission duration without interference with other scientific and technical experiments.

The nature of the experiments conducted on this mission is such that no limitations are imposed on orbital characteristics. The vehicle is required to rendezvous with the Flight 229 vehicle and similar orbital parameters are therefore required. Stabilization requirements are essentially within normal design capabilities; however, additional experiments initiated on Flight 523 may require added stabilization capability.

Great care should be taken on this flight to minimize the explosive hazard due to static charge generation occurring as a result of propellant transfer. A requirement exists for transferring propellant by means of a liquid cargo transfer system from at least 100 yards away from the vehicle. It is essential that basic assembly operations in space and EVA techniques be mastered before the most advanced phase of this experiment is performed.

3. BASIC EXPERIMENT REQUIREMENTS

The weight, volume, crew time, EPS, and SCS requirements are presented in Table 230-73.

Table 230-72. Basic Experiment Requirements

Application Area/Instrumentation	Total Weight (pounds)	Volume (cubic feet) Pressurized	Volume (cubic feet) Unpressurized	Power Requirements (kwh)	Astronaut Time (man-hours)	Attitude Hold (hr)	Data Return Weight (lb)	Data Return Volume (ft^3)	Remarks
Biomedical/behavioral package (0101-0121, 0201-0203)	0.0	0.0	0.0	67.2	471.8	0.0	255.0	4.6	From flight 523
Radiation monitor (0501)	0.0	0.0	0.0	5.7	3.0	0.0	3.0	0.1	From flight 523
Extra-vehicular operations (1504, 1506) Propellant and tanks Fuel transfer system Cargo Cargo transfer mechanism	2360.0	0.0	110.0	1.5	11.0	375.8	15.0	0.2	From flight 229
Living organisms (0401-0406) Centrifuge incubator Refrigerator, microscope Cages and animals Physiological equipment	205.0	6.5	0.0	286.3	407.5	0.0	24.0	0.3	From flights 523 and 229
Astronomical observations and techniques (0703) Coronagraph Camera Image monitoring system	0.0	0.0	0.0	1.5	20.0	7.5	12.0	0.2	From flights 523 and 229
Liquid/gas and solids behavior (0601-0606) Tests surface, storage, stereo microscope, stereo camera, collision chamber, bomb tank, bomb cell optics, oven-centrifuge, emulsion stack	79.1	1.0	0.0	4.0	111.5	296.8	71.0	0.8	From flights 523 and 229
TOTAL	2644.1	7.5	110.0	370.8	1042.6	721.5	391.0	6.3	

4. CONDENSED MISSION/EXPERIMENT CHARACTERISTICS

Pertinent parameters of the experiments carried on this mission are shown in Table 230-74. This data formed the basic input to the automatic experiment scheduling program. Reference may be made to paragraph 4, Flight 209, for a detailed description of the parameters presented in the table.

5. DATA MANAGEMENT REQUIREMENTS

As indicated in Table 230-75, with the exception of Experiments 1504 and 1506, the additional experiments listed will require either real-time TV transmission and/or film recording, or no data management at all. Experiments 1504 and 1506 will be conducted simultaneously at a total data acquisition rate of 167 bits per second, for a period of 100 minutes repeated three times per mission. The standardized data management subsystem described in Section I will readily process the data for these two experiments in the low-bit rate mode at the record tape speed of 3-3/4 ips, with a tape accumulation of 1675 feet per data acquisition period. During transmission of this data to Earth the tape playback speed will be 120 ips, requiring a total mission transmission period of 9.5 minutes. Total transmission time for all analog and digital data of Flight 230 is 849.4 minutes for the 45-day mission, or an average of 18.9 minutes per day.

The data management profile for Experiments 1504 through 1506 requires 167 bits per second from 30 to 150 minutes after test start.

6. POWER PROFILES

Figure 230-22 contains the operating power profile for each experimental task that has not appeared in a previous flight.

7. REACTION CONTROL SYSTEM AND SERVICE PROPULSION SYSTEM REQUIREMENTS

The RCS and SPS propellant requirements are listed in Table 230-76.

8. CONTROLS AND DISPLAYS

The integrated control and display panel is modified by deleting the digital read-out component and adding a circular indicator and rotary.

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
010261	0101,0102	1141	1/7 Days	40			40			40	30	-	-	*	7 min A	7 min ▲	7.0
010252	0101,0102	1142	1/7 Days		40		40			40	30	-	-	*	7 min A	7 min ▲	-
010243	0101,0102	1143	1/7 Days			40	40			40	30	-	-	*	7 min A	7 min ▲	-
010361	0103,0107	1001	1/3 Days	50			50			6	40	-	-	-	1 min A	1 min	33.6
010352	0103,0107	1002	1/3 Days		50		50			6	40	-	-	-	1 min A	1 min	-
010343	0103,0107	1003	1/3 Days			50	50			6	40	-	-	-	1 min A	1 min	-
010461	0104	1021	1/3 Days	20			20			6	15	-	-	-	3 min A	3 min	5.0
010452	0104	1022	1/3 Days		20		20			6	15	-	-	-	3 min A	3 min	-
010443	0104	1023	1/3 Days			20	20			6	15	-	-	-	3 min A	3 min	-
010561	0105	1151	1/7 Days	10			80			25	60	-	-	-	-	-	473
010652	0106	1011	1/6 Days		30		30			8	30	-	-	-	2 min A	2 min	-
010843	0108	1031	2/1 Days			25	5			5	15	-	-	-	4 min A	4 min	3.0
010961	0109,0110	1041	1/7 Days	35			35			56	10	-	-	-	4 min A	4 min	30.0
010952	0109,0110	1042	1/7 Days		35		35			56	10	-	-	-	4 min A	4 min	-
010943	0109,0110	1043	1/7 Days			35	35			56	10	-	-	-	4 min A	4 min	-
011161	0111	1111	2/7 Days	15			15			15	5	-	-	-	1 min A	1 min	3.2
011152	0111	1112	2/7 Days		15		15			15	5	-	-	-	1 min A	1 min	-
011143	0111	1113	2/7 Days			15	15			15	5	-	-	-	1 min A	1 min	-
011261	0112	1044	1/7 Days	5			5			10	5	-	-	-	-	-	36.8
011252	0112	1045	1/7 Days		5		5			10	5	-	-	-	-	-	-
011243	0112	1046	1/7 Days			5	5			10	5	-	-	-	-	-	-
011361	0113	1121	1/7 Days	40			40			5	40	-	-	-	2 min A	2 min	0.6
011352	0113	1122	1/7 Days		40		40			5	40	-	-	-	2 min A	2 min	-
011343	0113	1123	1/7 Days			40	40			5	120	-	-	-	2 min A	2 min	-
011307	0113	1124	1/7 Days				60			5	60	-	-	-	-	-	-
011407	0114	1131	2/7 Days				10			4.5	10	-	-	-	-	-	0.5
011501	0115	1161	3/Mission	10						1	10	-	-	*	-	-	-
011502	0115	1162	3/Mission		10					1	10	-	-	*	-	-	-
011503	0115	1163	3/Mission			10				1	10	-	-	*	-	-	-
011652	0116	1171	1/Mission		160		30			5	160	-	-	-	-	-	47.9
011761	0117	1051	1/2 Days	5			5			-	-	-	-	-	-	-	-
011752	0117	1052	1/2 Days		5		5			-	-	-	-	-	-	-	-
011743	0117	1053	1/2 Days			5	5			-	-	-	-	-	-	-	-
511761	0117	1055	1/7 Days	5			5			-	-	-	-	-	-	-	-
511752	0117	1056	1/7 Days		5		5			-	-	-	-	-	-	-	-
511743	0117	1057	1/7 Days			5	5			-	-	-	-	-	-	-	-
011807	0118	1054	1/2 Days				23			10	15	-	-	-	-	-	12.8
511807	0118	1058	1/7 Days				23			10	15	-	-	-	-	-	-

Table 230-74. Flight 230 Experiment Parameter (Sheet 1 of 3)

STORED VOLUME CU. FT.	REMARKS
0.6	*0 RPM, 3 RPM, 6 RPM, 9 RPM, 6 RPM, 3 RPM, 0 RPM, Fire SPS
-	▲Also real time TV or cine-camera for 25 min/exp
-	
1.8	
-	
-	
1.0	
-	
-	
9.0	
-	
0.25	
1.5	
-	
-	
0.05	
-	
-	
2.1	
-	
-	
0.01	
-	
-	
-	Lab work for 0113
0.25	
-	Schedule on 3 successive days
-	*Minimum rotation
-	
2.0	
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Schedule during 1st 2 days only
-	Start 7 days after 011761
-	Start 7 days after 011752
-	Start 7 days after 011743
0.11	Schedule during 1st 2 days only
-	Start 7 days after 011807

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INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)
011907	0119	1061	1/2 Days				30	-	-	10	30	-	-	-	-	-	-
511907	0119	1062	1/7 Days				30	-	-	10	30	-	-	-	-	-	-
011207	0120	1071	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
511207	0120	1072	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
611207	0120	1073	1/14 Days				20	-	-	10	15	-	-	-	-	-	-
012107	0121	1181	1/14 Days				35	-	-	5	1440	-	-	-	-	-	19.0
512107	0121	1182	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-
612107	0121	1183	1/14 Days				35	-	-	5	1440	-	-	-	-	-	-
FREEZER (LYOPHILIZER) AND REFRIGERATOR FOR ABOVE EXPERIMENTS										50	Cont.	-	-	-	-	-	-
020161	0201	1091	1/6 Days	82			33			30	26	-	-	-	-	-	75.0
020152	0201	1092	1/6 Days		82		33			30	26	-	-	-	-	-	-
020143	0201	1093	1/6 Days			82	33			30	26	-	-	-	-	-	-
520161	0201	1094	1/6 Days	32			8			30	26	-	-	-	-	-	-
520152	0201	1095	1/6 Days		32		8			30	26	-	-	-	-	-	-
520143	0201	1096	1/6 Days			32	8			30	26	-	-	-	-	-	-
020261	0202	1081	1/3 Days	63			14			105	50	-	-	-	-	-	-
020252	0202	1082	1/3 Days		63		14			105	50	-	-	-	-	-	-
020243	0202	1083	1/3 Days			63	14			105	50	-	-	-	-	-	-
020361	0203	1101	1/6 Days	100						160	75	-	-	-	-	-	-
020352	0203	1102	1/6 Days		100					160	75	-	-	-	-	-	-
020343	0203	1103	1/6 Days			100				160	75	-	-	-	-	-	-
520361	0203	1104	1/6 Days	40						160	15	-	-	-	-	-	-
520352	0203	1105	1/6 Days		40					160	15	-	-	-	-	-	-
520343	0203	1106	1/6 Days			40				160	15	-	-	-	-	-	-
150461	1504	37	6/Mission	120			120			200	95	-	-	95	-	-	540
150452	1504	38	6/Mission		120		120			200	95	-	-	95	-	-	-
150443	1504	39	6/Mission			120	120			200	95	-	-	95	-	-	-
130507	1305	40	1/Mission				120			-	-	-	-	120	-	-	1250
630507	1305	41	1/Day				15			-	-	-	-	15	-	-	-
130207	1302	42	1/Mission				120			-	-	-	-	120	-	-	150
130607	1306	43	1/Mission				60			600	30	Towards Earth		30	-	-	525
630607	1306	44	1/Day				10			600	60	Towards Earth		60	-	-	-
040207	0402	1201	2/1 Day				30			125	Cont	-	-	-	-	-	-
540207	0402	1202	1/1 Day				60				for	-	-	-	-	-	-
640207	0402	1203	1/1 Day				30				45 Day	-	-	-	-	-	-

Table 230-74. Flight 230 Experiment Parameter (Sheet 2 of 3)

TORED OLUME CU. FT.	REMARKS
-	Schedule during 1st 2 days only
-	Start 7 days after 011907
-	
-	
-	
1.7	Start after 30 days
-	*Do not include in missions less than 30 days
-	
-	
3.13	
-	
-	
-	Schedule 3 days after 020161
-	Schedule 3 days after 020152
-	Schedule 3 days after 020143
-	
-	
-	
-	
-	
-	
-	
-	Schedule 3 days after 020361
-	Schedule 3 days after 020352
-	Schedule 3 days after 020343
6.5	Schedule day 1, 9, 17, 25, 33, 41
-	Schedule day 2, 10, 18, 26, 34, 42
-	Schedule day 3, 11, 19, 27, 35, 43
26.2	Schedule on day 4
-	Schedule on day 5 through 20
10	Schedule on day 21
204	Schedule on day 22
-	Schedule after 130604 and on day 22, 23, 24, 25, 26, and 27
-	12 hours ±1 hr between exps. E. Cole
-	Pseudomonas
-	Paramecium and hela cells

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[redacted]

INTEG. NO.	EXP. NO.	PRI-ORITY	FREQ	CREW TIME (MINUTES) #1	#2	#3	ANY CREW MEMBER	POWER STAND-BY WATTS	STAND-BY MIN	OPERATING WATTS	OPERATING MIN	SCS ORIENTATION		DATA ATTITUDE HOLD (MIN)	BITS STORED	TRANS-MITTED	WEIGHT (LB)	ST VO CU
040407	0404	1301	8/Day				15			5	Cont	-	-	-	-	-	17	
540407	0404	1302	3/Day				20			5	Cont	-	-	-	-	-	-	
040507	0405	1401	4/Day				45			125	Cont	-	-	-	-	-	108	
040607	0406	1501	8/Mission				15			-	-	-	-	-	-	-	-	
040107	0401	1601	6/Mission				10			125	5	-	-	-	-	-	-	
040307	0403	1701	3/Day				10			10	Cont	-	-	-	-	-	80	
050101	0501	1702	1/3 Day	4	-					5.3	Cont	-	-	-	12,000	1/Sec	-	
050102	0501	1703	1/3 Day		4						for	-	-	-	per	per	-	
050103	0501	1704	1/3 Day			4					45 Days	-	-	-	orbit	orbit	-	
130177	1301	1705	2/Mission				120/120			200	100	-	-	100	-	-	-	
	0701																	
	0702																	
070307	0703	1706	1/3 Days				65	100	15	200	30	Towards Sun		30	-	-	-	
570307	0703	1707	1/8 Days				45	-	-	-	-	-	-	-	-	-	-	
	0704																	
	0705A																	
	1401																	
060107	0601	1803	1/Day				20			10	15	-	-	10	-	-	5	
560107	0601	1804	1/Day				11			250	5	-	-	5	-	-	-	
060207	0602A	1901	1/4 Day				135	50	15	133	20	-	-	120	-	-	3	
560207	0602B	1902	1/2 Day				60	100	30	101	15	-	-	15	-	-	5	
060307	0603A	1903	10/Mission				60	100	30	150	15	-	-	15	-	-	50	
560307	0603B	1904	5/Mission				120	50	30	100	90	-	-	-	-	-	10.1	
060407	0604	1905	2/Mission				150	40	30	200	120	-	-	120	-	-	1	
060507	0605	1906	1/2 Days				90			-	-	Towards Sun		30	-	-		
060607	0606	1907	1/Mission				30			130	3	Towards Sun		10 Days	-	-	5	
560607	0606	1908	1/Mission				30			50	90	-	-	-	-	-	-	
150601	1506-I	32	1/Mission	60						200	40	-	-	30	-	-	950	6
150602	& 1504	33	1/Mission		60					200	40	-	-	30	-	-	-	
150603		34	1/Mission			60				200	40	-	-	30	-	-	-	
650677	1506-II	35	1/Mission				120/120			200	100	-	-	100	-	-	710	
	& 1504																	
750677	1506-III	36	1/Mission				120/120			200	100	-	-	100	-	-	700	

Table 230-74. Flight 230 Experiment Parameter (Sheet 3 of 3)

ORED LUME J. FT.	REMARKS
).5	3 hours ± 1 hour between exps
-	8 hours ± 2 hour between exps
4.0	6 hours ± 2 hour between exps
-	
-	
2.5	
-	
-	
-	
-	At 20 days ± 2 days and 1 at 40 days ± 2 days (EVA)
	Need not be continued
	Cannot be continued as primary experiment
-	Peak power 250 W 2 min
-	Start scheduling after 070307
	Need not be continued
	Need not be continued
	Do not schedule - time accounted for in fixed times
).05	
-	
).16	Peak power 200 W 20 min.
).1	Peak power 150 W 5 min
).25	
).02	Peak power 200 W 20 min
).01	
).35	Schedule before 30th day
-	Schedule 10 days after 060607
;	
-	
-	
)	Schedule after 150603
;	Schedule after 650677

Table 230-75. Data Requirements Summary

	ACQ RATE (BITS/SEC)	ACQ PERIOD (MINUTES)	EXP FREQ	TAPE SPEED (IPS)	TAPE QUANT PER ACQ PER (FT)	XMSN TIME MISSION (MINUTES	REMARKS
0101, 0102	Analog	7	3/7 Days	15	525	135	
0103, 0107	Analog	1	1/Day	15	75	45	
0104	Analog	3	1/Day	15	225	135	
0105	--						
0106	Analog	2	1/6 Day	15	150	15	
0108	Analog	4	2/Day	15	300	360	
0109, 0110	Analog	4	3/7 Days	15	300	78	
0111	Analog	1	6/7 Days	15	75	39	
0112	--						
0113	Analog	2	3/7 Days	15	150	33	
0114-0121	--						
0201-0203	--						
1506, 1504	167	100	3/Mission	3-3/4	1875	9.5	
1302, 1305, 1306	--						Video
0401-0406	--						None
0501	3	Cont			--		Multiplexed with Other Exps
0301	--						Video & Film
0703	--						Film
0601-0606	--						None

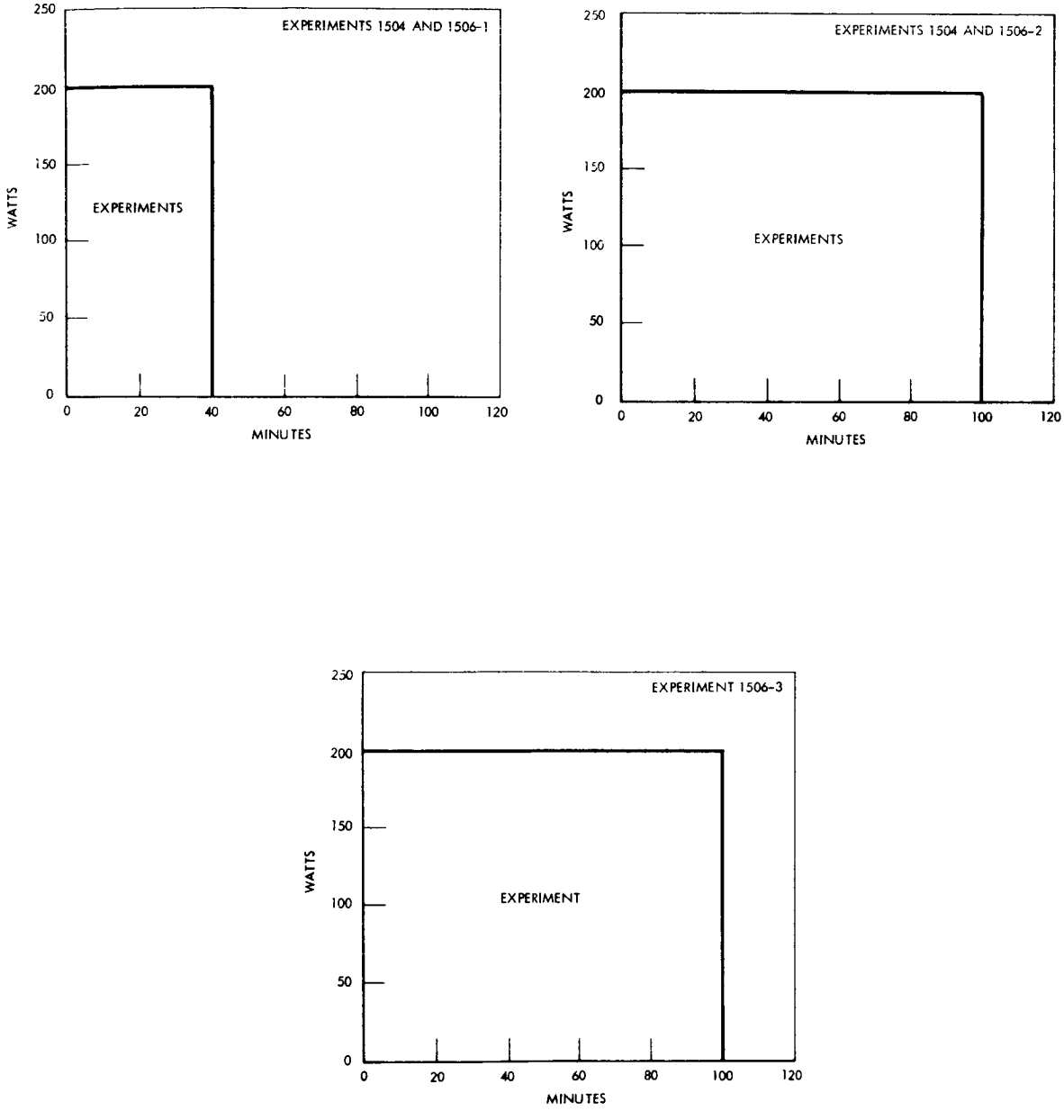

Figure 230-22. Operating Power Profiles

Table 230-76. RCS and SPS Propellant Requirements

Experiment	Maneuver	RCS Requirements		
		Operations	Propellant (lb)	
			Conf C	Conf D
RCS REQUIREMENTS				
0101-0102	Spin profile	19	1750	2350
	Linear accelerations	6	78	78
1504-1506	Maneuvers	5	9	12
	Attitude hold	5 hr	3	4
1305	Maneuvers	17	31	42
	Attitude hold	6 hr	4	5
1302	Maneuvers	8	15	20
1306	Maneuvers	13	18	22
	Attitude hold	6 hr	9	11
1301	Maneuvers	2	4	5
0703	Maneuvers	15	18	24
	Attitude hold	8 hr	9	10
0605	Maneuvers	22	26	35
	Attitude hold	11 hr	12	14
TOTAL WEIGHT			1986	2362
SPS REQUIREMENTS				
0101	10-sec firing	6	4200	
	Rendezvous w/229	-	650	

9. CREW FUNCTIONS

Crew times for Flight 230 involve only one experiment not previously discussed, 1506, although this experiment is scheduled in combination with Experiment 1504 in its Phase-I stage. Experiment crew times for Flight 230 are presented in Table 230-77.

Table 230-77. Crew Times

Experiment	Specific to Crewman (min)			Any C (min)	Total (hrs)	Remarks
	C-1	C-2	C-3			
1506 I and 1504				60	11.0	Propellant handling and cargo handling combinations
1506 II and 1504	120			120		
1506 III	120			120		Propellant transfer only
0100-0200					471.8	
0501					30.0	
0401-0406					407.5	
0601-0606		(Possibly)			111.5	
0703					20.0	
TOTAL					1042.8	

This flight is similar to Flight 229 in many crew operational respects, as it docks with Flight 229 and involves inter-personal transfer. The only experiment crew operations not previously discussed are associated with Experiment 1506 which involves complicated and potentially hazardous fuel transfer activities. Experiment 1506 is described in Table 230-78.

Table 230-78. Crew Experiment Function Description

Function	Description
Set-up, periodic	Phase I; connect transfer lines; Phase II-III; EVA steps a-f; connect transfer lines
Teardown, periodic	Disconnect transfer lines; Phase II, III; EVA steps h-n
Pilot	Standard docking procedure with deployed tanks (Phase II, III). Roll and V (Phase I)
Utilize special equipment	Utilize tools, etc. to connect-disconnect transfer lines; utilize fuel control switches
Observe, self	Self observation during connect-disconnect activities
Observe, other	Observe crew member connecting, disconnecting activities
Observe, direct, non-man	Observe behavior of deployed tanks and transfer lines
Observe, display	Monitor fuel and other liquid parameters from display panel; monitor EVA crew member status
Subject	Coordinate activities with observer
Photo, etc.	Camera and TV coverage of connect-disconnect activities and tank and transfer line behavior
Direct transmit	Open line communication between subject, observer, ground
Record	Log record of observations

10. SUMMARY OF MISSION ACCOMPLISHMENTS

Possibly the most significant feature of this flight is that a rendezvous and docking with Flight 229 will extend the in-orbit time of one crew member to 135 days. Due to RCS propellant limitations, one of the 19 spin-ups

required for Experiments 0101 and 0102 will be deleted from configuration C, and 7 will be deleted from configuration D. No linear accelerations (SPS firings) will be conducted. Consideration will be given to further weight-saving by deletion of four spin-ups from configuration C and reduction of flight duration of configuration D to 22 days. It is also noted that the total duration of Flights 523, 229, and 230 is limited to 85 days if configuration D is utilized.

Propellant transfer tests will be conducted on this flight initially on the experiments rack and subsequently in free space.