NASA TECHNICAL MEMORANDUM

NASA TM X-64902

CVT/GPL PHASE III INTEGRATED TESTING

By R. E. Shurney, Eddie Cantrell, George Maybee, and Stan Schmitt
Systems Analysis and Integration Laboratory and Test Laboratory

January 1975

NASA

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. NASA TM X-64902	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE CVT/GPL Phase III Integrated Testing		5. REPORT DATE January 1975
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R. E. Shurney, Eddie Cantrell, George Maybee, and Stan Schmitt		8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D.C. 20546		13. TYPE OF REPORT & PERIOD COVERED Technical Memorandum
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared by Systems Analysis and Integration Laboratory and Test Laboratory, Science and Engineering

16. ABSTRACT The purpose of the Phase III CVT/GPL integrated test was to exercise Spacelab type experiment integration and operations concepts, using the GPL simulator, to accomodate a dedicated life sciences payload from the Ames Research Center (ARC). The general objective of ARC was the identification and evaluation of problems associated with ten candidate Spacelab experiments in the areas of radioisotope tracer studies, subhuman primate research, and medical research. The general objective of MSFC/CVT testing was the assessment of the impact of ARC candidate experiments upon a simulated payload carrier system. Following hardware installation in the GPL, a five day, simulated Spacelab Mission, using humans, primates, rats, chickens, and marigold plants as test subjects was conducted. In addition to candidate experiment scientific data, information concerning experiment procedures, design and integration, as well as GPL support systems, test operations, and experiment objectives was acquired. No major problems were encountered during the experiment hardware integration process. GPL experiment support, data acquisition, video documentation and environmental control systems performed satisfactorily throughout the test. A brief interruption of RF communications early in testing demonstrated the need for improvements in the communication system. The use of a direct audio and closed circuit video link would facilitate the exchange of information between ground-based scientists and on-board experimenters. All experiment objectives were, in the opinions of experimenters, successfully accomplished. The payload specialist concept was again successfully demonstrated. A bioclean room and specimen transportation van functioned well in support of the test.

17. KEY WORDS		18. DISTRIBUTION STATEMENT Unclassified-unlimited	
19. SECURITY CLASSIF. (of this report) Unclassified	20. SECURITY CLASSIF. (of this page) Unclassified	21. NO. OF PAGES 153	22. PRICE NTIS

MSFC - Form 3292 (Rev December 1972)

For sale by National Technical Information Service, Springfield, Virginia 22151

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONCLUDED)

LIST OF TABLES

TECHNICAL MEMORANDUM X-64902

CVT/GPL PHASE III INTEGRATED TESTING

SUMMARY

This report was compiled by Marshall Space Flight Center's (MSFC) Test Laboratory and Systems Analysis and Integration Laboratory, with contributions by Ames Research Center Life Sciences specialists, and presents the results of the Phase III Concept Verification Testing/General Purpose Laboratory (CVT/GPL) integrated test. The hardware for 10 candidate Shuttle program life sciences experiments was installed in the GPL and experiments were conducted during a 5-day simulated Spacelab mission. The experiments involved humans, primates, rats, chickens, and marigold plants. All experiments were completed to the satisfaction of the experimenters. In addition to the scientific data gathered for each experiment, information was obtained concerning experiment hardware design and integration, experiment procedures, GPL support systems, and test operations.

I. INTRODUCTION

The third in a series of concept development tests, utilizing the Mark-I GPL,[1] was completed at MSFC during the week ending July 19, 1974. The GPL provides a means of investigating experiment hardware interface and support requirements, assessing documentation requirements, and testing operational procedures under physical constraints similar to those expected for Spacelab. The purpose of this test was to implement Spacelab experiment integration and operations concepts in the GPL to accommodate a dedicated life sciences payload from the Ames Research Center (ARC). Prior to this test, the ARC life

1. Two GPL simulators, the Mark-I and Mark-II, have been developed to support CVT. Both simulators are cylinders 7.3-m (24-ft) long and 4.3 m (14 ft) in diameter. The Mark-I has an offset floor on the centerline of the cylinder which provides two working levels. The Mark-II has a single floor located 1.1 m (3.7 ft) below the cylinder centerline. The Mark-II will be used in future CVT/GPL tests.

sciences payload had been installed and tested in an integration fixture at ARC to establish equipment layout and interface requirements for subsequent installation in the GPL. The use of an integration fixture minimizes the need for dry run operations, as normally practiced in the Convair 990 (CV990) program.[2]

The general objective of ARC was to scope the problems associated with 10 candidate Spacelab experiments in the areas of medical research, subhuman primate research, and radioisotope tracer studies in a variety of organisms. The general objective of MSFC/CVT was to assess the impact of the ARC candidate experiments on a simulated payload carrier system. The objectives of Phase III with respect to experiment integration, operations, experimentation, and facilities were as follows:

1. Experiment Integration: Investigate the utility of an experiment integration fixture concept.

2. Operations:

- Investigate test specimen transfer operations
- Assess GPL communications
- Assess photo and video documentation of test activities
- Investigate principal investigator/payload specialist operational interface
- Identify non-scientific crew functions
- Evaluate test preparation activities
- Assess stowage and maintenance requirements

---

2. Candidate experiment integration and flight operations designed to study Spacelab-type experiment missions are carried out, using a Convair 990, under the direction of the Airborne Science Office, Ames Research Center. The experiment integration concepts of both the CV990 and CVT/GPL are being studied in support of the Shuttle program.

3. Experiments:

   - Perform experiments according to protocols and schedules planned for a 5-day mission.

   - Investigate payload specialist concept.

4. Facilities:

   - Assess GPL power consumption and environmental control.

   - Identify candidate experiment support/GPL systems design requirements.

   - Investigate ground facility concepts for specimen holding.

GPL/Life Sciences Experiment integration requirements for this test were defined and implemented through a coordination effort initiated between ARC and MSFC several months prior to the test. This effort resulted in an extremely successful test mission with no major experiment hardware integration problems.

The test simulated a five-day (eight-hour work day) Spacelab mission with a crew of three payload specialists and a crew chief. Three ARC life sciences researchers performed as payload specialists, each conducting several experiments. The payload specialists exercised experiment protocols provided by candidate investigators. An MSFC systems integration engineer, familiar with the GPL and experiment support systems, performed as the crew chief; interfacing and coordinating between the payload specialists, test conductor, and GPL facilities personnel as required throughout the mission to maintain operations and obtain documentary data. A host of candidate experiment investigators and co-investigators provided ground support to the crew through the GPL television and audio communications systems. A list of the candidate experiments and the individuals associated with each is given in Appendix A.

This report describes the test facility, the experiment integration process, and test operations; presents observations concerning GPL/experiment integration and support systems; and provides a general description of experiment results. Scientific reports are the responsibility of individual investigators.

II. APPROACH

A. Test Facility

The test facility included the GPL and pallet assembly (Fig. 1), and external facilities for test control, data handling, utilities, and a bioclean environment. A schematic of the GPL/pallet and the external support facilities is given in Figure 2.

1. GPL/Pallet Assembly. The GPL is a test enclosure which is configured to be representative of Spacelab geometry and permit functional simulation of Spacelab-type missions. It is equipped with experiment support and interface hardware to accommodate a wide variety of candidate experiment equipment and to maintain appropriate environmental conditions during simulated mission operations. The GPL has a 4.3-m (14-ft) external diameter, a 4.1-m (13.5-ft) internal diameter, and a length of 7.3 m (24 ft). It contains two levels, divided by an offset floor, where experiment workstations are located as required for a given mission. The floors are designed to withstand 45.4 kg/m^2 (100 lb/ft^2). The workstation arrangement for Phase III is shown in Figure 3.

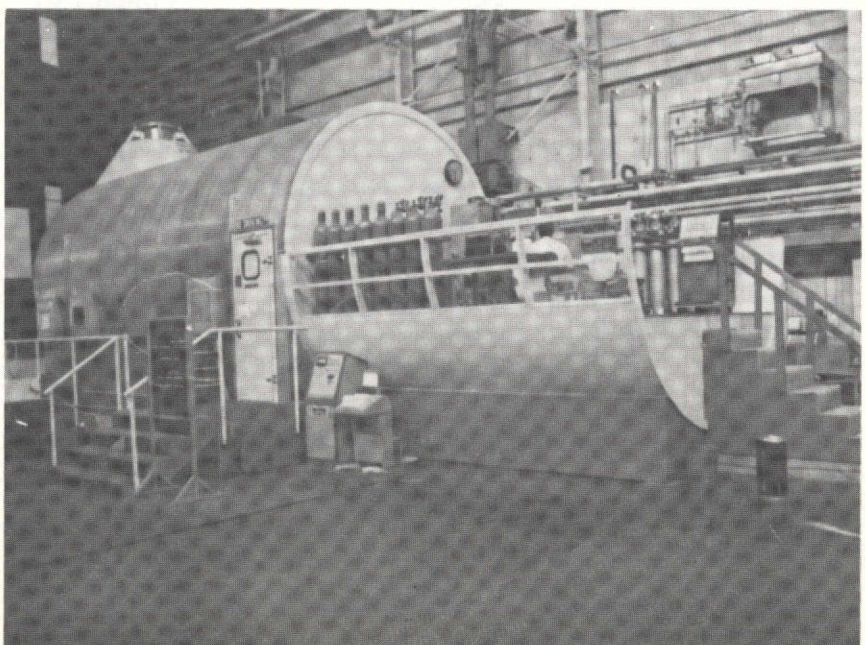


Figure 1. General Purpose Laboratory and pallet assembly.

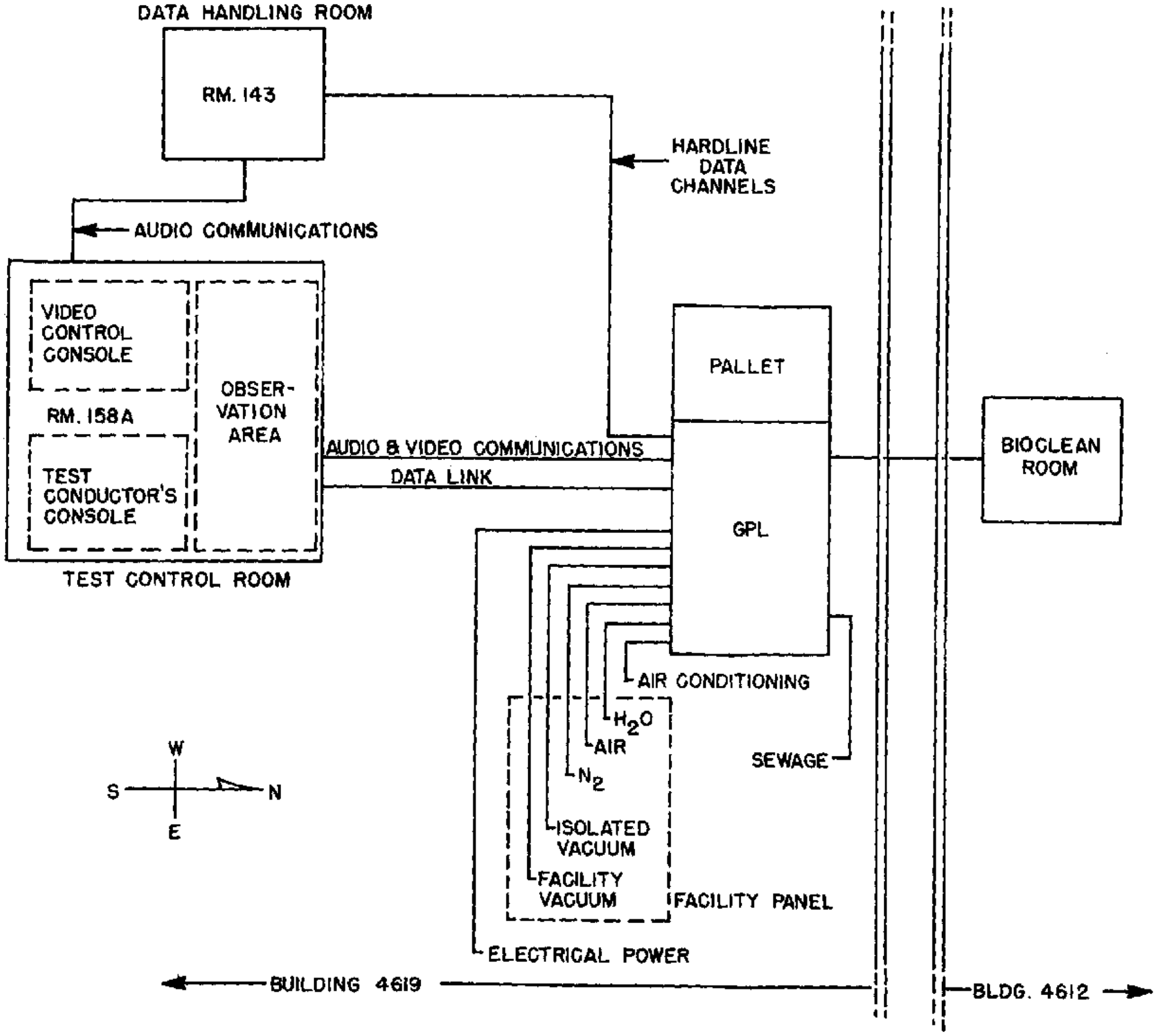
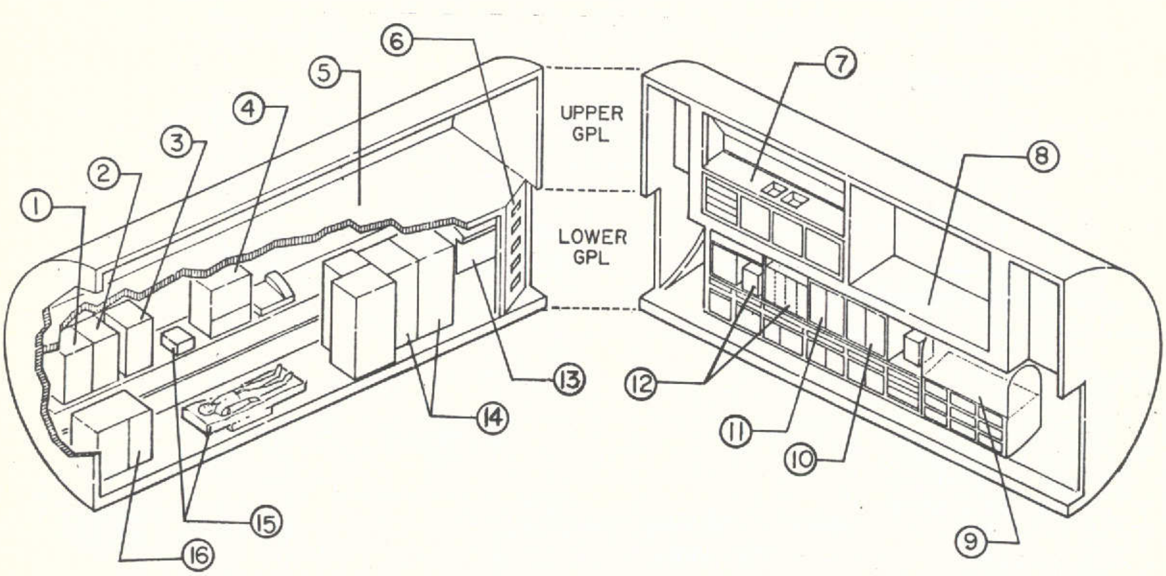


Figure 2. Test facility schematic.

The pallet assembly is a cylindrical half-section, 3.7-m (12-ft) wide and 4.9-m (16-ft) long. The pallet, attached to the west end of the GPL, simulates the Shuttle system pallet which will be used to mount equipment requiring direct exposure to space. However, for the Phase III test the pallet was used to mount equipment and carry out operations which would normally require a shirt-sleeve environment. This approach was followed to facilitate testing and not to simulate actual pallet operations. Pallet-mounted equipment (Fig. 4) included three equipment racks, two eight-channel recorders, eleven gas bottles and a tape recorder. Most of this equipment was associated with the P1 experiment.



1. Experiment P2
2. Experiment P3
3. Experiment A1
4. Experiment H1
5. Unassigned Space
6. Ladder Between Upper and Lower GPL
7. General Purpose Workstation
8. Unassigned Space
9. Hooded Workbench/ Surgical Table
10. Experiment R2
11. Experiment R1
12. Experiment B1
13. Crew Chief's Station
14. Experiment P1
15. Experiment H2
16. Experiment P4

Figure 3. CVT/GPL workstation arrangement.

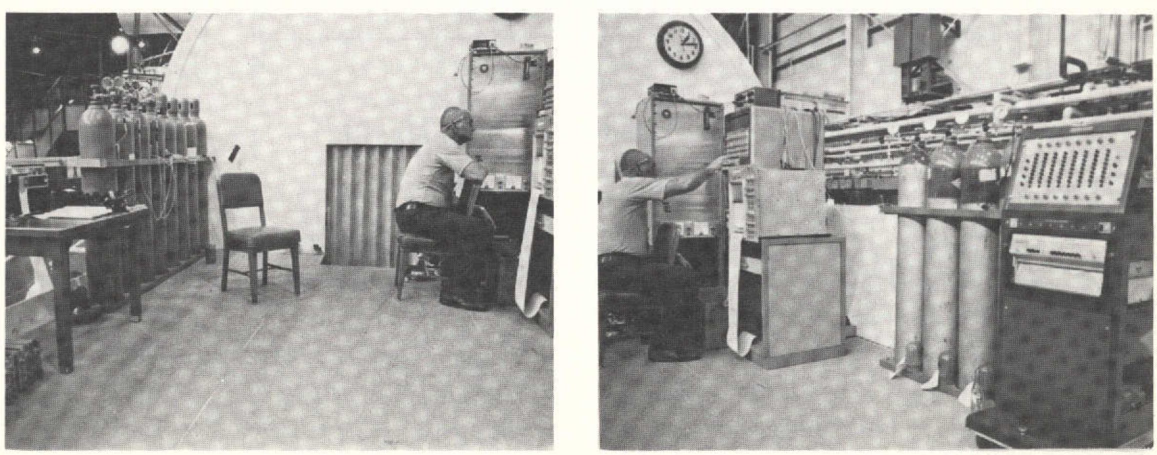


Figure 4. Pallet-mounted equipment.

a. Upper GPL. The upper level of the GPL includes stowage provisions, a general purpose workbench and interface panels for experiment hardware connections. The upper level was not used for this test.

b. Lower GPL. The lower level of the GPL includes the Crew Chief's station, a general purpose workbench and experiment interface panels. Stowage provisions include drawer and cabinet space in the workbench unit and cabinets above the experiment area. Most of the Bioresearch Laboratory apparatus was installed in the lower GPL. Additional equipment was installed on the Pallet assembly.

c. Crew Chief's Console. This console was located at the lower west end of the GPL and contained equipment for systems monitoring, data management and communications. It included a talk-a-phone intercom which provided an audio link to the test control room. Readouts on the console included percent relative humidity and partial pressure of oxygen for upper and lower GPL; water pressure, flow and temperature; and facilities vacuum and GN_2 inlet pressure. Other items at the Crew Chief's station included a library containing equipment drawings, schematics, operating procedures, maintenance logs and other documentation; and a maintenance repair kit.

d. GPL Access. Personnel access to the GPL is gained through a 96.5-by 207.2-cm (38-by 82-in.) airlock doorway at the east end of the GPL. A 71-by 207.2-cm (28-by 82-in.) emergency doorway is located at the north side of the GPL (quick-release for emergency egress). A ladder is located at the west end of the GPL for access to the upper level. The access opening between the upper and lower levels is approximately 81.2 by 101.8 cm (32 by 40 in.). A 91.5-by 190.5-cm (36-by 75-in.) hatch on the west end of the GPL provides access to the pallet assembly.

e. Illumination. All GPL lighting is florescent and is permanently installed in the upper and lower decks. A master switch is located on the upper and lower decks to control all the lights on the respective decks. In addition, some local light switches are provided.

f. Temperature and Humidity Control. Temperature and humidity control was provided by externally and internally cooled atmosphere and thermostatically-controlled duct heaters with distribution through fan/coil units located in the upper GPL. The system included a humidifier and a dehumidifier. Conditioned air flowed through the GPL and was then recirculated.

g. Fluids. The GPL was furnished with water, sewage, vacuum, GN_2, missile grade air pressurant, and hot and cold potable water. Waste water flowed into the sanitary sewage. The vacuum was provided by MSFC-facility system rated at 3.99×10^{-2} N/cm^2 (3 torr) and a small vacuum pump rated at 1.33×10^{-3} N/cm^2 (0.1 torr). Internal fittings for access to the vacuum system are standard AN 1.27-cm (0.5-in.) bulkhead fittings. The pressurant gases are GN_2 and missile grade air at 68.94 N/cm^2 (100 psi). Gas fittings are standard 0.64-cm (0.25-in.) bulkhead fittings. Three fluids interface panels are located on the upper level and four are located on the lower level.

h. Power. All GPL power was derived from a 208, 3-phase, 60 Hz line source. A motor-generator unit provided automatic restoration of full power to the GPL within three seconds, in the event of a line power failure. Power available for GPL experiments included 28 Vdc, 110 Vac, and 220 Vac (single-phase, 60 Hz). Also, a 120/208, 3-phase, 400 Hz source was available upon request by an experimenter. Two electrical power panels were located on the upper level and four were located on the lower level.

i. Communications. Audio and visual communications systems were provided for continuous communication between the GPL and external facilities and for monitoring and recording mission activities. The audio communications system included transmission links between the GPL and the test control room, and between the test control room, pallet, and data handling room. Wireless microphones and pocket transmitters were used by the GPL crew for communications with external support facilities. Pocket transmitter signals were picked up by an antenna in the GPL and hardlined to the test control room receivers. Headsets were worn by the test conductor, video control operator, and principal investigators. Voice transmission from the GPL was also provided through speakers in the test conductor's room and in the test observation room. General transmission from test control to the GPL was hardlined to two speakers, located in the upper GPL. In addition, a talk-a-phone system was located at the crew chief's console and was used for communications between the crew chief, test conductor, and video control operator.

The video communications system included five cameras located in the lower GPL. Video signals were hardlined to displays at the test conductor's console, the test observation room, and the video control room.

j. Instrumentation. Instrumentation wiring installed in the GPL provided for monitoring and recording experiments and GPL systems hardware. The outputs of 34 transducers measuring temperature, power, and other GPL/experiment parameters were routed to the data handling room for continuous recording and selective monitoring. A complete measurements list is given in Appendix B. Additional measurements were routed to local strip charts and monitoring displays. A systems monitor panel, located outside the north door of the GPL, provided continuous monitoring of five parameters, including GPL temperature, vent system No. 1 (rat exhaust fan), vent system No. 2 (monkey exhaust fan), air conditioning system No. 1 (external), and air conditioning system No. 2 (internal). The GPL temperature was displayed on a meter having a range of 0 to 300° F (-17.7 to 148.9° C). Display devices for the vent and air conditioning systems consisted of two system condition lamps; a green lamp denoting operation within tolerance limits and a red lamp denoting operation out of tolerance limits.

2. Support Facilities. GPL support facilities included the test control room, data handling room, and bioclean room.

a. Test Control Room. The test control room is located near the GPL in room 158-A, building 4619. It contains the Test Conductor's Console, Video Control Console, and a general observation area. It is the center for external test operations.

The Test Conductor's Console (Fig. 5) included audio/visual communications links with the GPL and external workstations and displays for monitoring GPL environmental parameters, utilities, and fire detection system. Equipment in the console included the following:

1. Two 22.8-cm (9-in.) video monitors.

2. Two audio headsets, a microphone, and a speaker.

3. A push-to-talk intercom.

4. Twenty-two gages monitoring relative humidity, vacuum pressure, air inlet pressure, partial pressure of CO_2, partial pressure of methane, cabin differential pressure, pressure of H_2O, partial pressure of O_2, air duct temperature, cold H_2O temperature, hot H_2O temperature, CO level, and H_2O flow rate.

5. Four fire sensor indicator lamps and a fire alarm.

6. Eight facility/utilities power indicator lamps.

The video control console (Fig. 6) included displays for the five video cameras located in the GPL, with pan-tilt-zoom controls for two of the cameras, and voice communications with the test conductor's console and the GPL.

Figure 5. Test conductor' s console.

Figure 6. Video control console.

Experiment activities and commentary were selectively recorded by the video control operators. The system was capable of recording any four of the five video channels simultaneously, including the audio signal.

The console included the following equipment:

1. Eight 22.8-cm (9-in.) video monitors.

2. Two pan-tilt-zoom controls for GPL mounted cameras.

3. Four 48.3-cm (19-in.) video monitors.

4. Four video tape recorders.

5. Video/audio distribution switches.

6. A push-to-talk intercom.

The general observation area provided an audio/visual display of experiment activities in the GPL and seating accommodations for observers. Equipment in the observation area included the following:

1. Five 22.8-cm (9-in.) video monitors.

2. A speaker.

3. Chairs for observers and visitors.

b. Data Handling Room. The Data Handling Room was located at the west end of building 4619, in room 143. It was equipped with an Astrodata analog-to-digital recording system which provided approximately 100 hardline data channels for GPL measurements. Thirty-four channels were used for continuous recording and selective printout of test measurements. All channels were scanned and 10 selected channels were printed every 50 seconds. Once each hour, all channels were printed. In addition to the measurements wired for printout, two acoustical data channels were routed from the GPL to the data handling room. Acoustical data was recorded for post-test analysis. All data channels were calibrated between 0745 and 0800 each day, throughout the test.

c. Bioclean Room. The Bioclean room (Fig. 7), located in the high-bay area in the southeast section of building 4612, provided a controlled environment for housing and working with test animals. It was designed to meet the requirements for a Class 100 clean room, according to Federal Standard 209A. Animals used in the test were transported by van (Fig. 8)

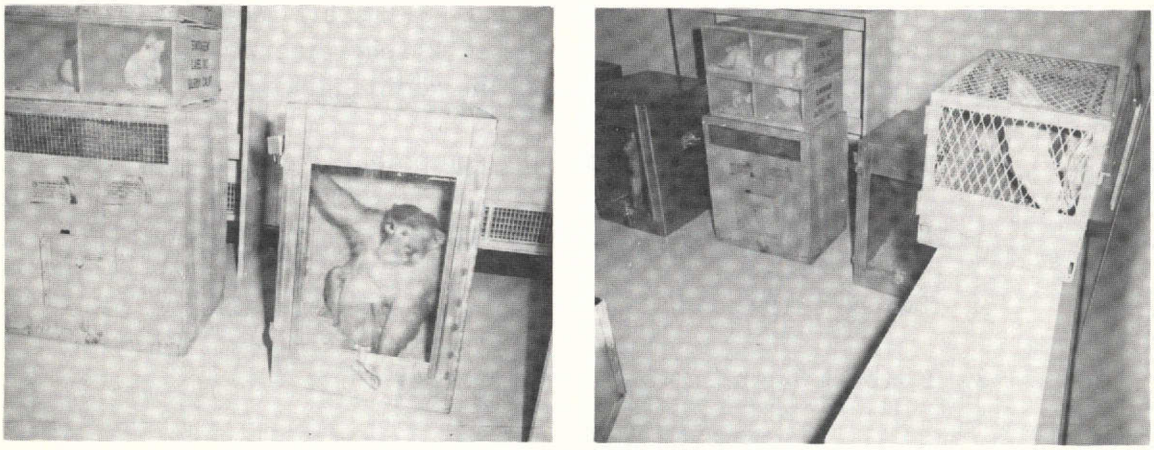


Figure 7. Bioclean room (animals are in shipping cages, having just been unloaded from Van).

between the airport and the Bioclean room and between the Bioclean room and the GPL. Backup specimens remained in the Bioclean room during the test. Bioclean room temperature and humidity were continuously recorded and monitored during the test.

B. Experiment Integration

Experiment integration involved the determination and implementation of GPL/experiment hardware interface and facility support requirements.

1. Experiment Descriptions. Ten typical experiments involving three research areas were conducted. Two experiments concerned medical studies, four concerned subhuman primate studies, and four were radioisotope tracer studies. An objective which was common to all experiments was to obtain an operational assessment of experimental design under conditions representative of a Spacelab mission.

a. Medical Studies. The studies pertaining to medical measurements were:

(1) Human Cardiac Dimensions (H1). Echographic measurements of the left ventricular dimensions were made on members of the crew and GPL support team. Echograms were generated by holding an ultrasonic transducer against the left side of the subject's chest. The subjects were tested in a semisupine position. The workstation for these tests is shown in Figure 9.

Figure 8. Unloading specimen transportation van.

(2) Human Visual Function (H2). The visual parameters of visual acuity, binocular stereoscopic acuity, accommodation, and fusional reserves were measured for subjects chosen from the crew and GPL support team. The apparatus involved in this experiment is shown in Figure 10.

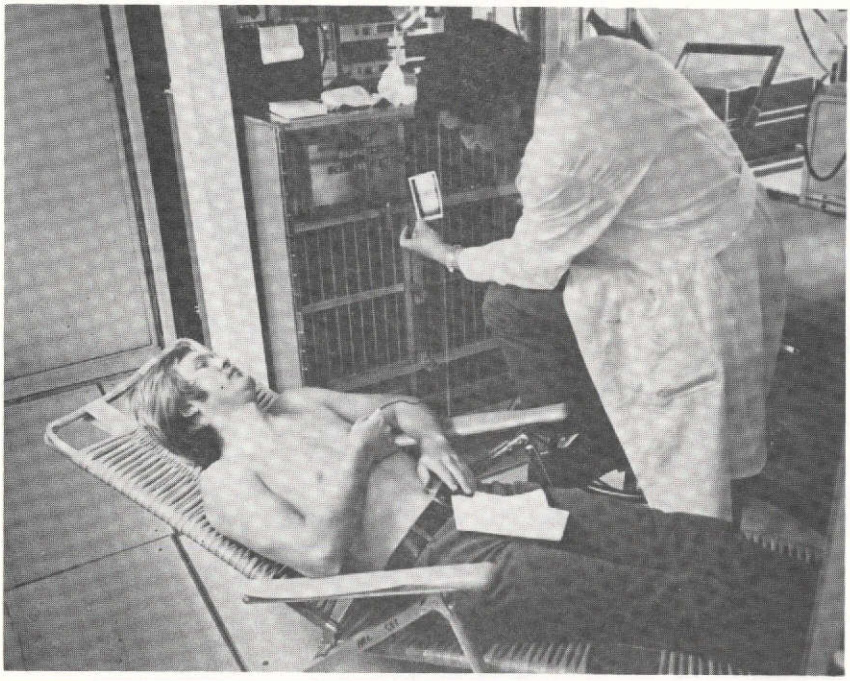


Figure 9. Experiment workstation H1.

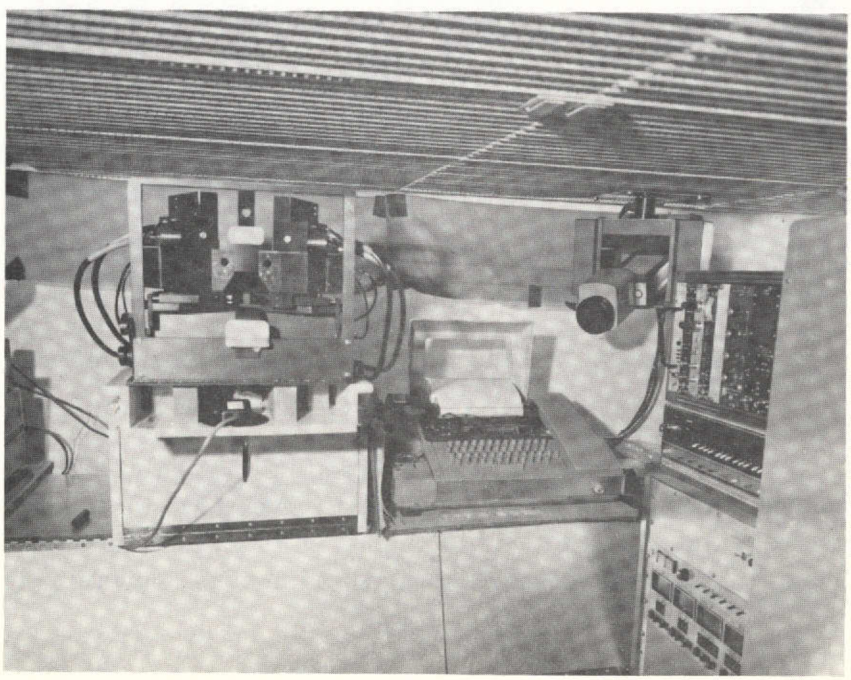


Figure 10. Experiment workstation H2.

b. Subhuman Primate Studies. The studies pertaining to subhuman primates were:

(1) Metabolic and Cardiovascular Studies in Monkeys (P1). The subject, a pig-tailed monkey (Macaca nemistrina), was seated in a metabolism pod throughout testing. The pod, divided into upper and lower halves, permitted metabolic gas exchange measurements in the upper portion and the application of negative body pressure in the lower portion. Metabolic gas exchange parameters were measured and included oxygen consumption, carbon dioxide production, water content, and N_2 of affluent and effluent air. Metabolic wastes were collected and frozen for later analysis of basic elements for metabolic balance evaluation. Heart rate and blood pressure were monitored by implanted sensors. Food (pellets) was available ad lib; water was limited to one liter per day. Daily food consumption was recorded automatically and daily water consumption was recorded manually. Test equipment was located both inside the GPL and on the pallet as shown in Figures 11 and 12, respectively.

(2) Physiologic Cost of Repeated Monkey Shuttle Sorties (P2). The test subject was a Cebus albifrons monkey. The subject experienced 12 hours of illumination and 12 hours of darkness per 24-hour period. Physiological parameters were measured continuously by implanted sensors and included body temperature and heart rate. Urine and feces were collected and frozen for recovery and analysis. The subject's gross behavior was visually scored by the experimenter. Food and water were available ad lib. The experiment apparatus is shown in Figure 13.

(3) Photoperiod Effects on Central Nervous System and Physiological Biorhythms of Monkeys (P3). The test subject was a Cebus albifrous monkey. The subject was exposed to constant illumination, 24 hours daily. Physiological parameters, which were measured continuously by implanted sensors, included heart rate, EEG, and body temperature. Body weight was recorded pre- and post-test. The subject's excrements were collected and frozen for recovery and analysis. Food and water were available ad lib. The experiment apparatus is shown in Figure 13.

(4) Histopathology and Histochemistry of Rhesus Monkeys (P4). The test subject was a Rhesus monkey (Macaca mulatta). The subject was maintained unrestricted in a cage and was provided with food and water ad lib. A blood sample was obtained during the testing period for red and white blood cell counts and smears were made for differential counts. The experiment apparatus is shown in Figure 14.

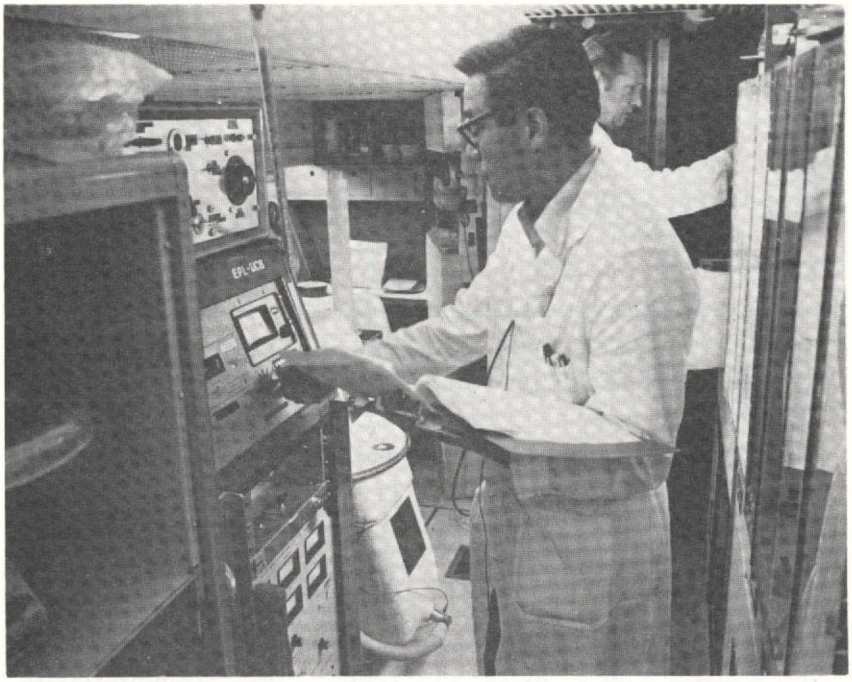


Figure 11. GPL workstation for experiment P1.

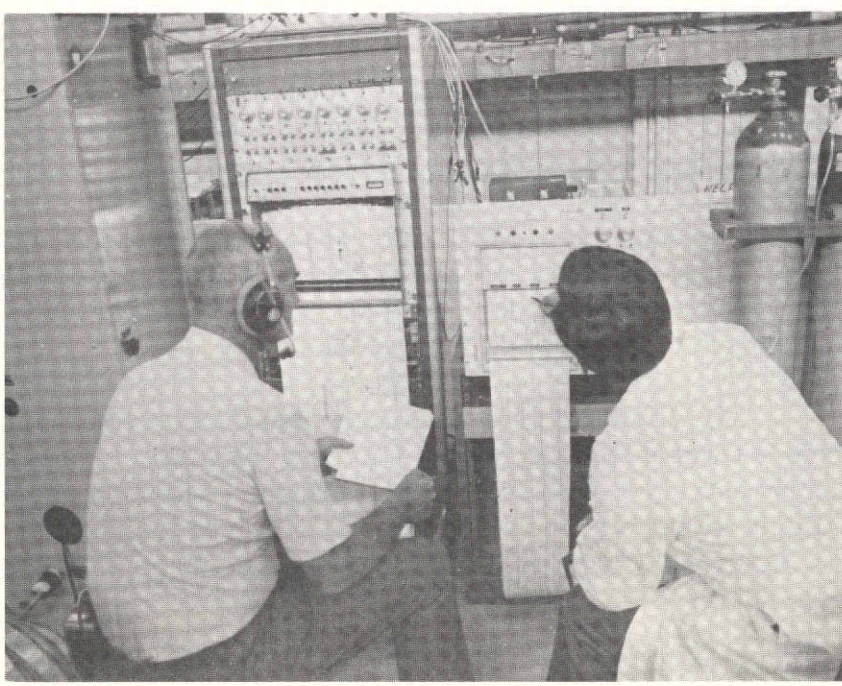


Figure 12. Pallet-mounted equipment for experiment P1.

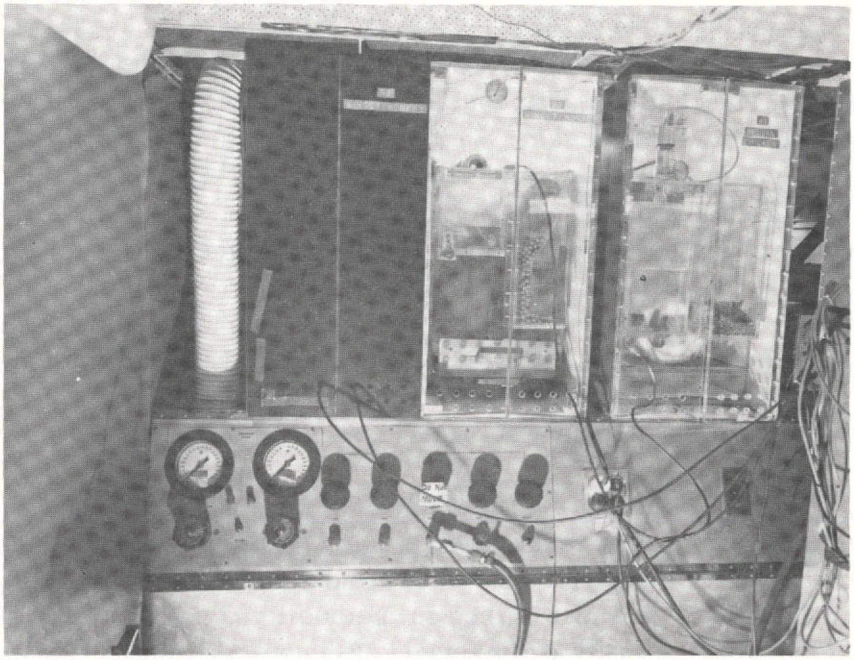


Figure 13. Workstations for experiments P2, P3, and A1.

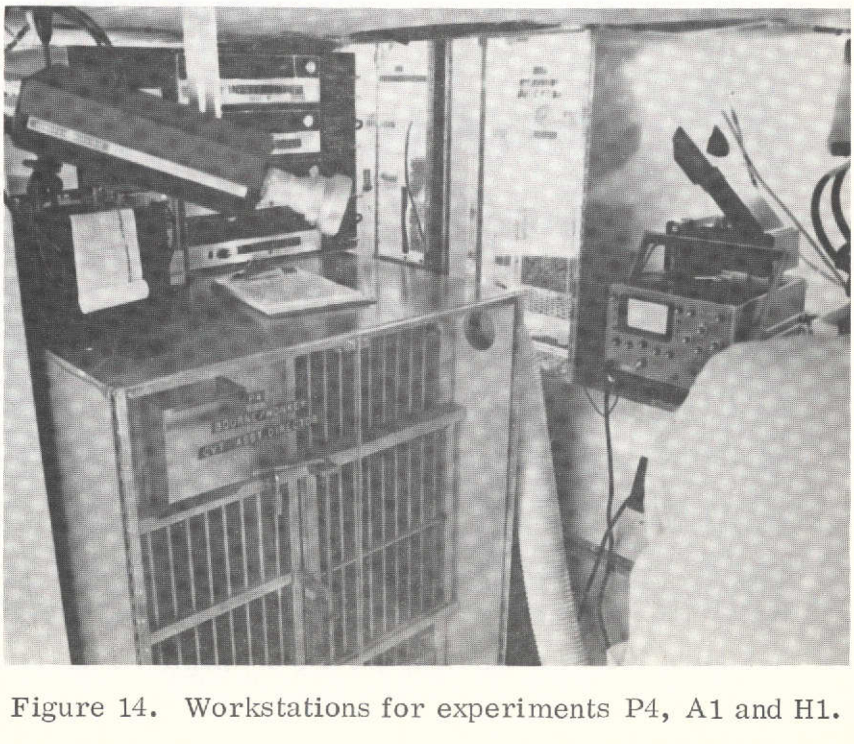


Figure 14. Workstations for experiments P4, A1 and H1.

c. Radioisotope Tracer Studies. The studies utilizing radioisotope tracers were:

(1) Hemolytic Rate of Young and Senescent Red Blood Cells of Rats (R1). The test subjects consisted of six rats, comprising three groups A, B, and C of two rats each. Each subject was injected with 70 microcuries of 2-^{14}C Glycine 55 days prior to the onset of testing. The subjects were exposed to 12 hours of illumination and 12 hours of darkness daily. Food and water were available ad lib. Each group experienced different experimental atmospheres. Group A was exposed to a pure oxygen atmosphere, Group B to a normal air atmosphere, and Group C to an atmosphere composed of 95 percent oxygen and 5 percent nitrogen. Approximately 30 breath samples were collected in soda-lime discs for each subject during testing. The experiment apparatus is shown in Figure 15.

(2) Pituitary Function, Plasma Enzymes, and Bone Metabolism of Male Rats (R2). The test subjects consisted of six rats. Each rat was injected with 25 microcuries of ^{14}C-Proline 30 days prior to the initiation of testing. The rats were maintained in metabolic cages with food and water available ad lib. The rats experienced 12 hours of illumination and 12 hours of

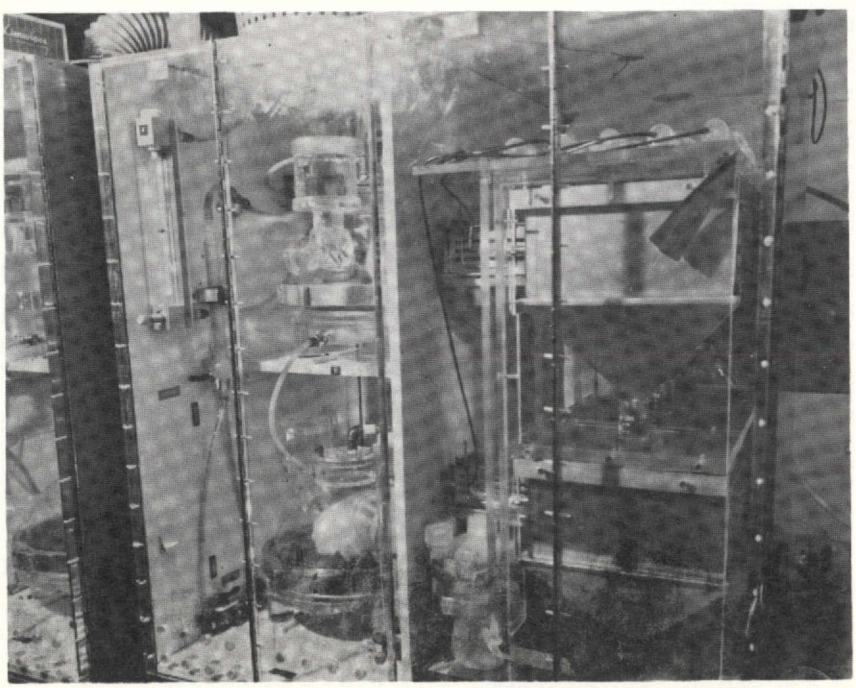


Figure 15. Workstations for experiments R1 and R2.

darkness daily and were monitored by television for a period of 30 minutes daily. Daily measurements included the amount of food and water consumed, tail length and body weight. Feces and urine were collected daily and frozen for recovery and analysis. On the final day of the mission, blood samples were obtained by cardiac puncture from each animal, centrifuged, and the plasma frozen. All animals were subsequently decapitated, tissue samples taken, weighed and frozen. The pituitary, adrenals, left tibia/fibula and femur were dissected from the carcass and frozen. The test equipment is shown in Figure 15.

(3) Quantitation of Calcium Dynamics of Chickens (A1). A Single Comb White Leghorn chicken (Gallus domestica) was injected with strontium 85, 10 days prior to initiation of test. Parameters measured included ^{85}Sr resorption rate and EKG (by telemetry). Excrements were frozen for recovery and analysis. The workstation for this experiment is shown in Figure 13.

(4) Metabolism and Energetics in a Higher Plant (B1). Twenty dwarf marigold seedlings (Tagetes patula, var. Petite Gold) were maintained in a controlled environment. Morphological and metabolic responses were observed. The plants were kept on a 12-hour light, 12-hour dark, illumination cycle. Measured amounts of food and water were administered daily in the form of 1/2 strength Hoagland's solution. The study consisted of four parts as follows:

a. Photosynthesis and respiratory measurements

b. Glutamic amino acid metabolism (using ^{14}C-glutamic acid.

c. Lignification measurements and leaf epinasty (by time lapse photography).

d. Respiration and trace contaminant measurements (using a CO_2/O_2 gas exchange chamber).

The experiment workstation for this experiment is shown in Figure 16.

2. Integration Procedure. GPL/Experiment integration required an understanding of GPL support facilities and interface accommodations by the experimenters (ARC) and an understanding of experiment hardware support and interface requirements by the integrators (MSFC). The development of this mutual understanding began in March 1974, during the installation of

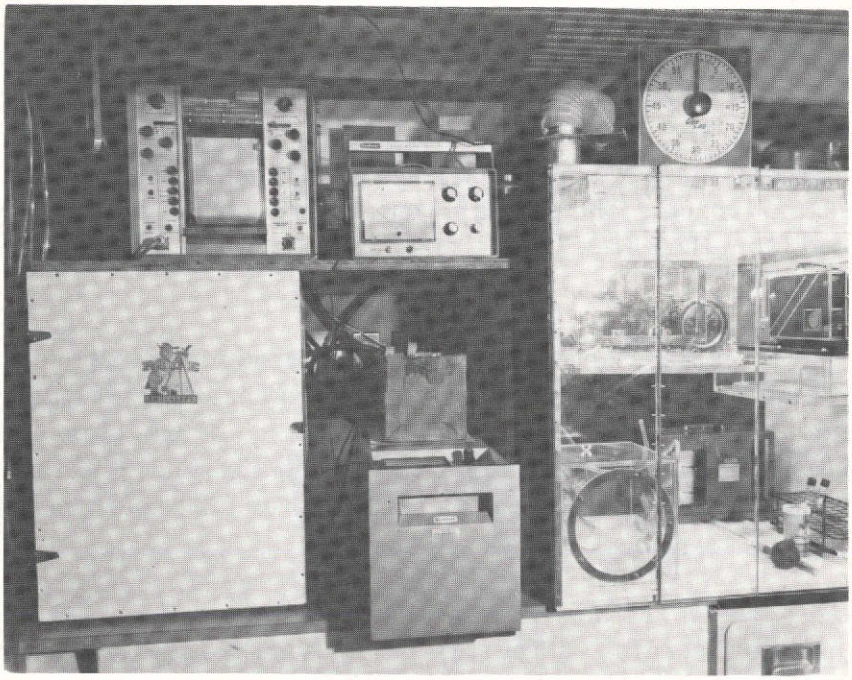


Figure 16. Workstation for experiment B1.

experiment hardware in the integration fixture at ARC, and continued until testing was initiated in July 1974. The implementation of experiment hardware interface requirements involved modifications to the GPL and support facilities and the process of assembly, installation, and checkout of systems in the GPL.

a. Integration Requirements. The candidate experiment equipment was installed in the lower GPL and on the Pallet assembly. Some equipment for the P1 experiment was mounted on the Pallet for ease of operations rather than simulation of flight conditions; normally, the experiment would be located inside the GPL (Spacelab). Figures 17 and 18 show the interior lower level of the GPL, looking from west to east, before and after experiment equipment was installed. The interface/integration requirements for the installation of Life Sciences equipment are given in Appendix C.

b. GPL Modifications. The GPL ventilation and air conditioning system was modified to accommodate CVT/GPL Test III. The bioresearch support equipment included a hooded workbench (Figs. 19 and 20) which was used as a workbench and surgical table, as required. An industrial vacuum cleaner was connected to the hooded workbench to provide approximately

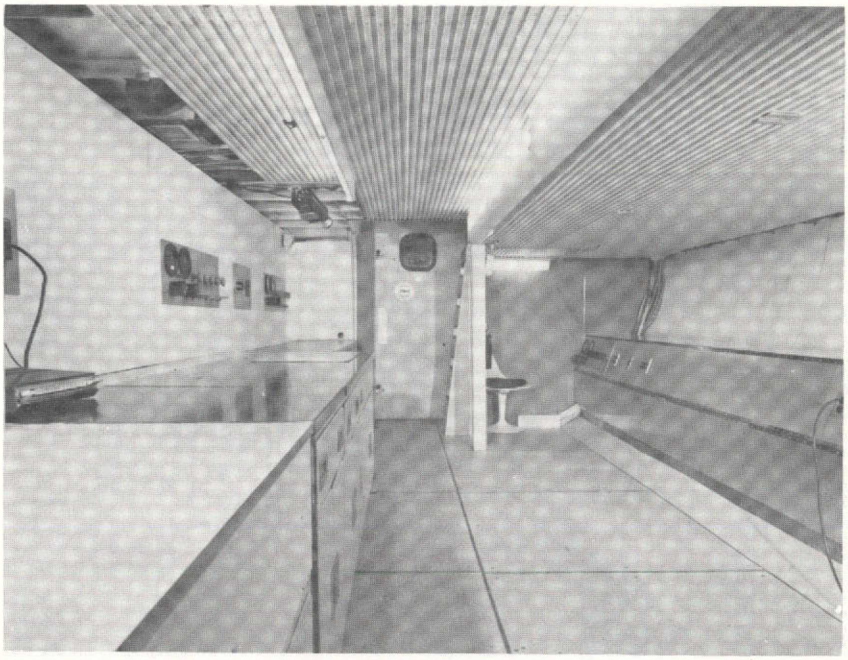


Figure 17. GPL lower level before experiment equipment installation.

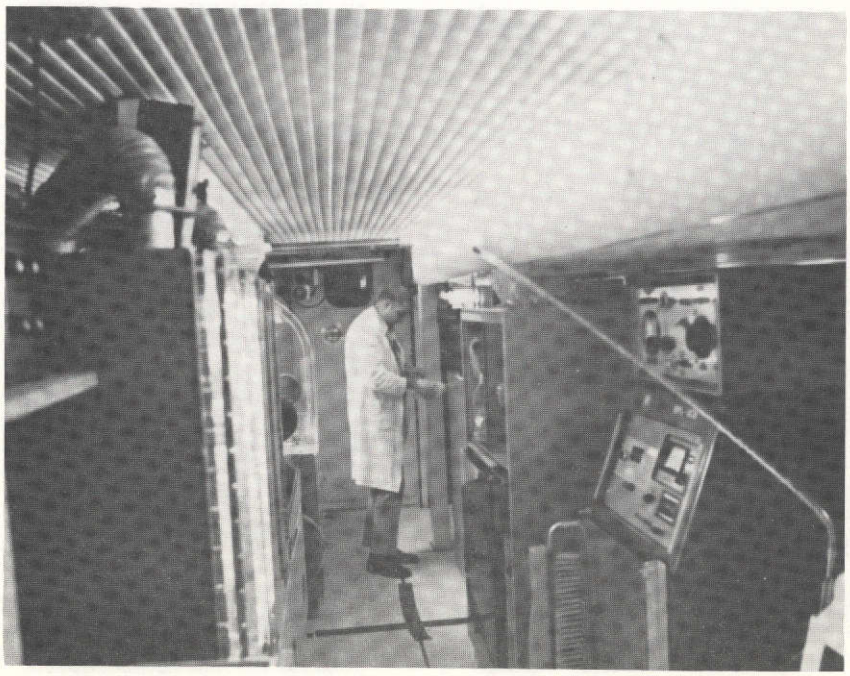


Figure 18. GPL lower level after experiment equipment installation.

Figure 19. Hooded workbench/surgical table used in experiment R1.

Figure 20. Hooded workbench/surgical table used in experiment R2.

7.1 m^3/min (250 ft^3/min) ventilation flow for the workbench. Two squirrel cage blowers, originally used in the Skylab test system, were used to provide ventilation in plant and animal cages. The blowers moved air through charcoal and glass fiber filters. One blower was used to ventilate the Bourne and Winget monkeys and the Beljan rooster. The other blower provided ventilation for the rats and plants.

Cool air was routed from the GPL air conditioning system to the plant module lights to keep the module cool.

The external airconditioner was changed from 100 percent outside air to 100 percent recirculated air for Phase III.

c. Facility Modification. Several modifications were made to the GPL support facilities as a result of CVT/GPL Test II recommendations and as required to support Test III. Modifications included the addition of vacuum pumps, bottled gases, battery operated RF microphones, and TV monitors for test observers.

(1) Vacuum System. Two vacuum pumps were installed to maintain a constant negative pressure on the P1 monkey pod. Also, an auxiliary vacuum system was manifolded into the console for the P1 monkey. This unit was provided as a backup in the event of failure in the primary system. The purpose of the system was to provide constant air flow in the upper half of the pod.

(2) Bottled Gases. Thirteen bottles of pressurized gases were provided to support Test III. Racks for mounting 11 gas bottles on the GPL pallet were provided. Replacements of expended bottles were made as required.

MSFC provided nine bottles of gases which effectively satisfied the requirements of the rat and plant studies. A list identifying the quantity and contents of gas bottles provided by MSFC is as follows:

(a) Five bottles of compressed breathing air, containing a minimum of 20 to 23 percent O_2 by volume with maximum impurities of not more than 500 ppm as CO_2, 10 ppm as CO, 0.005 milligrams per liter as oil and particles, and 0.02 milligrams per liter as H_2O.

(b) One bottle containing 100 percent nitrogen.

(c) One bottle containing nitrogen with 17 percent O_2.

(d) Two bottles containing air with 570 ppm CO_2.

ARC provided four bottles of gases which satisfactorily fulfilled the requirements of experiment P1. The quantity and contents of gas bottles provided by ARC was as follows:

(a) One bottle containing compressed breathing air.

(b) One bottle containing 20 percent O_2, 1 percent CO_2, and 79 percent N_2.

(c) One bottle containing 19.5 percent O_2, 1.5 percent CO_2, and 79 percent N_2.

(d) One bottle containing 19 percent O_2, 2 percent CO_2, and 79 percent N_2.

(3) Communications. The capability to address all GPL workstations simultaneously and for crew members to communicate with external personnel without interrupting experiment activities, was provided by the addition of battery operated RF microphones. RF microphones were used by the Test Conductor, the Pallet equipment monitor, and the experimenter in the GPL.

(4) Observation Area. The area in the Test Control Room adjacent to the Test Conductor's and Video Control rooms was equipped with five TV monitors and a speaker to display GPL activities and associated commentary for test observers, principal investigators and visitors.

C. Test Operations

Test operations included the transfer of equipment and experimental subjects between MSFC, ARC, Baylor University, and Rice University; the pretest checkout of GPL systems; and the conduct of integrated test runs.

1. Experiment Hardware and Specimen Transfer. Test equipment and specimens were carried to and from MSFC by commercial van lines or by the NASA-10 aircraft (Gulfstream). Delicate items, such as electronics and balance scales, were shipped by air. The plants were shipped by auto. Animals were shipped by air, arriving approximately one week prior to the test. The animals were then carried by van from the airport to the bioclean room to await installation in the GPL. Non-delicate equipment, including a refrigerator, equipment racks, and animal cages, was shipped by truck. Most of the support

equipment arrived at MSFC approximately one month prior to the test, which was sufficiently in advance of the test to allow for smooth installation and checkout.

2. Pretest Checkout. Subsequent to the installation of all experiment equipment in the GPL, a pretest checkout was conducted. This checkout was designed to insure the operability of all GPL and experiment systems. The following GPL and experiment support system conditions required verification prior to the initiation of testing:

a. The operation of both internal and external GPL air conditioning systems.

b. The operation of experiment vent systems.

c. The activation of the GPL vacuum system and the operation of its small vacuum pump.

d. The calibration, manning, and operation of the instrumentation system.

e. The manning of the positions of test conductor and mission manager and the TV consoles, as required to support the test.

f. The reporting of the payload specialists to the test conductor.

The following procedure provided verification of the GPL emergency power system:

a. Place the emergency power test switch into the "test" position and verify that the generator and GPL systems function properly.

b. Place the emergency power test switch into the "normal" position and verify that the GPL systems operate properly using facility power.

Pretest checkout procedures for the verification of GPL/experiment system interfaces are given in Appendix D.

3. Test Team. Test operations were carried out by a test team consisting of the Mission Manager, the GPL Test Conductor, a support organization, and the GPL crew. The operations test team structure is indicated in Figure 21.

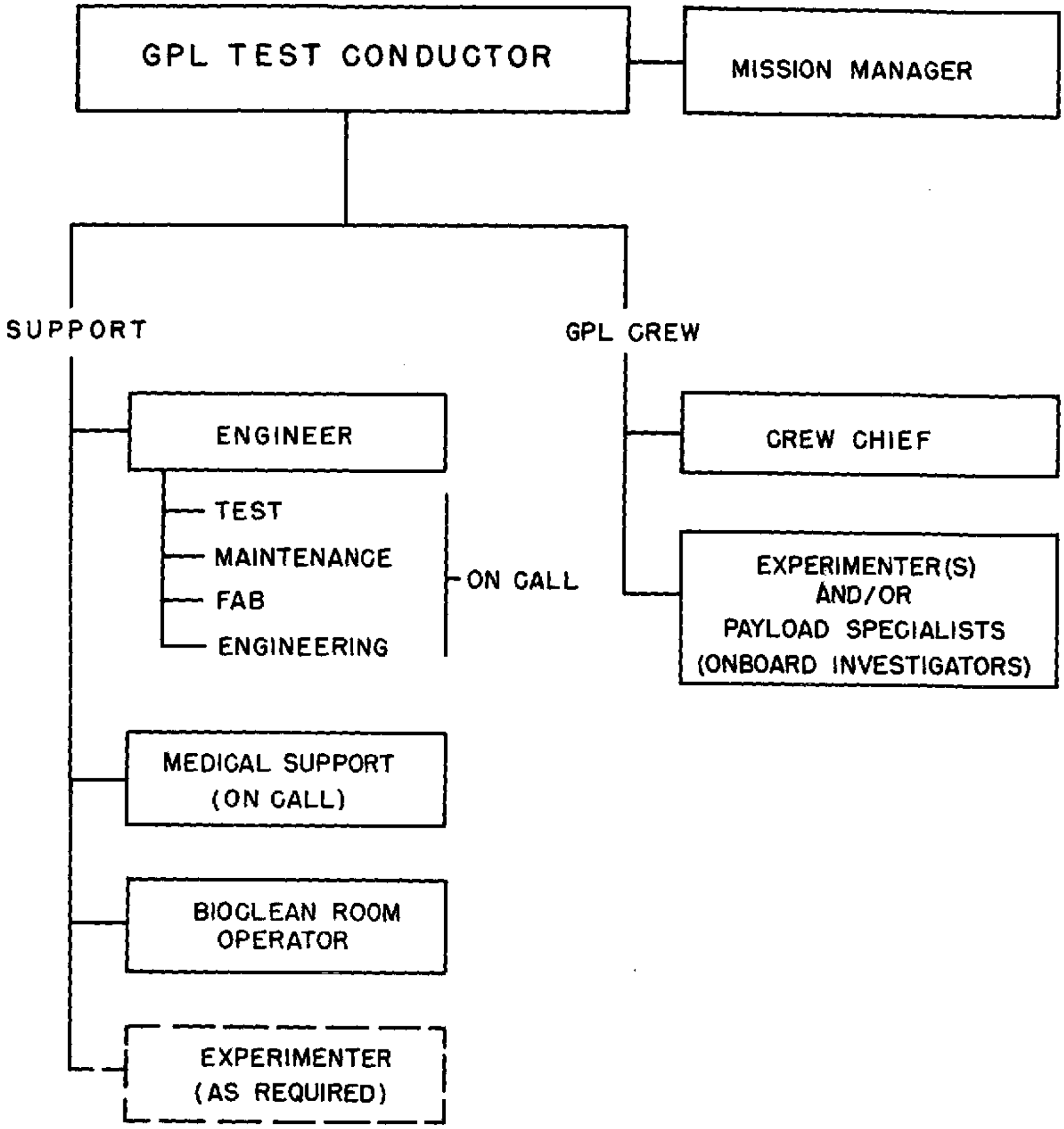


Figure 21. Operational test team.

a. Mission Manager/Test Conductor. The Mission Manager was responsible for coordinating pre- and post-test activities and preparing test documentation. When testing was initiated, the Mission Manager assumed the duties of Test Conductor, directing the GPL operations and coordinating external activities. The Test Conductor directed the daily test briefings and the final debriefing.

b. Test Support. The test support organization included an engineer with on-call assistance, a bioclean room operator, an on-call medical doctor, and investigators to provide ground support for GPL crew members.

c. GPL Crew. The crew was composed of three payload specialists (onboard investigators), responsible for conducting the Life Sciences candidate experiments, and a crew chief, responsible for supporting test operations and obtaining documentary data.

4. Agenda. Test organisms were transferred from the Bioclean Room to the GPL on Sunday, July 14, 1974. Test activities began the following Monday and were concluded on Friday, July 19, 1974. Each day began with an 0800 briefing of all personnel to review the previous day's activities and the plans for the current day. Testing was initiated each morning at 0830 and concluded each afternoon at 1600, daily. Test organisms were removed from the GPL and transferred to the Bioclean Room on Friday morning. The final debriefing was held on Friday afternoon. The daily GPL test activity schedule is given in Figure 22.

5. Documentation. Testing was conducted in accordance with "CVT/GPL Phase III Test Plan and Procedures," MSFC drawing number 10M33227, dated July 1, 1974. Copies of this document may be obtained from the MSFC repository. The following is a complete list of the documentation which was generated in support of the test:

a. Intercenter Agreement MSFC/ARC/JSC/NASA HQ.

b. Experiment Interface Requirements Matrix

c. Test Plan and Procedures

d. Bioclean Room Operating Procedures

e. ORI Committee Report

This relatively small amount of documentation is considered a significant improvement with respect to the documentation requirements for a typical CV990 test.

TIME	DAY 1 (M)	DAY 2 (T)	DAY 3 (W)	DAY 4 (TH)	DAY 5 (F)
8 A.M.	LEON (R1) PACE (P1) BELJAN (A1)	LEON (R1) PACE (P1) BELJAN (A1)	LEON (R1) PACE (P1) BELJAN (A1)	LEON (R1) PACE (P1) BELJAN (A1)	LEON (R1) PACE (P1)* BELJAN (A1)*
9 A.M.	WARD (B1) WINGET (P2/P3)	WINGET (P2) WARD (B1) BOURNE (P4)	WINGET (P2) WARD (B1) BOURNE (P4)	WINGET (P2) WARD (B1) BOURNE (P4)	WINGET (P2)* WARD (B1)* BOURNE (P4)*
10 A.M.	BOURNE (P4)			WINGET (P3)	
11 A.M.	SANDLER (H2)	SANDLER (H2)	SANDLER (H2)	SANDLER (H2)	SANDLER (H2) WINGET (P3)*
NOON	LEON(R1)	LEON(R1)	LEON(R1)	LEON(R1)	LEON(R1)*
1 P.M.	DECKER (H1)	DECKER (H1)	DECKER (H1) WINGET (P3)	DECKER (H1)	DEBRIEFING
2 P.M.	ELLIS (R2)	ELLIS (R2)	ELLIS (R2)	ELLIS (R2)	
3 P.M.	PACE (P1) BELJAN (A1)	PACE (P1) BELJAN (A1)	PACE (P1) BELJAN (A1)	PACE (P1) BELJAN (A1)	
4 P.M.	BOURNE (P4)	BOURNE (P4) WINGET (P3)	BOURNE (P4)	BOURNE (P4)	
5 P.M.					* REMOVE ORGANISMS FROM SIMULATOR TO HOLDING ROOM AT END OF TEST

(REVISED 4-18-74)

Figure 22. Daily activity schedule.

III. RESULTS AND DISCUSSION

A. Experiment Integration

The use of an integration fixture to mount experiment equipment and perform preliminary tests of hardware and procedures, prior to installation in the GPL, was an effective approach to determining integration requirements and preparing for GPL test operations. No major problems were encountered during the experiment hardware integration process. In some cases, hardware interface connections established at the integration fixture required modifications to accommodate user equipment. Some of the power connections with the integration fixture were determined to be incompatible with GPL experiment interface panels, e.g., equipment which was hardwired into the integration fixture required the addition of plugs in order to mate with the GPL power system.

The utility of the integration fixture which was demonstrated in preparing for the test strongly suggests that this concept be considered for the integration of experiment payloads for Spacelab missions.

B. Operations

A detailed log of events and problems which occurred during test operations is given in Appendix E. Results and discussion relevant to test specimen transfer, communications, photography, activity documentation, crew chief functions, stowage, pretest operations, and maintenance are given below.

1. Specimen Transfer. The transfer of specimens from Ames to the MSFC Bioclean Room, from the Bioclean Room to the GPL, and the return to Ames was very smooth. The NASA-10 aircraft and the air conditioned ground transportation van functioned to the satisfaction of the Ames personnel.

2. Communications. Audio communications were improved with respect to the previous Bioresearch Laboratory test. However, some problems encountered will require attention for better communications in future tests. The first day of testing was interrupted because of an intermittent malfunction in the Test Conductor's headset. Reception of the Test Conductor in the GPL was normally good but occasionally weak. Communications between the Beta (video control) console and the GPL were inadequate. Communications between the pallet and the GPL were difficult due to background noise. A headset was used by the investigator on the pallet during the last three days of the test to

help alleviate this problem. Communications between the Payload Specialists (experimenters in the GPL) and the Principal Investigators (ground control) during the test was not planned. However, there was considerable communication between these personnel which was accommodated through the Test Conductor's console. This sometimes caused traffic problems in the Test Conductor's area. The effect of these problems on the total test operation was considered relatively insignificant.

Communications systems improvements suggested by experimenters included a push-to-talk system to avoid inadvertent cross-talk and a direct audio-visual channel between principal investigators and payload specialists. Direct communications between principal investigators on the ground and experimenters on orbit was strongly recommended.

3. Photography. Photographic coverage by the mission manager for documentation purposes was excellent and non-intrusive. However, the adjustment of TV cameras within the GPL by crew members proved to be periodically intrusive. As a result, it was suggested that a control panel permitting complete adjustment of all TV cameras from a point external to the GPL be provided.

The presence of unscheduled visitors proved to be intrusive at times. It was suggested that a particular time period be scheduled solely for the purpose of accommodating the photographic coverage requirements of such visitors. Another suggestion concerned the need for a closed loop audio-video system providing coverage of each experiment. It was suggested that this could facilitate communications among experimenters and ground based scientific investigators.

4. Activity Identification/Documentation. With three payload specialists working continuously on a variety of experiments involving complex acitivities, it was sometimes difficult to correlate action displayed on the video monitors with a specific location or experiment function. It was suggested that displays be developed to provide better identification of what is being done and at what location.

The practice of each payload specialist giving a verbal summary of what was accomplished, prior to signing off for the day, was recommended.

Color television was suggested as a means for enhancement of experiment documentation.

An up-link video monitor was suggested as a means to better convey information from ground control to experimenters in the GPL.

5. Crew Chief Functions. The non-scientific duties required to carry out the mission were performed by the crew chief as planned. Those duties included systems startup, monitoring and shutdown, GPL instrumentation monitoring, documentary photography, maintenance, trash management, changing the environmental control system filters, coordination between payload specialists and external support personnel, and keeping a log of observations concerning the total operation. The most demanding function of the crew chief was the setup and manipulation of photographic equipment. It was observed that while the crew chief's duties were essential to the mission, they did not necessarily require the full time participation of one individual. Considerable free time was inherent in the scheduled experiment activities. It was suggested that this time might be applied to non-scientific functions, dividing the workload between the three payload specialists, which would eliminate the need for a crew chief, as presently defined.

6. Stowage. An excessive number of small miscellaneous items were carried into the GPL during the test. Stowage of such items in the GPL, prior to test initiation, was recommended. The trash cans provided for cage waste stowage were too small.

7. Pretest Operations. It was recommended in future tests that the animals be moved into the GPL soon enough to allow at least one day for a dry run prior to starting the test. It was felt that many of the problems encountered during the first day of testing would not have occurred if more time for checkout of procedures and operations had been available before the test.

8. Maintenance. As an aid to operating and maintaining equipment, it was recommended that operating manuals for all equipment be located in the GPL.

9. Summary of Results. The following is a summary of results pertaining to test operations:

a. Test specimen transfer within and between centers was accomplished in a smooth and timely manner.

b. Minor problems which occurred in the audio communications system were resolved without causing significant loss of experiment data.

c. Communications was frequently required between principal investigators, located in the test control room, and payload specialists, located in the GPL, and this occasionally resulted in overloading the Test Conductor's facilities.

d. Photographic coverage of experiment activities by the crew chief was non-intrusive.

e. Television Coverage of experiment activities was largely non-intrusive but required some camera adjustments which were slightly intrusive.

f. It was sometimes difficult to correlate action displayed on the video monitors in the observation room with a specific location or experiment function.

g. Non-scientific duties were performed by the crew chief as planned.

h. An excessive number of small miscellaneous items were carried into the GPL during the test.

i. Trash cans provided for cage waste stowage were too small.

j. Transfer of test specimens into the GPL the day before the test did not allow enough time for debugging all systems and procedures prior to test initiation.

k. Equipment operation and maintenance manuals, which would have been useful on occasion, were not available on the GPL.

C. Experiments

The following results and discussion concern the identification of candidate experiments, the assignment of candidate experiment responsibilities to Payload Specialists, candidate experiment problems, and the effectiveness of the Payload Specialist concept.

1. Identification and Assignment of Experiments. Ten candidate experiments exercised during CVT Test III provided data utilized in the pursuance of the investigation of three research areas: medical studies, subhuman primate studies, and radioisotope tracer studies. Responsibilities for exercising the experiment protocols were divided among three experimenters. These payload investigators (specialists) included Drs. S. T. Taketa, P. X. Callahan, and R. Simmonds. Detailed operating procedures for each of the candidate experiment protocols are provided in Appendix F.

The candidate experiment protocols conducted by Dr. Taketa, who also served as science manager and coordinator, included; Metabolic and Cardiovascular Studies of Monkeys (P1), Human Cardiac Dimensions (H1), and Human Visual Function (H2). Protocols exercised by Dr. Callahan included;

Hemolytic Rate of Yound and Senescent Red Blood Cells of Rats (R1), Pituitary Function, Plasma Enzymes, and Bone Metabolism of Male Rats (R2), and Metabolism and Energetics in Higher Plants (B1). Those protocols conducted by Dr. Simmonds were as follows: Physiologic Cost of Repeated Monkey Shuttle Sorties (P2), Photoperiod Effects on Central Nervous System and Physiological Biorhythms of Monkeys (P3), Histopathology and Histochemistry of Rhesus Monkeys (P4), and Quantitation of Calcium Dynamics of Chickens (A1).

2. Candidate Experiment Problems. Although several minor problems involving individual candidate experiments occurred on the first day of testing, they were expediously resolved, enabling experimenters to adhere closely to experiment protocols and the same daily schedule of experimentation throughout the test period. Problems associated with individual experiment protocols had a minimal impact upon the total data package and, in the opinion of the experimenters, the objectives of the candidate experiments were satisfactorily accomplished.

3. Payload Specialist Concept. The technique of utilizing a Payload Specialist to exercise the candidate experiment protocols of a number of Principal Investigators was again satisfactorily demonstrated.

4. Summary of Results. Results derived from exercising the candidate experiments during CVT Test III are summarized below:

a. All experiment objectives were accomplished.

b. Experiment protocols and the daily activity schedule were closely followed.

c. The operational problems encountered were minor and were resolved without significantly impacting any experiment.

d. The Payload Specialist concept was again successfully demonstrated.

D. Facilities

Results and discussion concerning GPL power consumption, environmental control, and external support facilities are given below.

1. Power Consumption. The total electrical power consumption for the GPL, including all GPL experiment systems, experiment support systems, and environmental control systems, was continuously recorded on a stripchart. The stripchart recordings were analyzed to determine peak power consumption

within each 1-hour and 6-hour interval. Peak power for these intervals was then plotted, as shown in Figures G-1 and G-2, Appendix G. Referring to the 1-hour increment curve, peak power was a minimum of approximately 3.2 kW during the night before experiment activities were initiated and a maximum of 12.8 kW during the afternoon of the fourth day of testing, when experiment activities were nearing the finish. The average peak power increased from approximately 8.9 kW on the first day of testing to 10.5 kW on the fourth day of testing. Average peak power throughout the four days of testing was approximately 9.2 kW. Peak power levels did not vary appreciably from the minimum power levels during a given 1-hour interval, so that the peak power curve also serves as a rough approximation of the average power level for the GPL. Using this approximation for average power level, the total power consumed during the four days of experimentation was calculated to be 883 kW-h. Separate measurements of GPL systems power and experiment systems power are presented and discussed in Appendix G.

It was not necessary to activate the emergency electrical power system during the test.

2. Temperature. Copper constantan thermocouples were used for GPL systems and experiment module temperature measurements. These measurements were recorded continuously through the Astrodata system and hourly in the GPL log. Measurements which were recorded in the GPL log are summarized in Tables H-1 and H-2, Appendix H.

The temperature range originally specified for specimen cages was 22.5 ±1.1° C (72.5 ±2° F). This requirement was relaxed to 22.8 ±1.7° C (73 ±3° F) during the test. The provisions for monitoring specimen cage temperature in the GPL were inadequate. This resulted from the fact that specimen cage temperatures were not identified in the interface requirements as the most significant measurements. It was assumed that the cage temperatures would follow the GPL lower deck ambient temperature. Shortly after the specimens were moved into the GPL, a 3.3 to 4.4° C (6 to 8° F) spread in temperatures between cages was noted. Since no arrangements were made to display the temperatures except through the data handling room, 24-hour operation of the data handling room was instituted the night before the test began. This temperature data from each cage was used to maintain the cage temperatures between 21.1° C and 24.4° C (70° F and 76° F). The cage temperatures were manipulated by adjusting air flow through each module, heater strips in the GPL ducting, GPL air conditioners, and portable fans inside the GPL. Balancing these temperatures was a constant problem after each day's testing. Overall, this technique, while difficult, was successful in keeping temperatures properly adjusted. Analysis of the temperature data recorded in the GPL log shows that the temperatures in specimen cages were held between 20.2 and 26.1° C (68.4 and 78.9° F) and averaged 23.1° C (73.5° F) for the entire test. Instances in which the specified limits were exceeded are summarized in Table H-3, Appendix H. It should be noted that temperature excursions outside the 21.1° C to 24.4° C (70° F to 76° F) range would not negate an experiment or be harmful to test specimens unless extreme deviations occurred.

The acceptable temperature range for the GPL was 22.8 ±1.7° C (73 ±3° F). According to the temperature data recorded from the systems monitor panel (GPL parameter measurements log, Appendix H), the GPL temperature was held within acceptable limits throughout the test. These data indicate an average GPL temperature 22.8° C (73.1° F), within a minimum of 22.2° C (72° F) and a maximum of 23.9° C (75° F). However, the reference junction temperature for this readout had been checked with a thermometer which was found to be out of calibration after the test. The reference junction was then checked with an accurate thermometer and it was determined that the affected data should be corrected upwards by 1.1° C (2° F). Applying this correction to the data recorded during the four days of active experimentation, the actual GPL temperature range was 23.3° C to 25.0° C (74° F to 77° F) and the average temperature was 23.9° C (75.1° F).

3. Humidity. Percent relative humidity in the GPL, as recorded in the GPL log, Appendix H, averaged 45.5 during the test. The minimum humidity was 38 percent and the maximum was 51 percent.

4. Acoustics. Two channels of acoustical data were recorded on an 8-hour/day basis from microphones located in the east and west ends of the GPL. Three segments were selected from the data which are considered typical of a relatively quiet period, a period with an experiment in progress, and a period of general test activity. A spectral analysis was performed on a sample from each of these segments. Sound level and spectral analysis charts are given in Figures J-1 through J-5, Appendix J. Figure J-1 is a typical sound level chart, including all frequencies, which was recorded during the first day of testing. Figures J-2 through J-5 show the sound levels and frequency band distribution for the three typical activity periods. These charts were derived from data recorded on the second day of testing. All sound level measurements were recorded and played back for analysis on the B-scale.

Figure J-2, Section 1, shows that the average background noise level was approximately 71 dB. The spectral analysis chart (Fig. J-3) for this section shows that the 71 dB average level was the result of a continuous 71 dB ambient input which was limited to the relatively low 120-140 Hz range. Background noise in the 150-1400 Hz range averages approximately 60 dB. Sound levels during the period with an experiment in progress (Fig. J-2, Section 2) average 73 to 75 dB. The spectral analysis for this segment (Fig. J-4) indicates that the average level in the 150-1400 Hz range was approximately 63 dB with peak values of 73 dB in the 180 to 280 Hz range. The sound levels during a period of general test activity (Fig. J-2, Section 3) appear to be similar to those generated with one experiment in progress. However, the sample used for spectral analysis (Fig. J-5) of this period happens to cover a short interval of relative quiet. Thus, Figures J-3 and J-5 are nearly identical.

The 71 dB input in the 120-140 Hz range is present on all of the spectral analysis charts. Apparently this is a continuous input which may have originated from transformers or motors which were operating in the GPL.

The peak noise levels generated during the test were not excessive and the average levels were very comfortable.

5. <u>Lighting</u>. Lighting was satisfactory in the GPL with the exception of a few dark areas and some minor problems in controlling light and dark periods. It was too dark in the P4 monkey area. Light from the electronic panels had to be masked to avoid illuminating the plants during scheduled dark periods. Power for the hooded workbench was not routed through the timer which controlled light and dark periods in the GPL. Consequently, the workbench lights did not go off when the main power was cut. It was also noted that the timer was not sufficiently accurate to provide precise light and dark period control. It was suggested that a complete power-up, power-down checklist for all experiment and experiment support systems be developed for future tests. Individual light and temperature control, programmed for each animal and plant module, was suggested as a method for maintaining strict experimental conditions, independent of the general GPL environment.

6. <u>Ingress/Egress Cycles</u>. Equipment was installed in the GPL to measure the number of personnel passages through the CVT/GPL east and northwest doors. The photocell equipment at the northwest malfunctioned after a few hours and could not be corrected without disturbing test operations. It was left inoperative, although the northwest door was used more heavily than the east door. The east door registered 1204 operations between 11:00 p.m., July 14 and 3:30 p.m., July 19.

7. <u>Ventilation System Filtration</u>. Charcoal filters for the specimen cage vent systems required only one change during the week of testing.

8. <u>Bioclean Room</u>. The Bioclean Room performed very well as a holding area for test specimens. The Bioclean room environmental control system was tested prior to the animal holding period to verify that requirements were met. Temperature and humidity inside and outside the Bioclean Room were

recorded continuously throughout the pretest, test, and post-test activities. The results of the systems test and a sample of temperature and humidity data are presented and discussed in Appendix K.

9. Summary of Results. The following is a summary of results pertaining to facilities:

a. The total power consumption for the GPL during four days of experiment activity was approximately 883 kW-h.

b. Maximum peak power usage was 12.8 kW which occurred during the afternoon of the fourth day of testing.

c. The primary power system functioned properly throughout the test so that emergency power was never required.

d. Individual specimen cage temperature displays were not provided in the GPL which required continuous monitoring of cage temperatures through the Astrodata system and frequent adjustment of vent systems to maintain proper cage conditions.

e. Specimen cage temperatures were held between 20.2° C and 26.1° C (68.4° F and 78.9° F) and averaged 23.1° C (73.5° F) for the entire test.

f. Temperature excursions outside the acceptable range 22.8 ±1.7° C (73 ±3° F) defined for specimen cages, were infrequent and brief.

g. A calibration error in the reference junction for the GPL temperature measurement circuit resulted in inadvertently holding the GPL temperature approximately 1.1° C (2° F) above the nominal 22.8° C (73° F), i.e., throughout the test the average temperature appeared to be 22.8° C (73.1° F) but it was actually averaging 23.9° C (75.1° F).

h. Relative humidity in the GPL was maintained between 38 and 51 percent and averaged 45.5 percent.

i. The peak noise levels (approximately 75 dB) generated in the GPL during the test were not excessive and the average levels (approximately 60 dB) were acceptable.

j. Lighting in the GPL was generally satisfactory.

k. The east door of the GPL was operated 1204 times. The northwest door operations were not counted, due to an equipment failure, but this door appeared to have been operated approximately twice as often as the east door.

l. Charcoal filters for the specimen cage vent systems required one change during the test.

IV. CONCLUSIONS

The test was a success from end to end, proceeding effectively through the definition and implementation of experiment integration requirements, pretest checkout, test operations, and post test activities. Minor problems, which occurred before and during the test, were all handled smoothly and did not significantly affect the final outcome. All experiment objectives were met. The GPL experiment support, environmental control, data acquisition and video control systems performed effectively. The communications system was temporarily ineffective during the first day of testing, but this did not seriously impede the progress of the test. The Bioclean room and transportation van functioned as planned in housing and transferring test specimens.

A. Experiment Integration

Experiment integration requirements must be defined and experiment/payload carrier interfaces completely determined prior to the installation of experiment equipment into the payload carrier. The integration fixture used for this test was instrumental in the development of integration requirements and minimization of experiment/GPL interface problems. The success of the integration fixture concept, which was demonstrated in this test, suggests that it be considered for application in Spacelab experiment payload integration.

B. Operations

The following was concluded regarding test operations:

1. A direct voice and closed circuit TV link is required between investigators located on the ground (test control room) and payload specialists located in the GPL. The controls and displays for this communications link should be physically separated from the test conductor's console. An uplink video monitor would also enhance communications between ground control and payload specialists.

2. Difficulties encountered with voice communications were of the work-around variety and did not seriously disrupt operations. However, further improvements in the communications system are in order.

3. The voice communications between payload specialists and test control should include a push-to-talk option to avoid inadvertent cross-talk.

4. Video documentation of experiment activities was generally non-intrusive. However, the system can be improved by providing for complete control of all camera adjustments from the video control room.

5. A better method of correlating the broad mixture of action and commentary, as displayed in the test observation room, should be developed. An independent closed-loop audio-video channel for each experiment or explicit identification of what is displayed by each monitor in the present system would be an improvement.

6. The non-scientific duties, which were performed by the crew chief, were essential to the mission but might have been performed by the payload specialists during free time available between scheduled experiment activities. This would eliminate the need for a crew chief with responsibilities as defined for this test. The validity of this conclusion should be tested by conducting a similar mission with a crew of three payload specialists, each sharing the responsibility for non-scientific duties.

7. A dry run with test specimens aboard the GPL should be performed to exercise all systems and operational protocols before initiating future life sciences test activities.

8. Operating/maintenance manuals should be available in the GPL for all equipment.

C. Experiments

The following was concluded regarding experiment activities:

1. All experiment objectives, which were related to the acquisition of (1) scientific data pertinent to individual candidate experiments and (2) operational assessments of candidate experiment designs under conditions representative of Spacelab, were accomplished to the satisfaction of the experimenters.

2. Although candidate experiment protocols and the daily activity schedule were followed closely during the test period, some procedural changes were made until the start of the test and occasionally during the week of testing. Future testing should require the distribution of updated information concerning (1) changes in experiment procedures made before the initiation of testing and (2) procedural changes made by the Payload Specialists during the test period.

3. Only minor operational problems were encountered during testing and were resolved quickly and effectively. As a result, these problems had a minimal impact upon the experiments. Although it had no significant impact upon the experiments, one problem which requires corrective action prior to future testing concerns inadequate provisions for monitoring GPL specimen cage temperatures. Resistance type temperature sensors with an expanded scale around the ambient conditions would provide a more accurate reading of module temperatures. More care should be taken in the placement of measuring devices within the modules to obtain nominal temperature readings.

4. The feasibility of utilizing a Payload Specialist to exercise the candidate experiment protocols of a large number of ground based Principal Investigators was again demonstrated.

D. Facilities

The following was concluded regarding test facilities:

1. Peak power levels and total power usage were excessive with respect to Spacelab design requirements. The peak power levels during the test were typically 9.2 kW and once reached 12.8 kW. Spacelab requirements specify peak power levels of 9 kW. The total energy allotted to the Spacelab "module only" configuration is 595 kW-h. The total energy consumed by the GPL during four days of active experimentation was approximately 883 kW-h, 48.5 percent greater than the total Spacelab allotment. Extrapolating the four-day estimate to five days, the total power consumed by the GPL would be approximately 1104 kW-h, which exceeds the Spacelab allotment by nearly 86 percent.

2. Although the temperatures within the various animal cages and plant modules were generally held within acceptable limits, lack of direct temperature readouts for each module was a definite operational handicap. Future tests should include local readouts and ventilation adjustments for each module.

3. The average temperature in the GPL was maintained within acceptable limits throughout the test in spite of a calibration error which resulted in shifting the average temperature 1.1°C (2°F) above the nominal 22.8°C (73°F).

4. The limits specified for relative humidity in the GPL were 40 to 60 percent. During the last day of the test the relative humidity dropped to 38 percent for a 4-hour period. Otherwise, relative humidity was maintained within the required limits.

5. Noise levels in the GPL were generally within acceptable limits throughout the frequency range corresponding to normal speech.

6. Light levels were satisfactory throughout the GPL.

7. More precise control of light and dark periods will be required for future life science tests.

8. The Bioclean room functioned well in support of the test. However, more elaborate specimen holding facilities will be required to support Spacelab. It was suggested that the room be equipped with an air filtration system to remove animal odors and that separate holding facilities would be required for each animal species to support Spacelab operations.

APPENDIX A

CANDIDATE LIFE SCIENCES EXPERIMENTS, PAYLOAD SPECIALISTS AND EXPERIMENTERS

Experiment titles and corresponding codes for each of the ten candidate life sciences experiments are listed below.

Experiment Code	Experiment Title
H1	Human Cardiac Dimensions
H2	Human Visual Function
P1	Metabolic and Cardiovascular Studies of Monkeys
P2	Physiologic Cost of Repeated Monkey Shuttle Sorties
P3	Photoperiod Effects on the Central Nervous System and Physiological Biorhythms of Monkeys
P4	Histopathology and Histochemistry of Rhesus Monkeys
R1	Hemolytic Rate of Yound and Senescent Red Blood Cells of Rats
R2	Pituitary Function, Plasma Enzymes, and Bone Metabolism of Male Rats
A1	Quantitation of Calcium Dynamics of Chickens
B1	Metabolism and Energetics in a Higher Plant

Identified below are the candidate life sciences experiments exercised by each payload specialist during the week of testing.

Payload Specialist	Experiment Code
Dr. P. X. Callahan	R1 R2 B1

Payload Specialist	Experiment Code
Dr. R. C. Simmonds	A1 P1 P2 P4
Dr. S. T. Taketa	H1 H2 P3

Identified below are the investigators, co-investigators, and associate investigators; their test roles and areas of expertise; the institutions with which they are affiliated; and the particular candidate life sciences experiments with which they were associated.

Experiment Code	Scientist/Institution	Role/Expertise
H1	S.T. Taketa, PhD/Ames Research Center	Science Manager and Payload Investigator (Specialist)/ Mammalian and Radiation Physiologist
	H. Sandler, M.D./Ames Research Center	Candidate Investigator/ Cardiologist
	R. Lee, E.E./Ames Research Center	Associate Investigator/ Electrical Engineer
H2	S.T. Taketa, PhD/Ames Research Center	Science Manager and Payload Investigator (Specialist)/ Mammalian and Radiation Physiologist
	T. Decker, PhD/Baylor University	Candidate Investigator/ Experiment Physiologist
	R. Haines, PhD/Ames Research Center	Co-Candidate Investigator/ Experiment Physiologist
	L. Loper, O.D./Johnson Space Center	Co-Candidate Investigator/ Optometrist

Experiment Code	Scientist/Institution	Role/Expertise
H2 (Cont'd)	R. Williams, E.E./Baylor University	Associate Investigator/ Electrical Engineer
P1	R.C. Simmonds, V.D.M./ Ames Research Center	Test Veterinarian and Payload Investigator (Specialist)/ Ames Research Center Staff Veterinarian
	C. Winget, PhD/Ames Research Center	Co-Candidate Investigator/ Comparative Physiologist
P2	R.C. Simmonds, V.D.M./ Ames Research Center	Test Veterinarian and Payload Investigator (Specialist)/ Ames Research Center Staff Veterinarian
	J.V. Danellis, PhD/Ames Research Center	Candidate Investigator/ Pharmacologist
	C. Winget, PhD/Ames Research Center	Candidate Investigator/ Comparative Physiologist
P3	S.T. Taketa, PhD/Ames Research Center	Science Manager and Payload Investigator (Specialist)/ Mammalian and Radiation Physiologist
	N. Pace, PhD/University of California, Berkeley	Candidate Investigator/ Environmental Physiologist
	D. Rahlmann, PhD/ University of California, Berkeley	Candidate Investigator/ Environmental Physiologist
	D. Rahlmann, PhD/ University of California, Berkeley	Co-Candidate Investigator/ Mammalian Physiologist
	A. Kodama, PhD/ University of California	Co-Candidate Investigator/ Mammalian Physiologist

Experiment Code	Scientist/Institution	Role/Expertise
P3 (Cont'd)	R. Mains/University of California, Berkeley	Co-Candidate Investigator/ Mammalian Physiologist
P4	R.C. Simmonds, V.D.M/ Ames Research Center	Test Veterinarian and Payload Investigator (Specialist)/ Ames Research Center Staff Veterinarian
	G.H. Bourne, PhD/Emory University and Yerkes Primate Center	Candidate Investigator
R1	P.X. Callahan, PhD/Ames Research Center	Co-Candidate Investigator and Payload Investigator (Specialist)/Biochemist
	H. Leon, PhD/Ames Research Center	Candidate Investigator/ Environmental Physiologist
R2	P.X. Callahan, PhD/Ames Research Center	Co-Candidate Investigator and Payload Investigator (Specialist)/Biochemist
	S. Ellis, PhD/Ames Research Center	Candidate Investigator/ Endocrinologist
	D. Feller, PhD/Ames Research Center	Co-Candidate Investigator/ Mammalian Physiologist
	R. Grindeland, PhD/Ames Research Center	Co-Candidate Investigator/ Mammalian Physiologist
	L. Keil, PhD/Ames Research Center	Co-Candidate Investigator/ Mammalian Physiologist
	K. McDonald, PhD/Ames Research Center	Co-Candidate Investigator/ Biochemist

Experiment Code	Scientist/Institution	Role/Expertise
A1	R.C. Simmonds, V.D.M./ Ames Research Center	Test Veterinarian and Payload Investigator/Ames Research Center Staff Veterinarian
	J.R. Beljan, M.D./ University of California, Davis	Candidate Investigator/ Surgeon
B1	P.X. Callahan, PhD/Ames Research Center	Co-Candidate Investigator and Payload Investigator (Specialist)/Biochemist
	C.H. Ward, PhD/Rice University	Candidate Investigator/Plant Physiologist
	H. Conrad, PhD/Santa Monica, CA	Co-Candidate Investigator/ Plant Biochemist
	M. Mazelis, PhD/ University of California, Davis	Co-Candidate Investigator/ Plant Biochemist
	S. Siegel, PhD/University of Hawaii	Co-Candidate Investigator/ Plant Biochemist
	T.W. Tibbits, PhD/ University of Wisconsin	Co-Candidate Investigator/ Horticulturist
	J. King, PhD/Rice University	Associate Investigator/Plant Physiologist

APPENDIX B

MEASUREMENT LIST

CVT/GPL TEST #3 JULY 15-19, 1974

Power, W

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY			TRANSDUCER		
					M	SC	D	ID	PHYSICAL RANGE	ELECT RANGE
Power, GPL		W1	Local Stripchart		-	X	-		0-20 kW	30 208V
Power, Air Cond and Heating		W2								
Power Lighting GPL*	11	W3	D 21		-	-	X	SR #26 Wattmeter	1 kW	0-100 mV
Power, Exp. (P1)	1	W6	D 24		-	-	X	SR #44 Wattmeter	3 kW	0-5V
Power, Exp. (P2)	12	W7	D 25		-	-	X	SR #24 Wattmeter	1 kW	0-100 mV
Power, Exp. (P3)	13	W8	D 26		-	-	X	SR #25 Wattmeter	1 kW	0-100 mV
Power, Exp. H1	2	W11	D 20		-	-	X	SR #29 Wattmeter	2 kW	0-100 mV
Power, Exp. B1	14	W13	D 31		-	-	X	SR #21 Wattmeter	1 kW	0-100 mV
*NOTE: Measured prior to test.										

Temperature, T

CVT/GPL TEST #3 JULY 15-19, 1974

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY M	DISPLAY SC	DISPLAY D	TRANSDUCER ID	TRANSDUCER PHYSICAL RANGE	TRANSDUCER ELECT RANGE
Temperature, Upper GPL	17	T1	D 33		-	-	X	Thermocouple Copper-Constanta. (TC/CC)	50-100 °F	
Temp., Exp. P3 Winget Monkey	8	T2	D 34		-	-	X	TC/CC	50-100 °F	
Temp., Lower GPL Hot Water	18	T3	D 6		Test Console	-	X	TC/CC	50-100 °F	
Temp., Lower GPL Cold Water	19	T4	D 7		Test Console	-	X	TC/CC	50-100 °F	
Temp., Air Duct Outlet #1 (Lower NW)	20	T5	D 8		Test Console	-	X	TC/CC	50-100 °F	
Temp., Air Duct Outlet #2 (Lower N-Mid)	21	T6	D 9		Test Console	-	X	TC/CC	50-100 °F	
Temp., Air Duct Outlet #3 (Lower N-E)	22	T7	D 10		Test Console	-	X	TC/CC	50-100 °F	
Temp., Air Duct Outlet #4 (Upper NW)	23	T8	D 11		Test Console	-	X	TC/CC	50-100 °F	
Temp., Ambient External GPL	9	T9	D 35		Test Console	-	X	TC/CC	50-100 °F	
Temp., Exp. B1 Ward-Plants	24	T10	D 36		-	-	X	TC/CC	50-100 °F	
Temp., Exp. (R1A) Leon Rats	25	T11	D 37		-	-	X	TC/CC	50-100 °F	
Temp., Exp., P1	26	T12	D 38		-	-	X	TC/CC	50-100 °F	

Temperature, T

CVT/GPL TEST #3 JULY 15-19, 1974

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY			TRANSDUCER		
					M	SC	D	ID	PHYSICAL RANGE	ELECT RANGE
Temp., Exp. (P2)	27	T13	D 39		-	-	X	TC/CC	50-100 °F	
Temp., Exp. (P2) Winget Monkey	28	T14	D 40		-	-	X	TC/CC	50-100 °F	
Temp., Exp. (P4)	29	T15	D 41		-	-	X	TC/CC	50-100 °F	
Temp., Exp. (A1)	30	T16	D 42		-	-	X	TC/CC	50-100 °F	
Temp., Exp.(P4) Bourne Monkey	31	T17	D 43		-	-	X	TC/CC	50-100 °F	
Temp., Exp.(A1) Beljan Chicken	32	T18	D 44		-	-	X	TC/CC	50-100 °F	
Temp., Exp. (R2) Ellis Rats	33	T19	D 45		-	-	X	TC/CC	50-100 °F	

Pressure, P

CVT/GPL TEST #3 JULY 15-19, 1974

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY			TRANSDUCER		
					M	SC	D	ID	PHYSICAL RANGE	ELECT RANGE
Vacuum	3	P1	D 14		Test Console	-	X	Magnev PC GMA-140 SR #11093	10T to 10-3 Torr	1-10V
Pressure, Missile Grade Air	4	P2	D 47		-	-	X	Statham SR #5084 ± 100 psid	0-100 psi	(scaled to 0-5 V)
Pressure, Partial O_2 East GPL (Lower)	6	P4	D 3		Test/ Engrs Console	-	X	Beckman MSFC # 79584	0-250 mm Hg.	0-5V
Pressure, Partial O_2 West GPL (Upper)	15	P5	D 4		Test/ Engrs Console	-	X	Beckman MSFC # 79583	0-250 mm Hg.	0-5V
Pressure, GPL Barometric	7	P6	D 32		-	-	X	Tex. Inst. MSFC #72012 Capsule 5563	0-1000 Torr	0-1V
Pressure, Exp. Barometric (B1)		P8	Mechanical Local S.C. 7 day		-	X	-	Bendix SR #4852 MSFC 22106	28.5 to 31 inch water	
Pressure, Vacuum, Mass Spec. (P1)		P9	Local S.C.		-	X	-	Internal to P1 Exp.	0-10 Torr	
GPL Delta Pressure	16	P15	D 5		Test Console	-	X	Statham SR #2125 ± 5 psid	±1 psid	
NOTE: The following measurement was deleted:										
Pressure, GN_2	5	P3	D 2		Test Console	-	X	Statham SR #5287 ±100 psid	0-100 psi	

Miscellaneous

CVT/GPL TEST #3 JULY 15-19, 1974

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY M	DISPLAY SC	DISPLAY D	TRANSDUCER ID	TRANSDUCER PHYSICAL RANGE	TRANSDUCER ELECT RANGE
Humidity, GPL Upper East End	10	H1	D 12		Engrs Console GPL	-	X	Phys-Chem Rsch Corp MSFC 72962	0-100%RH	0-100 mV
Humidity, GPL Low West End	34	H2	D 13		Engrs Console GPL	-	X	Phys-Chem Rsch. Corp. MSFC 78703	0-100%RH	0-100 mV
Humidity, #1 (and Temp.) Portable		H3			-	Local		Bendix SR #9717 MSFC 22340	0-100%RH	
Humidity, #2 (and Temp.) Portable		H4			-	Local	-	Bendix SR #13504 MSFC 41150	0-100%RH	
Humidity, #3 (and Temp.) Portable		H5			-	Local	-	Bendix SR #10775 MSFC 66758	0-100%RH	
Fire and Smoke GPL Lower E		A1			Light and Bell	-	-	Lafayette	Trip at 130 °F	
Fire and Smoke GPL Lower W		A2			Light and Bell	-	-	Lafayette	Trip at 130 °F	
Fire and Smoke GPL Upper E		A3			Light and Bell	-	-	Lafayette	Trip at 130 °F	
Fire and Smoke GPL Upper W		A4			Light and Bell	-	-	Lafayette	Trip at 130 °F	
Time, Mission Lower GPL		Clock			Local GPL	-	-	-	-	
Radiation Level GPL		R1			-	-	-	-	-	-
Heart Rate Exp. #P1		M1	SC 8 Ch brush Ch 1 and 6		-	X	-	Surface Electrodes on P1	-	

Miscellaneous

CVT/GPL TEST #3 JULY 15-19, 1974

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY			TRANSDUCER		
					M	SC	D	ID	PHYSICAL RANGE	ELECT RANGE
EKG, Exp. P1		M2	SC 8 Ch brush Ch 1 and 6		-	X	-	Surface Electrodes On P1	-	
Mass Spec. Output Exp. P1		M3	Experimenter		-	X	-	Experiment System Output	-	
Voice Comm. Data Rm. to Test Cond. Console		-	-		-	-	-	-	-	
EKG, Exp. P2		M4	Experimenter		-	X	-	Surface Electrodes On P2		
EEG, Exp. P3		M5	Experimenter		-	X	-	Electrodes On P3		
			Experimenter							
Voltage, Mass Spec. Output (P1)		V1	Experimenter		-	X	-	Experiment System Output		3 to 4V
Voltage, Mass Spec. Ion Pump (P1)		V2	Experimenter		-	X	-	Experiment System Output		-10 to -20 mV
Temp., LBNP Air (P1)		T20	Experimenter		-	X	-	Experiment System Output		
Press. LBNP (P1)		P10	Experimenter		-	X	-	Experiment System Output		
Flow, LBNP Air (P1)		F1	Experimenter		-	X	-	Experiment System Output		
Press, Partial LBNP CO_2 (P1)		P11	Experimenter		-	X	-	Experiment System Output		

CVT/GPL TEST #3 JULY 15-19, 1974

Miscellaneous

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY			TRANSDUCER		
					M	SC	D	ID	PHYSICAL RANGE	ELECT RANGE
Press, Partial LBNP O_2 (P1)		P12	Experimenter		-	X	-	Experiment System Output	-	-
Press, LBNP N_2 (P1)		P13	Experimenter		-	X	-	Experiment System Output	-	-
Press., LBNP H_2O Vapor(P1)		P14	Experimenter		-	X	-	Experiment System Output	-	-
Acoustic Level GPL East		S1	CEC Ch 6		Local	-	-	Bruel & Kjaer SR# 186355	80 dB ±10	3V RMS
								MSFC 6171		
Acoustic Level GPL West		S2	CEC Ch 8		Local	-	-	Bruel & Kjaer SR#137805 MSFC 44931	80 dB ±10	3V RMS
Voice and Time on Tape		S3	CEC Ch 10		-	-	-	Mike and Amp	-	-
Event #4 Exhaust Fan On		E4	-		-	-	-	Local Elapsed Time Meter	-	-
Event #5 Traffic West Door		E5	Event counter at console near NW door of GPL							
Event #6 Traffic North Door		E6	Event counter at console near NW door of GPL							

Bioclean Room

CVT/GPL TEST #3 JULY 15-19, 1974

MEASUREMENT NAME	DATA SYS ID #	MEA #	DATA SYSTEM & CHAN	DATA SYSTEM PATCHING	DISPLAY			TRANSDUCER		
					M	SC	D	ID	PHYSICAL RANGE	ELECT RANGE
Barometric Press. Bioclean Room		P16	Local S. C. 7 Day Mechanical		-	X	-	Bendix SR#251 MSFC 10488	28.5 to 31 inch water	
Temperature Bioclean Room		T21	Local S. C. 7 Day Mechanical		-	X	-	Bendix SR# MSFC	-	
Relative Humidity % Bioclean Room		H7	Local S. C. 7 Day Mechanical		-	X	-	Bendix SR# MSFC	0-100%RH	
*NOTE: Remote printer for data display installed 7/16/74 at NW door of GPL.										

APPENDIX C

GPL/LIFE SCIENCES EQUIPMENT INTEGRATION REQUIREMENTS

PRECEDING PAGE BLANK NOT FILMED

A list of GPL/Life Sciences equipment integration requirements and interfaces is provided below. Prior to the initiation of Phase III testing, a number of the originally planned measurements were deleted from this list. Measurements were deleted for such reasons as changes in requirements, minimal power consumption, and the non-availability of certain instrumentation. Measurements which were deleted included power for candidate experiments A1, H2, P4, R1, and R2, barometric pressure for experiment P1,[3] external ambient humidity, and event measurements for the use of GN_2 and air.

GENERAL PURPOSE LABORATORY (GPL)

REQUIREMENTS	INTERFACES
	Support Facilities
Vent	3 systems
Hot H_2O	1.27-cm (0.5-in.) line, 6 outlets
Cold H_2O	1.27-cm (0.5-in.) line, 6 outlets
Drain	2.54-cm (1-in.) line, 3 outlets
Air	0.635-cm (0.25-in.) line, 6 outlets
GN_2	0.635-cm (0.25-in.) line, 6 outlets
Vacuum	2 systems, high-low
Power	110 Vac: 7 circuits, reg.
	Data and Instrumentation
	T5, T6, T7, T8, air duct temperatures T9, ambient external GPL P10, delta pressure GPL
Power	W1, GPL W2, air conditioning and heating (continuous recording)
Vacuum	P1, at facility panel engineer console (meter)
Barometric Pressure	P6, readout in GPL
Temperature	Digital readouts of thermocouples T1, upper GPL T2, lower GPL T3, lower GPL, hot H_2O T4, lower GPL, cold H_2O

3. See text for Experiment Descriptions, P1, P2, etc.

GENERAL PURPOSE LABORATORY (GPL) (Continued)

REQUIREMENTS	INTERFACES
	Data and Instrumentation (Continued)
Humidity	H1, lower GPL, west end H2, lower GPL, east end
Pressure	P2, missile grade air at facility panel P3, GN_2 P4, partial, east GPL P5, partial, west GPL
Miscellaneous	S1, acoustic level, east GPL S2, acoustic level, west GPL (both recorded on tape) E1, sink H_2O "on" E4, exhaust fan "on" E5, traffic, west GPL door E6, traffic, north GPL door Time, mission clock
	Safety
	Procedural approval for all experiments
Fire and Smoke	A1, lower GPL, east (local) A2, lower GPL, west (local) A3, upper GPL, east (T.C. and local) A4, upper GPL, west (T.C. and local)
Partial Pressure O_2	Test conductor console readout of sensors at each end of GPL
Temperature	All GPL power including experiments
Radiation Level	R1, GPL

GENERAL PURPOSE LABORATORY (GPL) (Concluded)

REQUIREMENTS	INTERFACES
Communications	
Intercom	Lower GPL intercoms as a backup system
RF system	Wireless microphone and transmitter worn by all payload specialists
Video	Five TV cameras covering work areas
Mission Manager Console	
	Video and audio instrumentation
Test Conductor Console	
	Instrumentation readout of facilities. Video and audio monitoring
Photographic Equipment	
Still camera	Experiment documentation
Still camera lens	Experiment documentation
Film, still (35 mm)	Experiment documentation

LIFE SCIENCES EQUIPMENT

REQUIREMENTS	INTERFACES
GPL Work Bench	
Support Facilities	
Mount	Bolt roller support to the ceiling of the GPL.
Vent	5.08-cm (2-in.) flex line, 2 each into 10.16-cm (4-in.) line to outside GPL (120 cfm)

REQUIREMENTS	INTERFACES
GPL Work Bench	
Support Facilities (Continued)	
Hot H_2O	1.9-cm (0.75-in.) tygon and 1.27-cm (0.50-in.) tygon
Cold H_2O	1.9-cm (0.75-in.) tygon and 1.27-cm (0.50-in.) tygon
Drain	1.27-cm (0.50-in.) tygon (gravity flow)
Air	1.27-cm (0.50-in.) tygon (less than 13.8 N/cm^2 (20 psi))
Vacuum	1.27-cm (0.50-in.) tygon (small flow)
Power	110 Vac (single plug, 15 amp)
Safety	
Radiation Level	RSO approval of all radiation levels in animals as safe to work with and waste disposal as nonradiation critical
Candidate Experiment A1	
Support Facilities	
Mount	Set on cable tray
Vent	6.35-cm (2.5-in.) flex line into manifold (15 cfm)
Power	110 Vac
Data and Instrumentation	
Temperature	T16, digital local readout

REQUIREMENTS	INTERFACES
Candidate Experiment A1 (Continued)	
Safety	
Radiation Level	RSO approval of all radiation levels in animals as safe to work with and waste disposal as nonradiation critical
GFE	
Freezer	Provided by MSFC
Candidate Experiment B1	
Support Facilities	
Mount	Set on counter
Vent	Two 6.25-cm (2.5-in.) flex lines per module into manifold (15 cfm)
Power	110 Vac: 6 plugs (20 amp total) lighting into timer 12 hrs "on" and 12 hrs "off"
Cool Air	6.25-cm (2.5-in.) flex line, two each from A/C ducts
Data and Instrumentation	
Power	W13, digital unit at experiment
Temperature	T19, digital local readout
Safety	
Radiation	RSO approval of all radiation levels in animals as safe to work with and waste disposal as nonradiation critical

REQUIREMENTS	INTERFACES
	Candidate Experiment B1 (Continued)
	GFE
Bottled Gas	100 percent N_2 (provided by MSFC) N_2 with 17 percent O_2 Compressed air with 570 ppm CO_2 (2)
Freezer	Provided by MSFC
Brush Recorder	Provided by MSFC (2)
N_2	LN_2 (provided by MSFC) LN_2 Dewar (provided by ARC)
MGA	CO_2 analyzer, high sensitivity (260-570 ppm)
	Candidate Experiment H1
	Support Facilities
Power	110 Vac: Single Plug (10 amp)
	Data and Instrumentation
Power	W11, digital unit at experiment
Temperature	T17, digital local readout
	GFE
Film (Polaroid)	Black and white, No. 107 (provided by MSFC)
	Candidate Experiment H2
	Support Facilities
Power	110 Vac: 4 plug (20 amp)

REQUIREMENTS	INTERFACES
Candidate Experiment H2 (Continued)	
Data and Instrumentation	
Temperature	T18, digital local readout
Candidate Experiment P1	
Support Facilities	
Mount	Set on counter
Vacuum	0.635-cm (0.25-in.) flex line (5 psi)
Power	110 Vac: Single plug (30 amp)
Data and Instrumentation	
Power	W6, digital unit at experiment
Vacuum	P9, mass spec. pressure (local measurements)
Temperature	T12, digital local readout
Humidity	H5, clock driven chart
Pressure	P11, partial LBNP CO_2 P12, partial LBNP O_2 P13, partial LBNP N_2 P14, partial LBNP H_2O vapor
Miscellaneous	T20, LBNP air temperature (local recorder) P10, LBNP pressure (local recorder) V1, mass spec. output voltage V2, mass spec. ion pump voltage (V1 and V2 to local recorders) M1, heart rate (local readout and recorder) M2, EKG (local) M3, mass spec. output F1, LBNP flow rate (local recorder)

LIFE SCIENCES EQUIPMENT (Continued)

REQUIREMENTS	INTERFACES
	Candidate Experiment P2
	Support Facilities
Vent	6.25-cm (2.5-in.) flex line to manifold (15 cfm)
Power	110 Vac: Single plug (5 amps)
	Data and Instrumentation
Power	W7, digital unit at experiment
Temperature	T13, digital local readout
Miscellaneous	M4, EKG (local and tape)
	GFE
Freezer	Provided by MSFC
	Candidate Experiment P3
	Support Facilities
Vent	6.25-cm (2.5-in.) flex line to manifold (15 cfm)
Power	110 Vac: 4 plugs (20 amp)
	Data and Instrumentation
Power	W8, digital unit at experiment
Temperature	T14, digital local readout
	GFE
Freezer	Provided by MSFC

LIFE SCIENCES EQUIPMENT (Continued)

REQUIREMENTS	INTERFACES
	Candidate Experiment P4
	Support Facilities
Vent	10.16-cm (4-in.) flex line to manifold (15 cfm)
Cold H_2O	1.27-cm (0.50-in.) tygon, 3.81-cm (1.5-in.) flex line
	Data and Instrumentation
Temperature	T15, digital local readout
	GFE
Freezer	Provided by MSFC
Microscope	Jointly provided by MSFC and ARC
	Candidate Experiment R1
	Support Facilities
Mount	Set on counter
Vent	6.35-cm (2.5-in.) flex line, 2 each into manifold (15 cfm)
Air	0.635-cm (0.25-in.) tygon (2 psig)
Vacuum	0.635-cm (0.25-in.) tygon (small flow)
	Data and Instrumentation
Temperature	T10, digital local readout
Humidity	H3, clock driven chart

REQUIREMENTS	INTERFACES
	Candidate Experiment R1 (Continued)
	Safety
Radiation Level	RSO approval of all radiation levels in animals as safe to work with and waste disposal as nonradiation critical.
	GFE
Bottled Gas	Compressed breathing air (5 bottles, MSFC)
	Candidate Experiment R2
	Support Facilities
Mount	Set on counter
Vent	6.35-cm (2.5-in.) flex line, 2 each into manifold (15 cfm)
	Data and Instrumentation
Temperature	T11, digital local readout
Humidity	H4, clock driven chart
	Safety
Radiation Level	RSO approval of all radiation levels in animals as safe to work with and waste disposal as nonradiation critical
	GFE
Freezer	Provided by MSFC
Refrigerator	Provided by MSFC
MGA	Balances provided by MSFC

REQUIREMENTS	INTERFACES
	Animal Holding Facility
	Data and Instrumentation
Barometric Pressure	P16
Temperature	T20, 7-day clock
Humidity	H7, 7-day clock
	Safety
Emergency Power	
	Equipment
	Two 35 gallon garbage cans Two waste disposal cans (one for radioactive matter) One bench, 30.48 cm by 121.9 cm (12 in. by 48 in.)

APPENDIX D

PRETEST CHECKOUT PROCEDURES FOR VERIFICATION OF GPL/EXPERIMENT INTERFACES

The procedures for pretest checkout and verification of the GPL/ candidate experiment system interfaces are given below.

Candidate Experiment A1

1. Verify that the cage module is properly connected to the following:

   a. Two 6.35-cm (2.5-in.) vent lines

   b. Instrumentation (sensor T16)

2. Insert a velocity flow meter into the vent lines and record the flow velocity.

3. Check measurement of sensor T16 on data channel ID30.

Candidate Experiment B1

1. Verify that the cage module is properly connected to the following:

   a. Two 6.35-cm (2.5-in.) vent lines per module

   b. 110 Vac power

   c. A timer

   d. Two 6.35-cm (2.5-in.) cool air lines from the air conditioning duct

   e. Instrumentation (sensors W13 and T19 utilized data channels ID14 and ID33).

   f. Four gas cylinders.

2. Insert a velocity flow meter into the vent lines and record the flow velocity.

3. Turn experiment light switch to one position and verify that all lights are operating, and that temperature and power measurements are recorded and also displayed at the test conductor and mission manager console.

4. Check the airflow from the air conditioning duct through the cage module. Utilize engineering judgment to determine if air flow is adequately removing heat from the experiment.

5. Turn on each of the four gas bottles and verify each flow by purging the lines to the experiment.

Candidate Experiment H1

1. Verify that experiment is properly connected to the following:

a. 110 Vac power

b. Instrumentation (sensors W11 and T17 utilized data channels ID2 and ID31).

2. Turn experiment power switch to the "on" position, verify that experiment components are functioning properly and that temperature and power measurements are being recorded.

Candidate Experiment H2

1. Verify that equipment is connected to the following:

a. 110 Vac power

b. Instrumentation (sensor T18 utilized data channel ID32)

2. Turn the experiment power switch to the "on" position, verify that the hardware components are functioning properly and that temperature measurements are being recorded.

Candidate Experiment P1

1. Verify that experiment P1 is connected to the following:

a. 0.635-cm (0.25-in.) flex line to vacuum system (5 psi)

b. 110 Vac power

c. Instrumentation (sensors W6, T12 and P9 utilized data channels ID1 and ID26)

d. Four gas bottles

2. Open the vacuum system valve and verify the flow at the cage module end of the line.

3. Turn the power switch to the "on" position, verify that the hardware operates, and that temperature and power measurements are recorded and also displayed at the test conductor and mission manager console.

4. Turn on each of the four gas bottles and verify each flow by purging the lines to the experiment.

Candidate Experiment P2

1. Verify that the experiment is properly connected to the following:

a. Two 6.35-cm (2.5-in.) flex lines

b. 110 Vac power

c. Instrumentation (sensors W7 and T13 utilized data channels ID12 and ID27)

2. Insert a velocity flow meter into the vent line and record the flow velocity.

3. Turn the power switch to the "on" position, verify that the hardware components are working properly and that temperature and power measurements are being recorded.

Candidate Experiment P3

1. Verify that the experiment is properly connected to the following:

a. Two 6.35-cm (2.5-in.) flex lines

b. 110 Vac power (4 plugs @ 20 amp)

c. Instrumentation (sensors W8 and T14 utilized data channels ID13 and ID28)

2. Insert a velocity flow meter into the vent line and record the flow velocity.

3. Turn the power switch to the "on" position, verify that the equipment components are operating properly and that temperature and power measurements are being recorded.

Candidate Experiment P4

1. Verify that the experiment is properly connected to the following:

   a. 10.16-cm (4-in.) vent line

   b. 1.27-cm (0.5-in.) cold water line

   c. Instrumentation (sensors W9 and T13 utilized data channel ID29)

2. Insert a velocity flow meter into the vent line and record the velocity.

3. Open the cold water line valve and utilize engineering judgment to determine if the flow is adequate.

4. Verify that temperature measurements are being recorded.

Candidate Experiment R1

1. Verify that the hardware is properly connected to the following:

   a. Two 6.35-cm (2.5-in.) vent lines

   b. One 0.635-cm (0.25-in.) air line

   c. One 0.635-cm (0.25-in.) vacuum line

   d. Instrumentation (sensor T10 utilized data channel ID24)

   e. Breathing air (none hooked up yet)

2. Insert a velocity flow meter into the vent lines and record the flow velocity.

3. Set the air regulator supplying air to the equipment and verify the air flow at the outlet position (prior to completion of plumbing into the experiment cage).

4. Open the vacuum valve and verify that the system can meet the small flow requirement. Utilize engineering judgment to determine the system' s capability to meet this requirement.

5. Verify that the temperature measurements are being properly recorded.

6. Verify breathing air to R1 experiment provided regulator (not available).

Candidate Experiment R2

1. Verify that the cage module is connected to the following:

   a. One 10.16-cm (4-in.) flex line

   b. Instrumentation (sensor T11 and recorder ID25)

2. Insert a velocity flow meter into the vent lines and record the flow velocity.

3. Verify that temperature measurements are being recorded.

Hooded Work Bench/Surgical Table

1. Verify that the work bench is properly connected to the following:

   a. Two 5.08-cm (2-in.) vent lines

   b. Hot water, 1.9-cm (0.75-in.) tygon and 1.27-cm (0.5-in.) tygon (from same line)

   c. Cold water, 1.9-cm (0.75-in.) tygon and 1.27-cm (0.5-in.) tygon (from same line)

   d. One 1.27-cm (0.5-in.) drain

   e. One 1.27-cm (0.5-in.) air line

   f. One 1.27-cm (0.5-in.) vacuum line

   g. 110 Vac power

2. Insert a velocity flow meter into the vent line and record the flow velocity.

3. Turn on the 1.9-cm (0.75-in.) and 1.27-cm (10.5-in.) hot water valves and verify that each flows.

4. Repeat step 3 for cold water.

5. During steps 3 and 4,verify that the drain flows freely and does not leak.

6. Set the air regulator on the work bench panel at 11.7 N/cm^2 (17 psig) and verify that the system will hold pressure between 10.3 and 13.8 N/cm^2 (15 and 20 psig) while flowing.

7. Open the valves on the vacuum system and observe the flow through the 1.27-cm (0.5-in.) line. Utilize engineering judgment to determine if the small flow requirement is met.

8. Cycle the 110 Vac power switches "on" and "off" and verify that proper control is being exercised and that the work bench components are functioning properly. Mission Manager:

a. Hood fan No. 1 - operational

b. Hood fan No. 2 - operational

c. Lamps, incandescent

d. Lamps, florescent

APPENDIX E

PROBLEM LOG FOR CVT/GPL TEST III LIFE SCIENCE

PRECEDING PAGE BLANK NOT FILMED

PROBLEM LOG FOR CVT/GPL TEST III LIFE SCIENCE

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
			GENERAL
1		TEST P1	Gas bottles that MSFC supplied for Test III Life Science were not used during test because regulators which AMES supplied would not fit gas bottles.
		GEN	Problem with communication system, linking GPL to Test Conductors (TC). Console was inoperative during portion of the first day of testing. This was an RF system; the problem was resolved and no further problems were encountered with this system during the remaining days of test.
			Problems with 35 mm hand hold camera due to lens jamming, which was cleared and photo coverage was adequate throughout the test.
2		TEST	(Human) H, 1 Haplosope had a minor problem, this was corrected by making the necessary repair.
3		GEN	Problem with readout on temperatures were incorrect due to thermacouple calibration. Calibration and thermacouples relocated within GPL and Cage Modules.
		GEN	Due to excessive buildup in the TV recording room, TV No. 1 and No. 4 went out. This happened the first and second day. This was repaired by improving the air condition in this area.
		GEN	Sign on hot water line mismarked, which read do not operate. Sign was removed and this part was operational.
		GEN	Cold water leak on tygon tubing was repaired by PI, using a small piece of wire to wrap around tubing; stopping leak.
			Code for TV camera was needed of camera location identification for visitors and T.C., to better determine which scenes were being viewed.

PROBLEM LOG FOR CVT/GPL TEST III LIFE SCIENCE

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
			Found that a telephone, along with a paging system, is needed in TC area. This will expedite the time required in locating persons when needed.
			It was found that a copy of the operating, procedures (as was used during test) would have been most useful to the TC, as well as other people which were involved.
4		TEST R1&R2	Loss of air pressure presented a problem for the rats to get water, resulted in some dehydration. This problem was solved after it was found that the facility regulator failed. It was replaced.
5		GEN	It was observed that the PI needed a separate console or a space where they could communicate with the Payload Specialist.
			Data control room personnel did not monitor their consoles continuously. This problem was corrected by installing a public address system in their area.
			Correlation of time relative to TV and audio recording was needed.
			The traffic (People) moving in and out of the GPL was not controlled. This was never corrected. For future tests, this can be corrected by coordinating outside activities with the TC and Payload Specialist.
		GEN	Lighting was a problem, not for running the experiments, but for TV and photo coverage. Fluorescent lights are not sufficient. A dimmer system with incandescent lamps is needed.
			Location of TV cameras should be given careful consideration; this allows better coverage.
			Several time clocks were needed in TC area, because of necessary calls to be made to on-board PI's.

PROBLEM LOG FOR CVT/GPL TEST III LIFE SCIENCE

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
			MSFC personnel was informed that 31½ liters of H_2O were used in running the Life Science Test at AMES.
6		TEST A1	Chicken Probe fell out, reinstalled by Dick using Surgical Work Bench.
			Bioclean Room – Chickens should not be in close proximity of monkeys.
7		GEN	Humidity return duct was taking in too much air. (readjust – O.K)
			MONDAY
	0852	GEN	Need individual to run problems (man assigned to T.C. for this function). Not enough, two runners probably required.
8	0925	TEST P2	Electrical problem. This problem was expected and can live with it.
9	0946	TEST B1	Stuck bleed valve on Plant experiment.
10	0948	TEST B1	Stuck bleed valve repaired.
	0951	TEST B1	Beckman C_{02} analyzer and recorder had strange shift in operation point.
	0959	"	Reset on Analyzer.
	1025	"	Item 26, Beckman CO_2 Analyzer Battery needs to be recharged, system drifting. Battery recharged during break.
	1028	TEST B1	Gasket on the plant module failed, crew will try to repair.
	1030	"	Gasket replaced.

PROBLEM LOG FOR CVT/GPL TEST III LIFE SCIENCE

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
11	0930	TEST P4	Blood was drawn; slides were made for blood count.
	1031	"	Blood count completed.
12	1037	TEST B1	Recorder and light started on light dark box.
	1137	"	Call was made to Paul (T2) to check light and record light cycle.
	1039	"	Time lapse camera been deleted from test position.
13	1042	TEST H1	Cardiovascular test started.
	1117	TEST H1	Cardiovascular test completed.
14	1051	TEST B1	Tracer injected into plants. Dilution of tracer to 0.6 was accomplished with H_2O.
	1056	"	Radio activity injection completed.
	1058	TEST	Radio active chemical injected into chamber.
15	1114	TEST R1	Rat's feeding dish broken.
	1115	"	Rat's feeding dish replaced.
16	1310	TEST H2	Visual acuity test started.
	1200	TEST H2	Begin test.
	1340	"	Test completed.
17	1350	TEST B1	Door removed from plant holding system to lower humidity in plant system.

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
18	1456	TEST A1	Checking electrode in the chicken.
19	1500	TEST R1	Test started
	1535	TEST R1	Test conclusion: R_1, B_1 complete, R_2 to be completed in 10 minutes.
			TUESDAY
19		GEN	AMES comment: Communications between pallet and GPL (inside) needs better system. People on pallet (due to background noise) needs head set that covers both ears. This needs to be evaluated for further tests.
20	0825	TEST B1	Calibration started.
	0856	"	Completed calibration.
21	0947	TEST H2	Ultrasonic Probe Test starting (Cardiac).
	1050	"	Ultrasonic (cardiac) Test completed.
22	0954	GEN	Plant light cycle test commenced. Needs call at 1054.
23	1006	TEST B1	Plant radioactivity started.
	1105	"	Radioactivity completed.
	1014	TEST B1	Camera was rewound (mysteriously). Problem: didn't function overnight as it should have.
	1015	"	Cardboard box 6" by 6" by 8" (15.2 cm by 15.2 cm by 20.3 cm) requested.
	1017	"	Request granted.

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
24	1101	TEST P4	Cleaned and fed.
25	1120	TEST P2	Afternoon (broken electrode EKG).
26	1201		Lunch Break
27	1311	TEST H1	Visual Activity began.
	1420	"	Visual activity completed.
28	1436	TEST P1	Pace experiment started (P-1).
			WEDNESDAY
29	0837		Test started.
30	0839	TEST B1	Camera functioned properly overnight on plant experiment.
31	0834	TEST P1	Began test.
32	0842	TEST P4	Was injected with drug to put him to sleep.
	0849	TEST P4	Removed from cage, blood samples taken.
	0850	TEST P4	Water system on monkey cage malfunctioned, valve inadvertently turned off. Opened and system O.K. Valve needs to be marked "open". T.C. will take the action to accomplish.
33	0900	TEST P1 P3	Time to clean monkey cages. P-1 and P-3 cleaned.
34		TEST P4	Returned to cage module.

PROBLEM LOG FOR CVT/GPL TEST III LIFE SCIENCE

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
35	0903	TEST B1	Calibration of plant experiment complete and the chamber bleed has been started.
36	0905	TEST P1	Recommencing.
37	0908	GEN	Fecal sample placed into freezer.
38	0909	TEST A1	Photomultiplier count underway.
39	0910	TEST P1	1000 ml of H_2O given.
40	0910	TEST B1	09:10:20 Plant light experiment commenced. Need call of 10:10:20 and 11:10:20.
41	0916	TEST B1	Plant radioactivity experiment started.
42	0918	TEST A1	Photomultiplier count completed.
43	0920	TEST B1	Injection complete on plant (messy) had to try second location.
	0923	TEST B1	Radioactivity solution being prepared for plant experiment.
44	0924	TEST P4	Blood stains being prepared.
45	0937	TEST B1	Flow Rate change on plant from 9 to 14 cfm (0.25 to 0.40 m^3/min).
46	0939	TEST P4	Blood count now being taken by microscope.
	1004	"	Completed Blood Count.
47	0940	TEST A2	Flow rate being returned to 9 cfm (0.25 m^3/min).

ITEM NO.	TIME	TYPP	PROBLEM DESCRIPTION
48	0949	TEST B1	Paper change in recorder required.
	0957	TEST B1	Test halted to change paper in recorder.
49	1002	TEST R1	Rats transferred for cleaning cages. Hemoglobin has been collected.
	1021	TEST R1	Completed cleaning of cages.
50	1025	TEST B1	Radioactivity collection on plant completed.
51	1035	GEN	Safety demonstration: T_2 poured LN_2 over hand to demonstrate it does not burn, due to rapid evaporation.
52	1045	GEN	Charcoal filter changed out. Reason: odors present.
53	1102	TEST H1	Test initiated.
54	1120	TEST H1	Completed.
55	1201		Lunch Break.
56	1305	TEST H2	Experiment initiated.
	1307	TEST H2	Request by Dick (test subject) to rest eyes for 5 to 10 min. prior to test. Decision for him to rest his eyes was granted. One purpose of test is to determine when such needs exist, i.e., to measure fatigue. Based on results of test no fatigue is apparent at this time.
57	1311	GEN	Requested Temp. Check for various points. (Ken)
	1312		This request was complied with by T.C.

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
58	1315	TEST H1	Completed Vision Test (Dick)
59	1324	GEN	Temp Check began, initiated by T.C.
	1325	GEN	Temp. check completed (GPL)
	1326	GEN	No. 6 Reading on trash bag weights gives 516.5 oz. (14.6 kg) total weight.
60	1328	TEST H1	Vision Test completed on KS.
61	1329	TEST H1	Paul remarked that it appears to have a definite hazing over the eyepiece.
	1340	TEST H1	Paul is about 3 inches (7.6 cm) from eyepiece. (This invalidates test. Instructions was given to rerun test at rest distance.) This information was given by P1 from GPL control room.
62	1300	TEST P3	Experiment finished 1:00 test.
	1300	TEST P3	Test began.
	1344	TEST P3	Completed.
63	1344	TEST H1	Paul repeating B5 with eye at eyepiece.
	1346	TEST H1	Human vision test completed by T3.
64	1352	TEST R2	Paul began test.
65	1445	GEN	Test partially interrupted for Public Affairs Office photo coverage (agreed to by P.I.'s and M.S. and not T.C.).

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
	1520	GEN	Humidity indicator in upper level is now reading 92 percent (too high), lower GPL OK at approximately 48 percent.
66	1600	TEST R2	Test Concluded.
67	1615	GEN	All tests concluded for this period.
			THURSDAY
68	0832	TEST B1	Plant experiment powered up.
	0833	TEST B1	Begin.
69	0835	GEN	Water turned on — no leak in GPL.
70	0900	TEST R1	Rats being transferred to clean respiratory chambers. Rats transferred at 0915.
	0915	TEST R1&2	Completed transfer.
71	0918	TEST B1	Plant prepared and placed in box; now preparing to bleed the chamber.
72	0921	TEST R1	Hemoglobin Experiment completed.
73	0936	TEST P4	Continuing test.
74	0947	TEST B1	Bleeding for morning.
	0948	TEST B1	Radioactivity test begun.
75	1037	GEN	Camera is capped, because Photolab is taking movies.

PROBLEM LOG FOR CVT/GPL TEST III LIFE SCIENCE

ITEM NO.	TIME	TYPE	PROBLEM DESCRIPTION
	1100	GEN	False alarm on Fire Sensor.
	1103	GEN	WAAY visited the GPL, asked to depart. REASON: No prior communications and radioactive materials were out.
76	1129	TEST B1	Plant test completed.
77	1300	TEST B1	Tests resumed.
78	1317	TEST H2	Subject Dick is now commencing.
79	1349	TEST R1& R2	Test initiated, animals anaesthetized, blood drawn by cardiac puncture, decapitated and dissected from various tissues and organisms, which were weighed and then frozen. Posterial = 0.066 mg Anterial = 6.135 mg
80	1405	TEST H2	Completed optical test.
81	1445	TEST P1	Test now commencing.
	1450	TEST P1	LBNP Test starting.
82	1458	TEST A1	Blood count on Chicken starting (Radioactivity).
			FRIDAY
83	0820	GEN	Animals and cages are being transferred out of GPL. They are being checked by Safety for radiation level prior to being shipped. All animals are removed 0930.

APPENDIX F

EXPERIMENT OPERATING PROCEDURES

ARC BIORESEARCH LAB BREADBOARD TEST II FOR CVT
MEDICAL CANDIDATE EXPERIMENTS

NO.	INVESTIGATOR INSTITUTION (ARC TECH. MONITOR/BR	CANDIDATE EXPERIMENT TITLE	ORGANISM	MEASUREMENTS
1 (H1)	H. Sandler, M.D./ARC-LR R. Lee, E.E./ARC-RFD	Human Cardiac Dimensions	Crew	Once Daily: Cardiac output/cardiac dimensions
2* (H2)	L. Loper, Ph.D./JSC R. Haines, Ph.D./ARC T. Decker, Ph.D./Baylor U	Human Visual Function	Crew	Once Daily: Visual acuity, binocular stereoscopic acuity, accommodation, fusional reserves
	*JSC Proposal			

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Drs. Sandler and Lee — Organism: Man — Date: 4-4-74
Test Title: Human Cardiac Dimensions (H1)

Day	Elapsed Time (Min.) Per Step	Elapsed Time (Min.) Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			<u>Pre-Test Instrument Calibration</u>[1]	
			Remove AC power cord and set switch on back to internal battery[2]. (Switch should be at middle position)	
			Turn display switch to A	
			Turn all controls to the far counterclockwise position	
			Turn the near gain 1/4 clockwise (CW)	
			Turn intensity to 1/2 CW position	
			All pushbutton switches in outward position	
			Gate 1 Controls: Depth (white) 1/8 CW Width (green) 1/2 CW	
			Gate 2 Controls: Depth (white) 1/4 CW Width (green) 1/2 CW	
			EKG Controls: Gain (white) 1/2 CW Position - 1/4 CW	
			Depth Display Controls: White knob to lb Vernier (green) to 1/2 CW	
			Focus to 1/2 CW	
			Vertical position to 1/2 CW	
			Horizontal position to 1/2 CW	
			Connect ultrasonic transducer to front panel transducer input	
			Allow 3-5 minutes warm-up time.	
			[1] Proper instrument calibration will require about one hour and will be accomplished prior to the initiation of testing. Once calibrated, adjustments may be required from time to time during testing. The time required for adjustments is minimal, no more than 1 or 2 minutes.	
			[2] Exceedingly important. Machine should never be operated on external power. Also, but sure that battery is recharged between uses by replacing AC power cord after returning switch to external power position and setting power switch to "OFF".	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Drs. Sandler and Lee | Organism: Man | Date: 4-4-74
Test Title: Human Cardiac Dimensions (H1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			Adjust intensity and focus for sharp and just visible base line trace. Push in marker button to display metric scale so that the zero is at the left edge of scope. Adjust vertical position so that 5 cm marker spikes just touch the bottom edge of scope. Release marker pushbutton and proceed to calibration check. Set coarse depth display (white) to 16 cm, push IN marker pushbutton to display depth marker. Adjust Vernier (green) control until 18 cm mark is at right edge of scope. Set EKG gain to 1/2 CW position, push IN EKG pushbutton and notice bright gliche in deplay base line; adjust position to 15 cm marker. Attach camera by sliding the camera down the grooves located on each side of the scope. BE SURE TO APPLY PRESSURE AT BACK OF THE CAMERA (Writing should face you) Tighten screw at bottom of camera Set film speed to that of film DO NOT TOUCH LENS ADJUSTMENT (Should be on black dot)	
	60	60	<u>Initiation of Test</u>	
			The subject is on the operators left with the subject's left side nearest the instruments. Apply ultrasonic transmission gel (Aquasonic 100) to transducer. Place transducer over third or fourth INTERSPACE rib opening. Increase coarse gain (CW) until near position signal echoes peaks are off the scope face at top. Push Depth comp pushbutton in. Push Display pushbutton in. Rotate near gain until a base line ramp appears. Adjust depth compensator, rate, and near gain until near signal echoes are the same amplitude as the far echoes. Increase coarse gain until signal echoes ampliture are near the top edge of scope.	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Drs. Sandler and Lee Organism: Man Date: 4-4-74
Test Title: Human Cardiac Dimensions (H1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			Release depth comp display button and push in marker button While viewing through camera hood, adjust focus and intensity to sharpen trace display. Push EKG pushbutton to activate EKG Adjust EKG position, gain, and/or vernier depth display for display of EKG on right side of scope or centered between left ventricle wall signal	
			Rotate Display Switch to B-Sweep Observe B-sweep through camera hood, blocking off all light to scope face. Adjust Intensity and Focus for sharp image.	
			Turn camera control to TIME Cock shutter by pulling toward operator When image completes sweep, depress camera shutter button (on camera right side) DO NOT REMOVE EYES FROM CAMERA HOOD Upon completion of sweep, depress shutter button again to close shutter Remove film and wait 15 seconds for development.	
	15 (per subject)	75	Repeat above sequence for additional pictures.	
			Upon completion, Turn camera control from TIME to OFF. EKG OFF Remove camera Power Switch OFF Switch (on back of ultrasonoscope) to external power	
	3	78	Replace AC power cord	
			Repeat Day 1 Procedures as applicable (e.g. 5 days)	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Dr. T. Decker & R. Haines   Organism: Man   Date: 3-18-74
Test Title: Human Visual Function (H2)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
	1	1	1. Initial setup: turn power on, set teletype, adjust luminance, and zero each target.	(Note: All of the following operations require the use of the self-contained "Haple-scope" Vision Testing Unit supplied by Baylor College of Medicine, Dept. of Ophthalmology, develope under NASA grant NGR 44-003-057.)
	2	3	2. Positioning of subject: measure interpupillary distance, adjust optical separations for subject's interpupillary distance, properly align subject vertically, laterally and proximally to the haploscope.	
	6	9	3. Instruct subject and perform test of distance monocular visual acuity. Repeat procedures for fellow eye. Stimulus sequence is subject-controlled.	
	1	10	4. Instruct subject and perform distance suppression test. Record responses on teletype.	
	1	11	5. Instruct subject and perform distance lateral fixation disparity test. Make teletype entry of response.	
	1	12	6. Instruct subject and perform distance lateral heterophoria test. Make teletype entry of response.	
	1	13	7. Instruct subject and perform distance vertical heterophoria test. Make teletype entry of response.	
	2	15	8. Positive and Negative Vergences at distance: subject controls extend of change in stimulus to endpoints of "blur" and "break" responses. Make teletype entry of responses.	
	8	23 (per subject)	9. Positive disparity distance stereopsis: subject controls stimulus sequence.	
			Note: The above Steps 1 - 9, will be performed on each of three subjects daily.	

ARC BIORESEARCH LAB BREADBOARD TEST II FOR CVT

PRIMATE CANDIDATE EXPERIMENT

NO.	INVESTIGATOR INSTITUTION (ARC TECH. MONITOR/BR	CANDIDATE EXPERIMENT TITLE	ORGANISM	MEASUREMENTS
1 (P1)	Nello Pace, Ph. D. U. C. Berkeley (B. D. Newsom, Ph. D. /LR	Metabolic and cardio-vascular studies in monkeys	N. nemestrina (pigtailed monkey)	Once Daily: Automated water/food intake, respiratory gases (O_2, CO_2, N_2)/water vapor; excrement collection/preservation Once in 2 Days: Hr/BP responses (telemetered) to LBNP
2 (P2)	C. M. Winget, Ph. D. ARC/LRH	Photoperiod effects on CNS and Physiological biorhythms of monkeys	C. albifrons (cebus monkey)	Once per 6 min: Telemetered ECG EEG, body temperature and activity signals. Once Daily: Feeding, watering and excrement collection/preservation.
3 (P3)	C. M. Winget, Ph. D. & J. Vernikos-Danellis, PhD ARC/LRH	Physiologic cost of repeated monkey Shuttle sorties	C. albifrons (cebus monkey)	Once per hr: Telemetered ECG and body temperature Once Daily: Food/water intake and excrement collection preservation.
4 (P4)	G. H. Bourne, M. D. Emory U. (D. Winter, M. D. / C. Winget, Ph. D.)	Histopathology and histochemistry of Rhesus monkeys	M. mulatta (Rhesus monkey)	Continuously: Automated watering, feeding and waste management Once Daily: Telemetered ECG Once Weekly: Manual blood withdrawal; preservation

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: N. Pace, D. F. Rahlmann, A. M. Kodama, R. C. Mains and B. W. Grunbaum
Organism: (1) Pig-tailed Monkey (Macaca nemistrina)(8-14 kg body weight)
Date: 3-22-74
Test Title: Metabolic and Cardiovascular Studies in Monkeys (P1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1			<u>Pre-Test Equipment Installation and Checkout</u>	
			Pod Preparation Prior to Monkey Insertion.	All pod parts
			Check cleanliness of lower and upper pod sections. Feeder secured in place and capable of being operated manually in upper pod.	(At monkey area)
			Remove blotting paper from plastic bag and insert in lower pod.	Pre-weighed - clean Eaton Dikeman #320 Blotting Pap enclosed in plastic bag.
			Installation of inner console into Shuttle Lab.	
			Interface gas lines and electronic lines to outer console.	(At Shuttle Lab area)
			Connect data output electronics from outer console to recorders.	
			Check out of system w/o monkey.	

CVT BIORESEARCH LAB. BREADBOARD TEST II

TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: N. Pace, D. F. Rahlmann, A. M. Kodama, R. C. Mains and B. W. Grunbaum

Organism: (1) Pig-tailed Monkey (Macaca nemistrina) (8-14 kg body weight)

Date: 3-22-74

Test Title: Metabolic and Cardiovascular Studies in Monkeys (P1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1			Pre-Test Animal Preparation	
	5	5	Selection of one test subject in individual colony squeeze cage on basis of physical condition, feeding and watering pattern and previous performance in pod configuration.	Log Book Pace Mask Colony entry clothing as required by NASA-Ames. Monkey Records.
	5	10	Test subject secured in squeeze cage. Single intramuscular (IM) injection of Ketamine Hydrochloride (4 to 6 mg/kg of body wt) and Atropine Sulfate (0.04 mg/kg of body wt).	3 ml syringe with 21 ga needle. Vinyl gloves Leather gloves
	5	15	Monkey removed from cage when tranquilizer effective, examined and weighed to nearest 10 grams. Weight recorded.	General weighing scale (metric) Table 75 cm high x 75 cm wide x 150 cm long.
	5	20	Monkey placed on prep. table and prepared for application of silver-silver chloride ECG electrodes by shaving thorax, scrubbing skin with gauze sponges and surgical soap followed by 70% alcohol wipe. Electrodes filled with paste, applied with double-stick washers and covered with a foam adhesive disc.	ECG electrodes Contact paste Gauze sponges Phisohex Alcohol Wipes
			Minimum of 2 people required for the following operations:	
	2	22	(1) Silicone divider seal passed over legs and positioned at iliac crest level.	
			(2) Elastic waistband applied to central sleeve of divider seal.	
			(3) Restraint jacket passed over head, velcro closure made and sewn with nylon cord.	Needle and nylon cord.

CVT BIORESEARCH LAB. BREADBOARD TEST II

TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

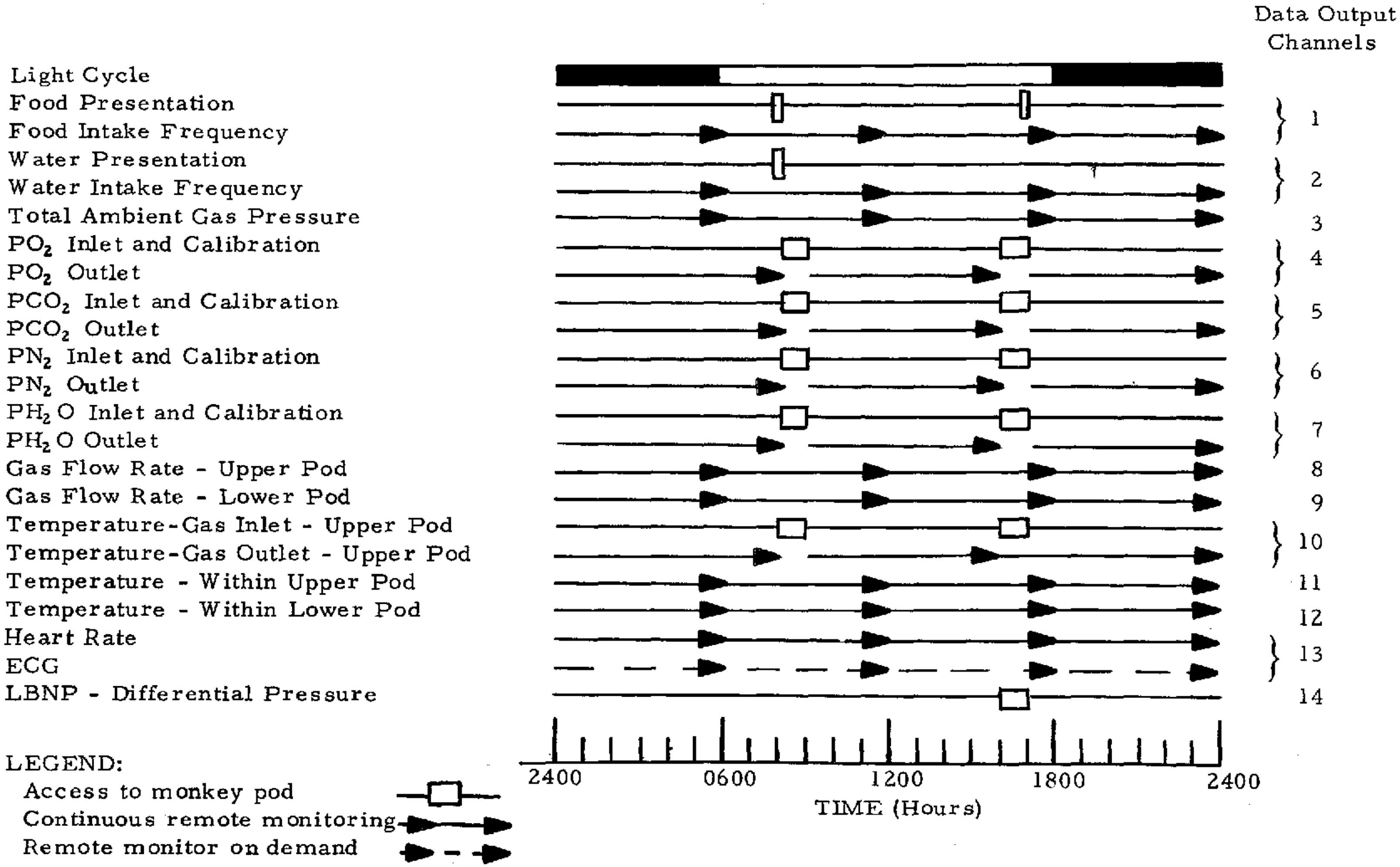
Investigator: N. Pace, D.F. Rahlmann, A.M. Kodama, R.C. Mains and B. W. Grunbaum
Organism: (1) Pig-tailed Monkey (Macaca nemistrina)(8-14 kg body weight)
Date: 3-22-74
Test Title: Metabolic and Cardiovascular Studies in Monkeys (P1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1	5	27	Lower Body Negative Pressure (LBNP) waist template assembled around waist with rubber gasket on edge of central hole.	
	1	28	LBNP waist template support plate passed over legs and positioned at iliac crest level of monkey.	
	2	30	Monkey placed in lower half of pod couch (sitting on table) and parts listed in Steps 5, (oiled spacer bar "0" rings), 1, and 3 (in that order) passed over spacer bars of couch.	
	2	32	Upper half of pod couch joined to lower half, and restraint jacket hammock secured to upper half of couch.	
	2	34	Upper and lower leg restraint bars positioned and secured.	
	1	35	Entire couch/pod divider/monkey assembly passed into the lower pod by one person holding onto the upper couch, while second person directs the positioning through the window of lower pod.	
	1	36	Waist template support plate pressed into position, compressing the silicone "0" ring seal.	
	5	41	Divider seal and jacket skirt edges slid into the groove in the edge of the pod divider shelf and compression ring and retainer ring placed on the jacket skirt perimeter and secured with screws.	
	1	42	Press rubber "0" rings into beveled seat on support plate.	
	2	44	Upper/lower pod "0" ring placed in groove of the lower pod and the upper pod set in place.	
	2	46	Barrel clamp placed over the edges of the upper and lower pod and the clamp tightened with bolt.	
	10	56	Transport of pod assembly to Shuttle Lab. If this step delayed, provision should be made for air flow through upper and lower pod.	Suitable transport vehicle - possible air

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: N. Pace, D. F. Rahlmann, A. M. Kodama, R. C. Mains and B. W. Grunbaum
Organism: (1) Pig-tailed Monkey (Macaca nemistrina) (8-14 kg body weight)
Date: 3-22-74
Test Title: Metabolic and Cardiovascular Studies in Monkeys (P1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1	10	66	Tie down pod frame. Connect gas lines to inner console.	
	10	76	Install waterer and connect electronic lines from feeder and waterer to inner console.	
	5	81	Add 1,000 ml H_20 to waterer and 200 PMC 5040 food.	Fresh H_20 5040 PMC Tablets
	15	96	Check continuous data output - refer to EPL-UCB Daily Activity Schedule dated 4 March 1974, copy attached.	Brush Recorders MK200



Daily activity schedule — NASA/AMES CVT monkey pod experiment.

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

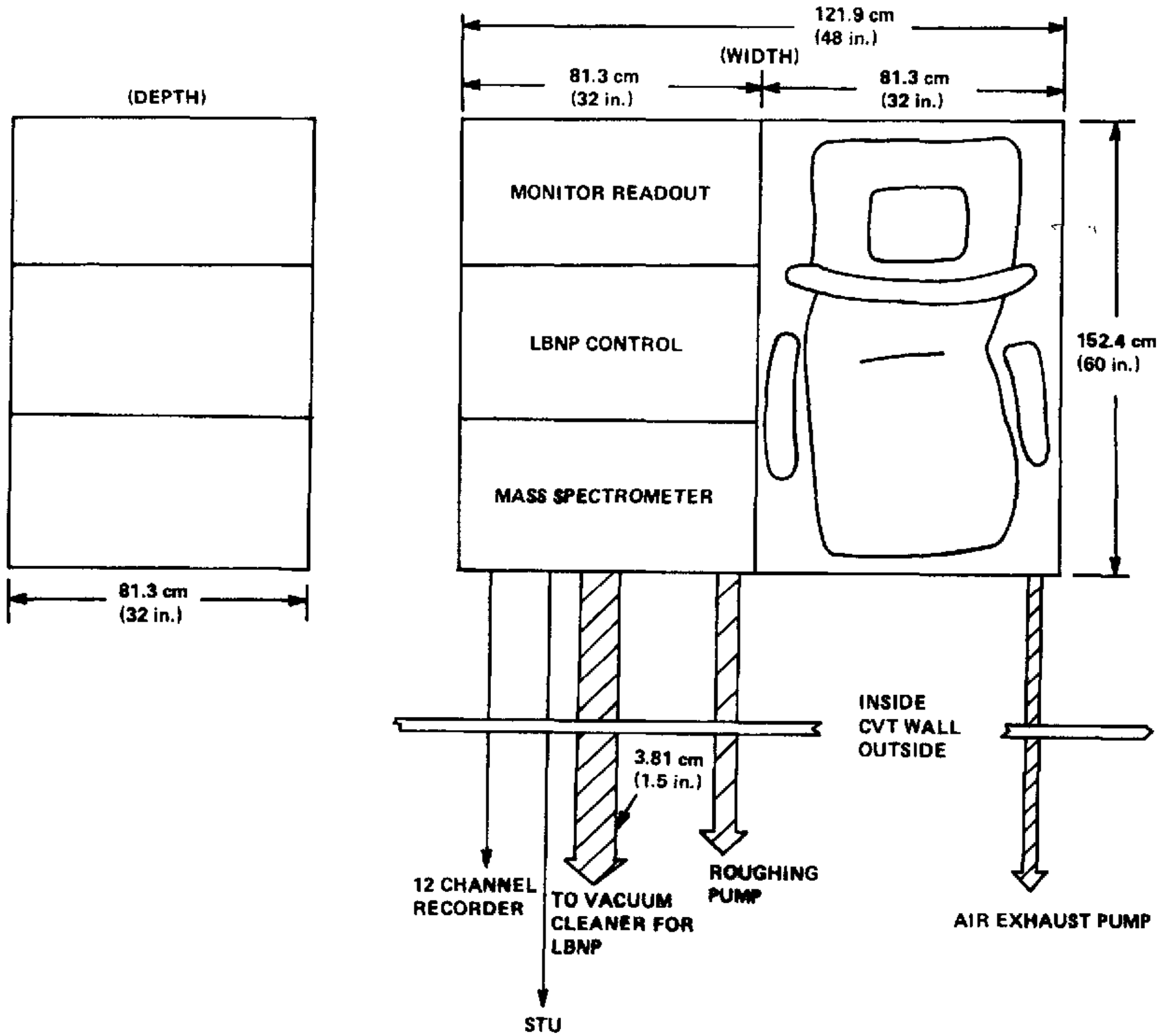
Investigator: N. Pace, D. F. Rahlmann, A. M. Kodama, R. C. Mains and B. W. Grunbaum
Organism: (1) Pig-tailed Monkey (Macaca nemistrina)(8-14 kg body weight)
Date: 3-22-74
Test Title: Metabolic and Cardiovascular Studies in Monkeys (P1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1			<u>Initiation of Test</u> Recorder chart speed continuous at 0.05 mm/sec throughout trial except EKG wave form on demand. Control from outside lab mockup. Lights on at 0700 hrs.	
	5	5	At 0800: Food presentation - add a known quantity of food tablets and record. Record number on tablet counter and zero.	5040 PMC Tablets
	5	10	Record volume of water left in waterer and add sufficient amount of water to bring up to 1,000 ml. Record volume of water added in terms of consumption of monkey from time of previous addition.	Fresh H_2O in clean container
	60	70	Calibration of bioinstrumentation in regard to N_2, O_2, CO_2, H_2O and temperature (may not need total hours time within lab).	Calibration - Gas Mixture Cyl. %O_2, %CO_2, %N_2 1 21 0 79 2 20 1 79 3 19 2 79 4 0 0 98
	60	130	At 1530: Calibration of metabolic instrumentation (same as at 0800). Lower body negative pressure (LBNP) (Monkey pod area should be free of extraneous sounds and traffic during this time)	
	5	135	At 1630: Add food to feeder. Record number of tablets added. Do not zero counter but note and record number on indicator dial. Water consumption recorded but no additional water added. At 1900: Lights off in the lab area. Note: The total time need per day for pod and/or inner console access is 135 minutes. Repeat Day 1 activities daily as applicable (e.g., 5 days).	5040 PMC Tablets

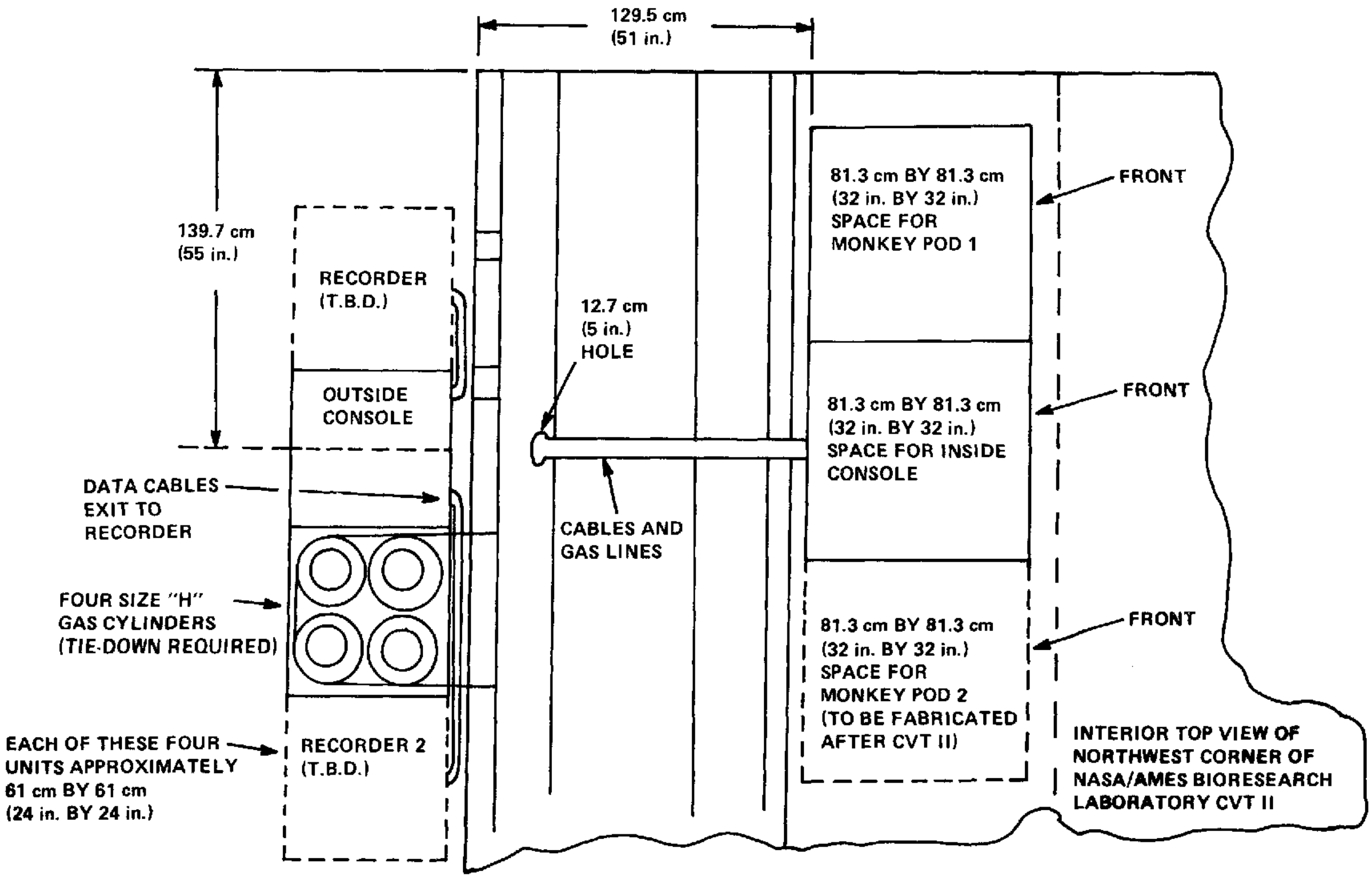
CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: N. Pace, D. F. Rahlmann, A. M. Kodama, R. C. Mains and B. W. Grunbaum
Organism: (1) Pig-tailed Monkey (Macaca nemistrina)(8-14 kg body weight)
Date: 3-22-74
Test Title: Metabolic and Cardivascular Studies in Monkeys (P1)

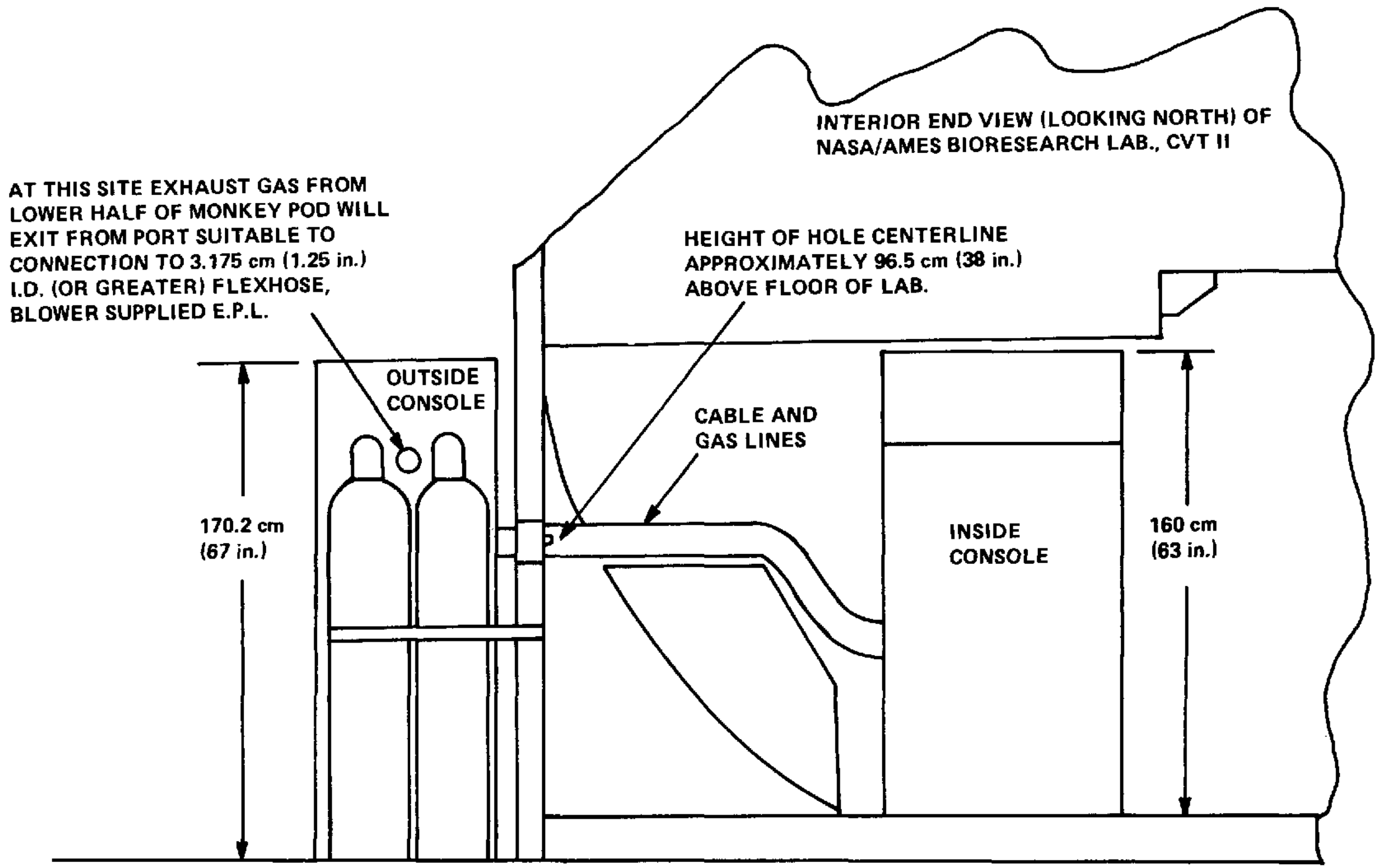
Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			Termination of Testing	
			Recovery	
			Record amount of food and water consumed.	
			Count all food tablets remaining in feeder.	
			Disconnect pod from inner console.	
	TBD		Release tie down from pod frame	
			Transport pod with monkey to animal recovery area.	Suitable transport vehicle.
			Remove upper pod.	
			Tranquilize monkey.	
			Remove debris and record number of uneaten food tablets which may be present.	
			Disassemble divider parts in reverse order of insertion procedure.	
			While removing couched monkey	
			Cleanse lower couch with distilled H_20 and clean spatula, allowing washings to be added to lower pod contents.	
			Remove monkey from couch.	
			Wash lower couch with distilled H_20 and spatula - washings to lower pod contents.	
			Wash lower portion of monkey body with distilled H_20 - washings to lower pod contents.	
			Determine body weight of test monkey and return to cage.	
			Remove lower pod contents and place in container for subsequent chemical analysis.	5 gallon polypropylene container with sealable lid.
			Wash lower pod interior with distilled H_20 and spatula - add washings to container.	
			Store container at -15°C.	Deep Freeze
			Note: The total time required is approximately 4 hours.	



Monkey pod - CVT II (requested space in mockup)



E.P.L./W.M.R.S./U.C.B. proposed equipment layout monkey pod experiment, CVT II



E.P.L./W.M.R.S./U.C.B. proposed equipment layout monkey pod experiment, CVT II

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Drs. Winget & Danellis   Organism: 2 Monkeys (Cebus Albifrons)   Date: 3-28-74
Test Title: Physiological Cost of Repeated Monkey Shuttle Sorties (P2) Photoperiod Effects on Central Nervous System and Physiological Biorhythms of Monkeys (P3)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			Initiation of Test	
1	5	5	1. Every day-check instrument calibration (Bob Johnson) prior to start of test.	
	15	20	2. Uncrate equipment and connect all cables (1a. through 4b.). Transport animal cage to CVT and install in module.	
	2	22	3. Attach cable label 1a to outlet 1a Attach cable 1b to outlet 1b Attach cable 2a to outlet 2a Attach cable 2b to outlet 2b Attach cable 3a to outlet 3a Attach cable 3b to outlet 3b Attach cable 4a to outlet 4a Attach cable 4b to outlet 4b	
	1	23	4. Turn scanner on Turn printer on	
	5	28	5. Feeding, watering, and cleaning schedule for subject P2, in clear cage can be done anytime of day as long as it's done at approximately the same time each day.	
	5	33	6. Feeding, watering, and cleaning of subject P3 in the opaque cage should be done at the following times: Day 1 0900 Day 2 1300 Day 3 1500 Require random timing. Day 4 1000 Day 5 1100	
5			Repeat Daily Steps 1, 4, 5, and 6.	
			Termination of Test	
	1	2	7. Turn scanner off Turn printer off	
	1	8	8. Disconnect all cables (1a through 4b) and crate equipment.	
	5	10	9. Remove animal cage from module and place on cart for transportation to animal facilities.	

CVT BIORESEARCH LAB. BREADBOARD TEST II

TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Drs. Winget & Danellis | Organism: 2 Monkeys (Cebus Albifrons) | Date: 3-28-74

Test Title: Physiological Cost of Repeated Monkey Shuttle Sorties (P2)
Photoperiod Effects on Central Nervous System and Physiological Biorhythms of Monkeys (P3) (Continued)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			Termination of Test (Continued)	
	10	15	10. Transfer caged animal to holding facilities, remove from cage and transfer to holding cage. Provide water and feed.	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Dr. Geoffrey H. Bourne   Organism: Rhesus Monkey (Macaca mulatta) Date: 4-9-74
Test Title: Histopathology and Histechemistry of Rhesus Monkeys (P4)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			In Animal Holding Area	
	15	15	1. Sedate monkey with ketamine HC1 (10 mg/Kg body weight).	Ketamine HCl, 5 cc syringe w/1 to 1-1/2", 20 ga needle stehoscope and rectal thermometer, scales, 10 cc heparinized vacutainer w/1-1/2" 20 ga needle hemacytometer, blood diluting pipettes, dilution fluids, centra-fuge, and microscope, sample vial for freezing serum.
	10	25	2. Weight monkey and perform cursory physical examination (weighing occurs only the first time in ARC colony).	
	5	30	3. Collect baseline blood sample in 10 cc heparinized vacutainer	
	(45)	(95)	3a. After completing Steps 4 thru 8, accomplish RBC & WBC counts and separate serum. Freeze serum.	
	10	40	4. Transport sedated monkey to CVT simulator.	Transport cage, vehicle
			In Simulator	
	5	45	5. Place monkey in CVT housing module	CVT P4 housing module
	5	50	6. Ensure that automatic waterer working and that food is available	
	5 @	10	7. Give monkey 12 food biscuits in the early morning and a like number in the late afternoon.	
	10	20	8. Remove the dirty cage paper and replace it with clean paper.	
	15	15	9. Sedate monkey with ketamine HC1 (10 mg/Kg body weight)	ketamine HCl & syringe as above (Step 1)
	5	20	10. Draw blood sample as in Step 3 above.	As in Step 3 above.
	(45)	(75)	10a. As in Step 3a above.	As in Step 3a above.
	5	25	11. Repeat Step 6 above	
	5	30	12. Repeat Step 7 above (but only for afternoon feeding)	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Dr. Geoffrey H. Bourne   Organism: Rhesus Monkey (Macaca mulatta)   Date: 4-9-74
Test Title: Histopathology and Histechemistry of Rhesus Monkeys (P4)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
		20	13. Repeat Steps 7 and 8 above.	
		75	14. Repeat Steps 9 thru 12 above.	As in Steps 9 thru 12 above.
	10	85	15. Return monkey to holding cage in animal holding facility.	Holding facility & vehicle.
			Post Test	
			16. Clean cage in preparation for next test (at ARC, cage may be steam cleaned at Bldg 236).	

ARC BIORESEARCH LAB BREADBOARD TEST II FOR CVT

RADIOISOTOPE TRACER CANDIDATE EXPERIMENTS

NO.	INVESTIGATOR INSTITUTION (ARC TECH. MONITOR/BR)	CANDIDATE EXPERIMENT TITLE	ORGANISM	MEASUREMENTS
1 (R1)	H. A. Leon, Ph. D. ARC/LRP	Hemolytic rate of young and senescent red blood cells of rats	Rat	^{14}C-2-Glycine – RBC – Expired ^{14}CO
2 (R2)	S. Ellis, Ph. D. & Consortium ARC/LRE	Pituitary function, plasma enzymes and bone metabolisy of male rats	Rat	^{14}C-Proline – Collagen – Urinary ^{14}C-Hydroxyproline: Blood/pituitary hormones; plasma fibrionogen, renin, angiotensin; femur-Ca, P, collagen
3 (A1)	J. R. Beljan, M. D. U. C. Davis (C. Winget, Ph. D. /LRH)	Quantitation of calcium dynamics of chickens	Chicken	$^{85}Sr/^{45}Ca$ – Bone – Blood/Excreta; Bone Density/ Fracture Repair Rate; EKG, body temp/wt., hematology
4 (B1)	C. H. Ward, Ph. D & Consortium Rice U. (S. T. Taketa, Ph. D/LF)	Metabolism and energetics in a higher plant	Higher Plant (Marigold)	^{14}C-labeled amino acids – $^{14}CO_2$; starch granules, pigmets, O_2, amino acid pathway, enzyme/hormone activity, Lignification, minerals

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Dr. H. A. Leon   Organism: Buffalo rat   Date: 3-14-74
Test Title: Hemolytic Rate of Young and Senescent Red Blood Cells of Rats (R1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
	60	60	1. Inject 6 200 gm Buffalo rats with 70 microcuries 2- ^{14}C-glycine, i. v.[1] (assume that six controls are injected)	500 microcuries 2-^{14} Cglycine radio-active hood for keeping rats.
	10	10	2. Place two rats in chambers - Air Group A (assume same for ground controls)	6 chambers
	10	20	3. Place two rats in chambers - Air Group B	
	10	30	4. Place two rats in chambers - Air Group C	
	2	2	5. Switch Group A to 600 torr 0_2, flow 600 cc/min (assume same for ground controls)	Oxygen supply
	2	4	6. Switch Group B to 600 torr air, flow 600 cc/min	Air supply
	2	6	7. Switch Group C to 600 torr 95% 0_2 + 5% N_2, flow 600 cc/min.	0_2 + air
	2	2	8. Attach ^{14}CO collection train to Group A. (assume same for ground controls)	6 collection trains
	2	4	9. Attach ^{14}CO collection train to Group B.	
	2	6	10. Attach ^{14}CO collection train to Group C.	
	10	10	11. Switch and detach ^{14}CO collector attached to Group A, place sample in sealable-labeled vial.	
	10	20	12. Switch and detach ^{14}CO collector attached to Group B, place sample in sealable-labeled vial.	6 vials labeled 1, 2, 3, 4, 5, 6
	10	30	13. Switch and detach ^{14}CO collector train attached to Group C, place sample in sealable-labeled vial.	

[1] This injection will be accomplished 55 days prior to the onset of testing.

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Dr. H. A. Leon Organism: Buffalo rat Date: 3-14-74
Test Title: Hemolytic Rate of Young and Senescent Red Blood Cells of Rats (R1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
	60	60	14. Clean rat capsules or transfer rats to clean capsules at stated pressure and composition, see Steps 5 to 7.	
	2	2	15. Same as 8.	
	2	4	16. Same as 9.	
	2	6	17. Same as 10.	
	10	10	18. Same as 11.	6 vials labeled 7, 8, 9, 10, 11, 12
	10	20	19. Same as 12.	
	10	30	20. Same as 13.	
			Same as Day 1	6 vials labeled 13, 14, 15, 16, 17, 18
			Same as Day 1	6 vials labeled 19, 20, 21, 22, 23, 24
			Same as Day 1	6 vials labeled 25, 26, 27, 28, 29, 30
			Same as Day 1	6 vials labeled 31, 32, 33, 34, 35, 36
			Same as Day 1	6 vials labeled 37, 38, 39, 40, 41, 42
			Secure rats and equipment. Return from orbit. Dispose of rats.	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Drs. Ellis, S., Consortium
Test Title: Pituitary Function, Plasma Enzymes and Bone Metabolism of Male Rats (R2)
Organism: 6-8 35 day old male rats, Sprague-Dawley strain of Rattus norvegicus
Date: 3-12-74

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			6-8 35 day old male rats will have been injected with 25 uc of ^{14}C-Proline 30 days prior to flight	
	6	6	Remove pre-weighed diet from refrigerator and place in each cage.	Refrigerator
	6	12	Measure water for each of six cages.	Mass balance
	12	24	Weigh each rat and measure tail length.	Mass balance, ruler
	6	6	Retrieve unused food from each of 6 cages and weigh. Record weight eaten.	Mass balance
	6	12	Place pre-weighed diet in each cage.	Diet from refrigerator
	6	18	Measure water required to refill water containers and record water consumed per animal.	Syringe or mass balance
	6	24	Recover feces from each cage and weigh. Store separately in plastic bags and freeze.	Mass balance, plastic bags, freezer
	18	42	Recover urine from each container, measure and record. Filter each to remove sediment. Aliquot 1/2 sample into vial containing toluene. Aliquot other 1/2 sample into vial containing acid. Freeze both samples.	Mass balance, 12 vials, freezer, centrifuge
	12	54	Weigh each rat.	Mass balance.
		54	Repeat day 2.	As above.
	6	6	Retrieve unused food from each of 6 cages and weigh.	Mass balance.
	6	12	Measure water required to refill water containers and record water consumed.	Mass balance.
	6	18	Recover feces from each cage and weigh. Store in plastic bag for each animal and freeze.	Mass balance, plastic bags, freezer
	18	36	Recover urine from each container, measure and record. Filter each to remove sediment. Aliquot as before. Freeze samples.	Mass balance, 12 vials, freezer, centrifuge
	12	48	Weigh each rat and measure tail length.	Mass balance, ruler

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Dr. Ellis, S., Consortium Organism: 6-8 35 day old male rats, Sprague-Dawley strain of Rattus norvegicus Date: 3-12-74
Test Title: Pituitary Function, Plasma Enzymes, and Bone Metabolism of Male Rats (R2)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
	60	108	Anesthetize each rat in turn with metaphane. With 20 gauge needle and 5 ml syringe, remove 4 ml blood from heart of rat and place in tube containing 4 mg EDTA, leaving needle in heart (it might be necessary to have the EDTA in the syringe-will be determined). Attach second 10 ml syringe to needle and remove 3-8 ml blood. Put 2.7 ml into tube containing 0.3 ml of 3.2% Na-Citrate, and remainder into heparinized tube. (The feasibility of a single drawing into a single anticoagulant is being investigated.) Centrifuge bloods, separate plasmas, and freeze both.	Gas chamber, metaphane 6 20 gauge needles, 6 5 ml syringes, 6 10 ml syringes, 6 EDTA tubes, 6 citrate tubes, 6 hepari tubes, centrifuge, freezer
	6	114	Decapitate each rat and strip head skin anteriorly over the eyes.	Guillotine
	24	138	With poultry shears, cut each rat head open anteriorly from the foramen magnum on each side of the head to the superior condyle (The cut from the foramen magnum will be "V" shaped. Cuts will be approx. 1" in length and, on the top of the skull will be approx. 2 cm apart.). Break bone flap by lifting with thumb, and remove. Lift brain from posterior base and remove. At a point below and slightly posterior to the optic chiasma will be a dura covered depression. Prick the dura and remove the pituitary. Separate into anterior and posterior portions, weigh, identify, and freeze. (Alternate to weighings of pituitarys and adrenals, non-desiccative freezing or DNA determinations are being investigated).	Poultry shears, scissors micro forceps, vials for pituitaries, mass balance
	24	162	Skin and clean left tibia/fibula pair and femur, remove from body and freeze in vial. Remove adrenals, clean, weigh, place in vials and freeze. Freeze remaining carcass for return to earth.	tibia/fibula/femur vials adrenal vials, scalpel, scissors, plastic bags for carcasses

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: Beljan/Winget Organism: Chicken Date: 4-13-74

Test Title: Quantitative of Calcium Dynamics of Chickens (A1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
			<u>Pre-Test Installation</u>	
	10	10	1a. Transport chicken to CVT	
	2	12	b. Transfer chicken to CVT cage, restrain, and install in CVT module.	
	2	14	2a. Connect PM-tube to Preamp (BNC connector to "S" on PM tube)	
			b. Connect High Voltage line (Black) to PM tube connection marked "HV"	
			c. Connect double green-gray line to Preamp output	
			d. Adjust PM tube to maximum height and <u>gently</u> tighten thumbscrews ONLY enough to hold tube.	
			<u>Initiation of Test</u>	
	3	3	3a. Turn on bin power (A)	
			b. Turn on High Voltage (B)	
			c. Push "STOP" and "RESET" (C) on TTY-interface	
			d. Turn teletype data selector to Chicken	
			e. Turn on teletype and enter "CHICKEN, DATE, EXACT TIME"	
	5	8	4a. Remove excreta and place in plastic bag	
			b. Immediately replace absorbent paper in tray	
			c. Identify excreta sample with "CHICKEN, Date, and Time", and place in freezer.	Freezer
	1	9	5a. Push "STOP", "RESET" and "START" on TTY-interface (This should initiate an automatic counting sequence on the scalar with subsequent data printout every 30 seconds on the teletype.)	
			b. After approximately 15 minutes push "STOP" on the TTY-interface	
			c. Turn off teletype, high voltage, and bin power.	
		9	Repeat steps 3, 4, and 5 of day 1.	
			<u>Termination of Test</u>	
		23	Reverse sequence of Steps 1 and 2 and perform opposite task.	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: C. H. Ward, et. al. Organism: Marigold (Tagetes patula) Date: 4-15-74
Test Title: Metabolism and Energetics in a Higher Plant (B1)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1	1	1	1. Check operations of time-lapse camera; wind.	Time-lapse camera focused on plant
	1	2	2. Remove L-glutamate-U-C^{14} from freezer to plant module and thaw.	L-glutamate-U-C^{14}; freezer
	20	22	3. Calibrate CO_2 analyzer with 570 ppm, 340 ppm, 260 ppm and 0 ppm CO_2. Calibrate O_2 analyzer with 0 ppm and 340 ppm CO_2.	CO_2 analyzer; O_2 analyzer; recorder; cylinders of 570, 340, 260 and 0 ppm CO_2.
	1	23	4. Remove 2 plants from plant growth chamber to work bench.	Plant growth chamber with 20 plants about 21 days old
	1	24	5. Seal one plant pot (#1) with plastic collar and apiezon Q.	Plastic collars; apiezon Q
	1	25	6. Place sealed plant (#1) in gas exchange chamber (#1). Secure chamber door.	Gas exchange chamber
	4	29	7. Pass 340 ppm CO_2 through gas exchanger chamber (#1) and "bleed" chamber with by-pass valve until maximum CO_2 peak is reached on recorder. Adjust flow meters for a flow rate of 140 cc/min.	Equipment specified in Step 3. By-pass valve installed in outflow line; Flow meters (602) capable of 140 cc/min.
	60	89	8. Activate lights and run experiment for 60 minutes, as specified in Steps 9 through 19 below.	Light source
	1		9. Make a shallow puncture in stem of 2nd plant (#2) cotyledons with 1 ml insulin syringe equipped with a 20 gauge needle. Allow exudate to dry (approximately 3 min).	1 ml insulin syringe; 20 gauge syringe needles
	4		10. While exudate is drying, fill each of six 25x200 mm test tubes with 5.0 ml of 1 M hyamine hydroxide in methanol. Label tubes in series from 1-6 and with date. Place tube #1 in large tube equipped with an open sidearm and close with bubbling tube.	Forty-six 25x200 mm test tubes with closures; 1 M hyamine hydroxide in methanol; label tape; tube with open sidearm; bubbling tube.

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: C. H. Ward, et. al. Organism: Marigold (Tagetes patula) Date: 4-15-74
Test Title: Metabolism and Energetics in a Higher Plant (B1) (Continued)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1			(Note: Approximately four hours are required to install and render operational the equipment utilized in this candidate experiment.)	
	3		11. Inject 0.05 ml of L-glutamate-U-C^{14} (60 UC) into same puncture in plant with insulin syringe.	Specified above
	1		12. Place injected plant (#2) in the gas exchange chamber (#2) located in the plant storage module.	Gas exchange chamber
	1		13. Clamp gas line leading to plant holding flat thus passing air through gas exchange chamber (#2) from compressed air cylinder. Air passing through gas exchange chamber (#2) is bubbled into the test tube containing 5 ml of 1 M hyamine hydroxide in methanol.	Hose clamp
	10		14. After 10 minutes remove test tube #1 and close with cap.	
	10		15. Repeat Step 13 with test tube #2.	
	10		16. Repeat Step 13 with test tube #3.	
	10		17. Repeat Step 13 with test tube #4.	
	10		18. Repeat Step 13 with test tube #5.	
		89	19. Start Step 13 with test tube #6.	
	61	150	20. Deactivate light over gas exchange chamber (#1) and cover chamber with black cloth. Run experiment 60 minutes.	Black cloth
	10		21. After the 10 min has elapsed for tube #6, remove plant from gas exchange chamber (#2) and cut stem directly above the injection point.	Scissors
	5		22. Weigh severed portion of plant.	Balance
	5		23. Freeze severed portion of plant in liquid N_2, label and store in freezer.	Liquid N_2
	1		24. Return L-glutamate-U-C^{14} and tubes #1-6 to freezer.	
	1		25. Remove clamp and allow gas to flow into plant holding flat.	
	1		26. Remove 3rd plant (#3) from holding flat.	

CVT BIORESEARCH LAB. BREADBOARD TEST II
TIMING, DESCRIPTION AND EQUIPMENT REQUIREMENTS FOR EACH OPERATION

Investigator: C. H. Ward, et. al. Organism: Marigold (Tagetes patula) Date: 4-15-74
Test Title: Metabolism and Energetics in a Higher Plant (B1) (Continued)

Day	Elapsed Time (Min.) Per Step	Total	Brief Description of Each Operation (Step by Step)	Equipment/Facility Requirements
1	1	150	27. Turn off gas flow to gas exchange chamber (#1). Remove plant.	
	5	155	28. Cut plants (#2 and #3) at soil level and weigh separately.	Specified above
	5	160	29. Freeze each individual plant in liquid N_2, label and store in freezer.	Specified above
	5	165	30. Clean-up; check operations of time-lapse camera.	
2			Same as day 1 except zero CO_2 analyzer with 0 ppm and 570 ppm CO_2. Zero O_2 analyzer with 0 ppm and 340 ppm CO_2.	
3			Same as day 2.	
4			Same as day 2.	
5			Same as day 2.	

APPENDIX G
POWER CONSUMPTION DATA

Total Power (Facility and Experiment). Total CVT/GPL electrical power consumption was measured, as well as a number of individual experiments and facility items. Total peak power ranged as high as 12.8 kW in one instance. Usually the sequence of operation of the cyclic equipment was such that the average power was much lower, as may be seen by the two attached "Power Consumption Charts" (Figs. G-1 and G-2). The information on these charts is derived from the single measurement of total power.

Power measurements made separately are shown below:

Facility Power

Lights (12 hr ON - 12 hr. OFF)	1.740 kW
Fixed Vacuum Pump (continuous)	1.560 kW
Portable Vacuum Pump (continuous)	1.290 kW
Fume Hood (vacuum cleaner)	2.300 kW (intermittent)
Door Monitor Console (continuous)	0.072 kW
External Recording Eqpt. (continuous)	0.300 kW
External Air Cond. (intermittent)	4.100 kW (Derived from total power chart and name plate data.)

Experiment Power

Experiment P1 (MEA. W6 - ID1)	0.570

Experiment P2, P3, H1, and B1 had wattmeters available but it can not be determined with certainty that use of the 4-way wattmeter receptacle was limited to each respective experiment. Neither can it be determined with certainty that all equipment of a particular experiment used a wattmeter receptacle. However, these were the normal readings.

Experiment H1 (MEA W11 - ID2)	147 watts nominal
Experiment P1 (MEA W6 - ID1)	570 watts nominal
Experiment P2 (MEA W7 - ID12)	100 watts nominal
Experiment P3 (MEA W8 - ID13)	850 watts nominal
Experiment B1 (MEA W13 - ID14)	. . . nominal zero

The power consumed by experiment P1 (W6 - ID1) seems unusually low (570 watts) considering that the criteria called for a 30 A, 120 V circuit. It may be noted, however, that its vacuum pump was not operated, as the facility system fullfilled that function. Also, all recording equipment was on a separate circuit.

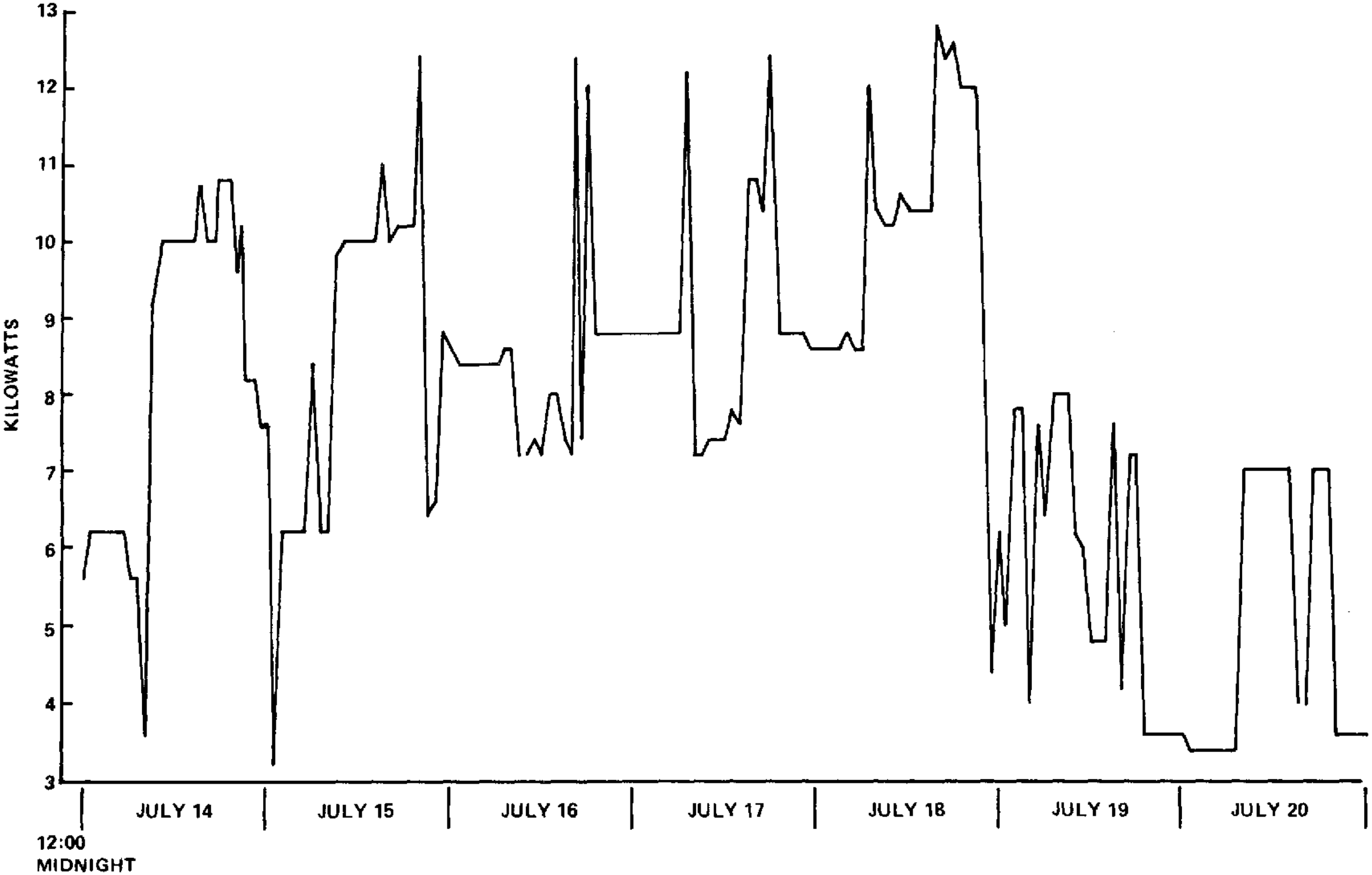


Figure G-1. Peak electrical power consumption (one-hour increments).

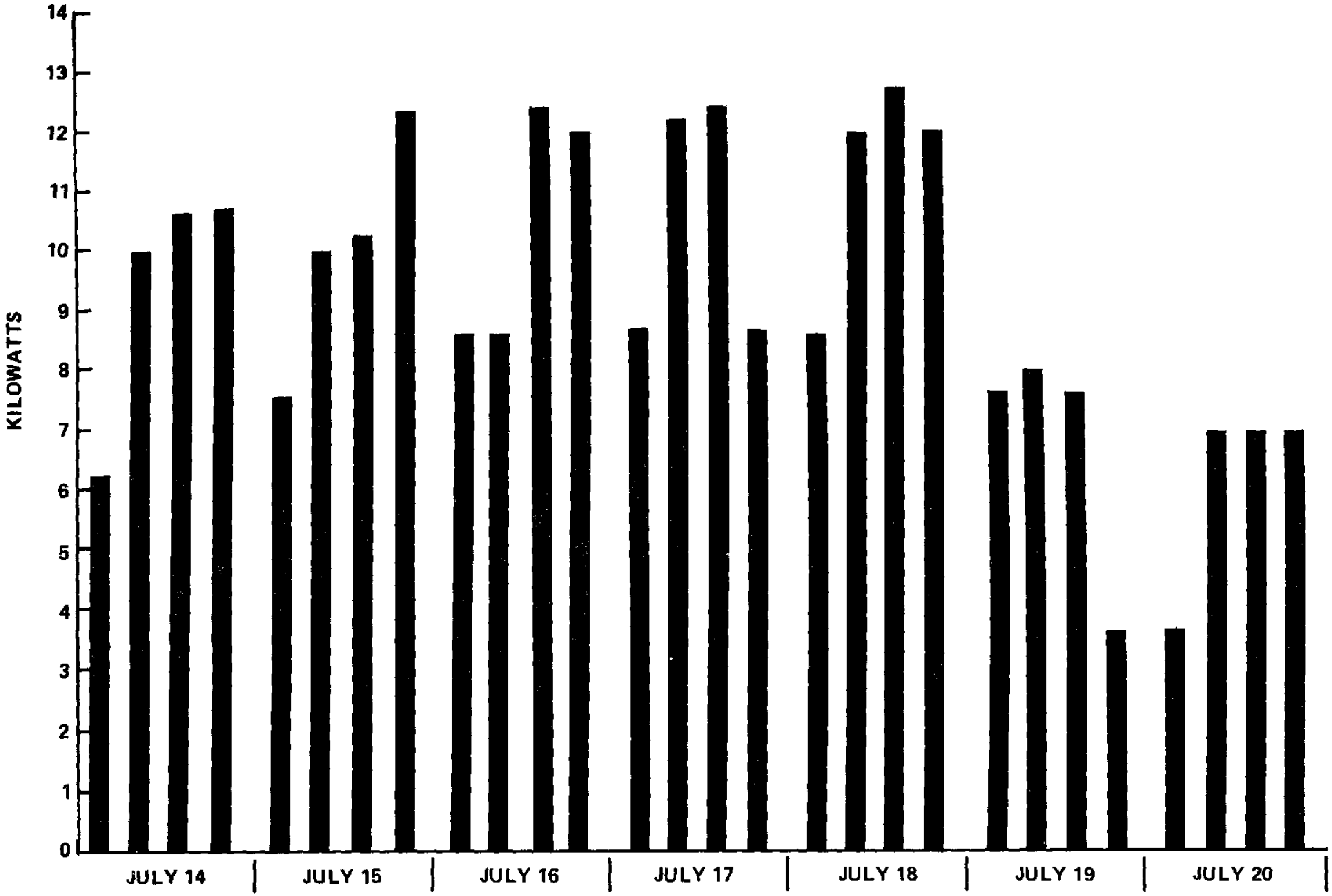


Figure G-2. Peak electrical power consumption (quarter-day increments).

APPENDIX H

TEMPERATURE AND SYSTEMS STATUS DATA

PRECEDING PAGE BLANK NOT FILMED

Table H-1 is a summary of the temperature measurements which were recorded hourly in the GPL log for the specimen cages (excluding the PI experiment). The temperatures recorded in the log for experiments R1 and R2 were adjusted upwards 1.1° C (2° F) to correct for a reference junction error.

Table H-2 is data which was recorded in the GPL log from the Test Conductor's console and systems monitor panel indicating system status and environmental conditions in the GPL.

Table H-3 is a list of departures from temperature specifications in the specimen cages. Table H-3 also indicates a departure from the humidity specification in the GPL.

There were a number of instances in which allowable temperature limits for various specimen cages were exceeded. The Ward Plants cage (B1) had five excursions beyond the specification range, but these were of such short duration and magnitude that the Experimenter felt that no degradation to the experiment resulted.

The R2 specimen cage temperatures departed from the specification range five times but the longest period of time out of specification was for only 60 minutes and by a temperature of 0.78° C (1.4° F).

TABLE H-1. EXPERIMENT MODULE TEMPERATURES

Exper.		1st Day (1300 - 2300) Range	1st Day Avg.	2nd Day (2400 - 2300) Range	2nd Day Avg.	3rd Day (2400 - 2300) Range	3rd Day Avg.	4th Day (2400 - 2300) Range	4th Day Avg.	5th Day (2400 - 0800)[b] Range	5th Day Avg.	1st Day - 5th Day Range	1st Day - 5th Day Avg.
P1	°C	23.7 - 24.3	24.0	22.8 - 24.5	23.7	21.2 - 23.6	22.6	20.2 - 23.6	22.0	22.1 - 23.4	22.8	20.2 - 24.5	23.1
	°F	74.7 - 75.8	75.3	73.1 - 76.1	74.6	70.2 - 74.5	72.7	68.4 - 74.5	71.6	71.8 - 74.1	73.3	68.4 - 76.1	73.5
P2	°C	23.4 - 24.6	24.0	22.9 - 24.4	23.7	22.7 - 24.2	23.3	20.9 - 24.2	22.6	22.0 - 23.3	22.7	20.9 - 24.6	23.3
	°F	74.2 - 76.2	75.3	73.2 - 76.0	74.7	72.9 - 75.6	74.0	69.7 - 75.5	72.6	71.5 - 73.9	72.9	69.7 - 76.2	73.9
P3	°C	22.9 - 23.8	23.3	22.3 - 23.8	23.0	21.4 - 23.1	22.3	20.9 - 22.8	22.0	22.1 - 23.2	22.7	20.9 - 23.8	22.7
	°F	73.2 - 74.9	73.9	72.2 - 74.8	73.4	70.5 - 73.5	72.1	69.7 - 73.0	71.6	71.7 - 73.7	72.9	69.7 - 74.9	72.8
R1[a]	°C	22.3 - 23.4	22.9	22.1 - 23.2	22.7	22.0 - 23.7	22.8	21.6 - 23.6	22.6	23.2 - 23.9	23.6	21.6 - 23.9	22.9
	°F	72.2 - 74.1	73.2	71.7 - 73.8	72.8	71.6 - 74.7	73.1	70.8 - 74.4	72.7	73.8 - 75.1	74.4	70.8 - 75.1	73.2
R2[a]	°C	23.0 - 24.3	23.5	22.1 - 24.6	23.6	20.9 - 24.5	23.2	20.7 - 23.9	22.9	22.9 - 23.8	23.4	20.7 - 24.6	23.3
	°F	73.4 - 75.7	74.3	71.7 - 76.3	74.4	69.7 - 76.1	73.8	69.3 - 75.0	73.2	73.3 - 74.9	74.1	69.3 - 76.3	74.0
A1	°C	22.6 - 23.9	23.2	22.7 - 23.6	23.0	21.8 - 23.8	22.8	21.9 - 23.8	22.9	22.1 - 23.5	22.8	21.8 - 23.9	22.5
	°F	72.7 - 75.0	73.8	72.8 - 74.5	73.4	71.3 - 74.9	73.1	71.4 - 74.8	73.2	71.7 - 74.3	73.1	71.3 - 75.0	73.3
B1	°C	23.2 - 26.1	24.2	21.7 - 23.9	22.9	22.3 - 24.4	23.4	21.5 - 24.3	23.1	NA[c]	NA	21.5 - 26.1	23.3
	°F	73.8 - 78.9	75.6	71.1 - 75.0	73.2	72.2 - 75.9	74.1	70.7 - 75.7	73.6			70.7 - 78.9	73.9
ALL	°C	22.3 - 26.1	23.6	21.7 - 24.6	23.2	20.9 - 24.5	22.9	20.2 - 24.3	22.6	21.9 - 23.9	23.0	20.2 - 26.1	23.1
	°F	72.2 - 78.9	74.5	71.1 - 76.3	73.8	69.7 - 76.1	73.3	68.4 - 75.7	72.6	71.5 - 75.1	73.5	68.4 - 78.9	73.5

a. Adjusted upward 1.1°C (2°F) to correct for calibration error.
b. All experiments were being removed between 0800 and 1300, 5th Day.
c. Plants for B1 experiment were removed by 2100, 4th Day.

TABLE H-2. TEMPERATURE AND SYSTEMS STATUS DATA[a]

Time	Temperature					% Relative Humidity				
	1st Day °C(°F)	2nd Day °C(°F)	3rd Day °C(°F)	4th Day °C(°F)	5th Day °C(°F)	1st Day	2nd Day	3rd Day	4th Day	5th Day
2400	23.3 (74)	22.2 (72)	23.3 (74)	22.8 (73)	22.2 (72)	50	46	44	50	45
0100	22.8 (73)	22.2 (72)	23.3 (74)	22.8 (73)	22.2 (72)	46	46	44	43	50
0200	22.8 (73)	22.8 (73)	23.3 (74)	22.8 (73)	22.2 (72)	48	50	49	45	42
0300	22.2 (72)	22.2 (72)	23.3 (74)	22.8 (73)	22.2 (72)	50	46	49	50	40
0400	22.2 (72)	22.2 (72)	22.8 (73)	23.3 (74)	22.2 (72)	56	46	49	43	48
0500	22.8 (73)	22.2 (72)	22.8 (73)	23.3 (74)	22.2 (72)	44	48	49	46	46
0600	22.2 (72)	22.2 (72)	22.8 (73)	23.3 (74)	22.2 (72)	52	48	48	50	43
0700	22.2 (72)	22.2 (72)	23.3 (74)	23.3 (74)	22.2 (72)	48	46	47	46	48
0800	22.8 (73)	22.2 (72)	22.2 (72)	22.2 (72)		44	50	52	50	
0900	22.8 (73)	22.2 (72)	22.2 (72)	22.2 (72)		50			45	
1000	22.2 (72)	22.2 (72)	22.2 (72)	22.2 (72)		52		49	51	
1100	22.8 (73)	22.2 (72)	22.2 (72)	23.3 (74)		50		48	49	
1200	22.2 (72)	22.2 (72)	22.2 (72)	22.8 (73)		52		48	42	
1300	22.8 (73)	22.2 (72)	22.2 (72)	22.8 (73)		48		48	49	
1400	22.8 (73)	22.2 (72)	22.8 (73)	23.3 (74)		48		43	47	
1500	22.8 (73)	22.2 (72)	23.9 (75)	22.8 (73)		50		46	51	
1600	23.3 (74)	22.8 (73)	23.3 (74)	22.8 (73)		52		43	48	
1700	22.2 (72)	22.2 (72)	23.3 (74)	23.3 (74)		47	42	48	49	
1800	23.3 (74)	22.2 (72)	22.8 (73)	23.3 (74)		46	48	46	44	
1900	23.3 (74)	23.3 (74)	22.2 (72)	23.9 (75)		40	46	41	40	
2000	23.3 (74)	23.3 (74)	22.8 (73)	23.3 (74)		43	46	49	40	
2100	23.3 (74)	23.3 (74)	22.2 (72)	23.3 (74)		50	48	42	39	
2200	22.8 (73)	23.3 (74)	23.3 (74)	23.3 (74)		46	48	46	40	
2300	23.3 (74)	23.3 (74)	22.8 (73)	23.3 (74)		49	46	43	40	
Daily Mean (Adjusted +1.1° C(2° F))	23.9 (75.0)	23.6 (74.5)	24.0 (75.2)	24.2 (75.5)	23.2 (74.0)	48.4	46.9	46.6	45.7	45.3
Weekly Mean	23.8° C (74.8° F)					46.6				
Range	23.3 to 25.0° C (74 to 77° F)					39 to 56				

TABLE H-2. (Concluded)

Time	Vacuum, Exp. P1 (mm Hg) 1st Day	2nd Day	3rd Day	4th Day	5th Day	Facility Air Pressure 1st Day N/cm² (psi)	2nd Day N/cm² (psi)	3rd Day N/cm² (psi)	4th Day N/cm² (psi)	5th Day N/cm² (psi)
2400	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)
0100	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)
0200	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)
0300	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)
0400	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)
0500	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)
0600	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.1 (90)	62.7 (91)	62.7 (91)
0700	2/7	2/7	2/7	2/6.5	2/6.5	63.4 (92)	62.7 (91)	62.1 (90)	62.1 (90)	62.7 (91)
0800	2/7	2/7	2/7	2/6.5		62.1 (90)	62.1 (90)	62.1 (90)	62.1 (90)	
0900	2/7	2/7	2/7	2/7		62.1 (90)	62.1 (90)	62.1 (90)	62.1 (90)	
1000	2/7	2/7	2/7	2/7		62.1 (90)	62.1 (90)	62.1 (90)	62.1 (90)	
1100	2/7	2/7	2/7	2/7		62.1 (90)	62.1 (90)	62.1 (90)	62.1 (90)	
1200	2/7	2/7	2/7	2/7		62.1 (90)	62.1 (90)	62.1 (90)	62.1 (90)	
1300	2/7	2/7	2/7	2/7		62.7 (91)	62.1 (90)	62.1 (90)	62.1 (90)	
1400	2/7	2/7	2/7	2/7		62.7 (91)	62.1 (90)	62.1 (90)	62.1 (90)	
1500	2/7	2/7	2/7	2/7		62.7 (91)	62.1 (90)	62.1 (90)	62.1 (90)	
1600	2/7	2/7	2/7	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.1 (90)	
1700	2/7	2/7	2/7	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.1 (90)	
1800	2/7	2/7	2/7	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.1 (90)	
1900	2/7	2/7	2/7	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)	
2000	2/7	2/7	2/7	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)	
2100	2/7	2/7	2/7	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)	
2200	2/7	2/7	2/7	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)	
2300	2/7	2/7	2/6.5	2/6.5		62.7 (91)	62.7 (91)	62.7 (91)	62.7 (91)	
Daily Mean	2/7.0	2/7.0	2/7.0	2/6.6	2/6.5	62.81 (91.1)	62.54 (90.7)	62.47 (90.6)	62.40 (90.5)	62.74 (91.0)
Weekly Mean	2/6.9					62.54 N/cm² (90.7 psi)				
Range	2/6.5 to 2/7.0					62.1 to 63.9 N/cm² (90 to 92 psi)				

a. Additional systems data recorded in the GPL Parameters Measurement Log included the tolerance conditions of two specimen exhaust vent systems, air conditioning systems both internal and external to the GPL, the upper monkey pod pump flow, the GPL fire detection system, and the emergency power system. All of these systems operated within acceptable tolerance limits throughout the test period.

TABLE H-3. TEMPERATURE AND HUMIDITY DEPARTURES FROM SPECIFICATIONS

Meas. ID No.	Nomenclature	Departed From Spec				Returned to Spec				Time out of Spec			Out of Spec. Reading
		Day	Hr	Min	Sec	Day	Hr	Min	Sec	Hr	Min	Sec	
24	Temp. Ward Plants B1	195	14	28	00	195	15	15	30	00	47	30	26.6° C (79.8° F)
		195	15	32	17	195	16	03	00	00	30	43	25.1° C (77.1° F)
		196	07	45	00	196	09	17	30	01	32	30	25.7° C (78.3° F)
		196	12	27	12	196	14	03	02	01	35	50	25.4° C (77.7° F)
		196	18	10	32	196	20	36	34	02	26	02	26.1° C (79.0° F)
25	(Temp.) Leon Rats	Did not depart from specification											
26	Temp. P1	195	19	32	18	195	19	50	38	00	18	20	24.8° C (76.6° F)
31	Temp. P4	195	14	28	30	195	14	49	00	00	12	30	19.6° C (67.2° F)
32	Temp. A1	Did not depart from specification											
33	Temp. R2	195	14	28	00	195	21	43	50	07	15	50	25.6° C (78° F)
		196	07	45	00	196	08	13	20	00	28	20	24.8° C (76.6° F)
		196	08	33	20	196	09	33	20	01	00	00	25.2° C (77.4° F)
		199	07	46	00	199	08	10	10	00	24	10	20.5° C (68.9° F)
		199	08	29	20	199	08	50	10	00	20	50	20.6° C (69.1° F)
34	GPL Humidity Low West End	199	19	45	00	199	23	45	00	04	00	00	38%
8	Temp. P3	195	14	28	00	195	15	45	30	01	17	30	19.9° C (67.8° F)
29	Temp. P4 (Range 68-75 F)	198	07	55	00	198	09	11	40	01	16	40	24.8° C (76.7° F)
		199	07	46	00	199	08	49	20	01	03	20	24.6° C (76.2° F)
28	Temp. P2	195	14	28	10	195	17	26	42	02	58	32	19.0° C (66.2° F)
		199	07	46	48	199	08	10	58	00	24	10	20.6° C (69° F)
		199	08	33	28	199	12	47	26	04	13	58	20.0° C (67.8° F)
		199	17	42	38	199	18	24	18	00	41	40	20.7° C (69.2° F)

APPENDIX I

ACOUSTICS DATA

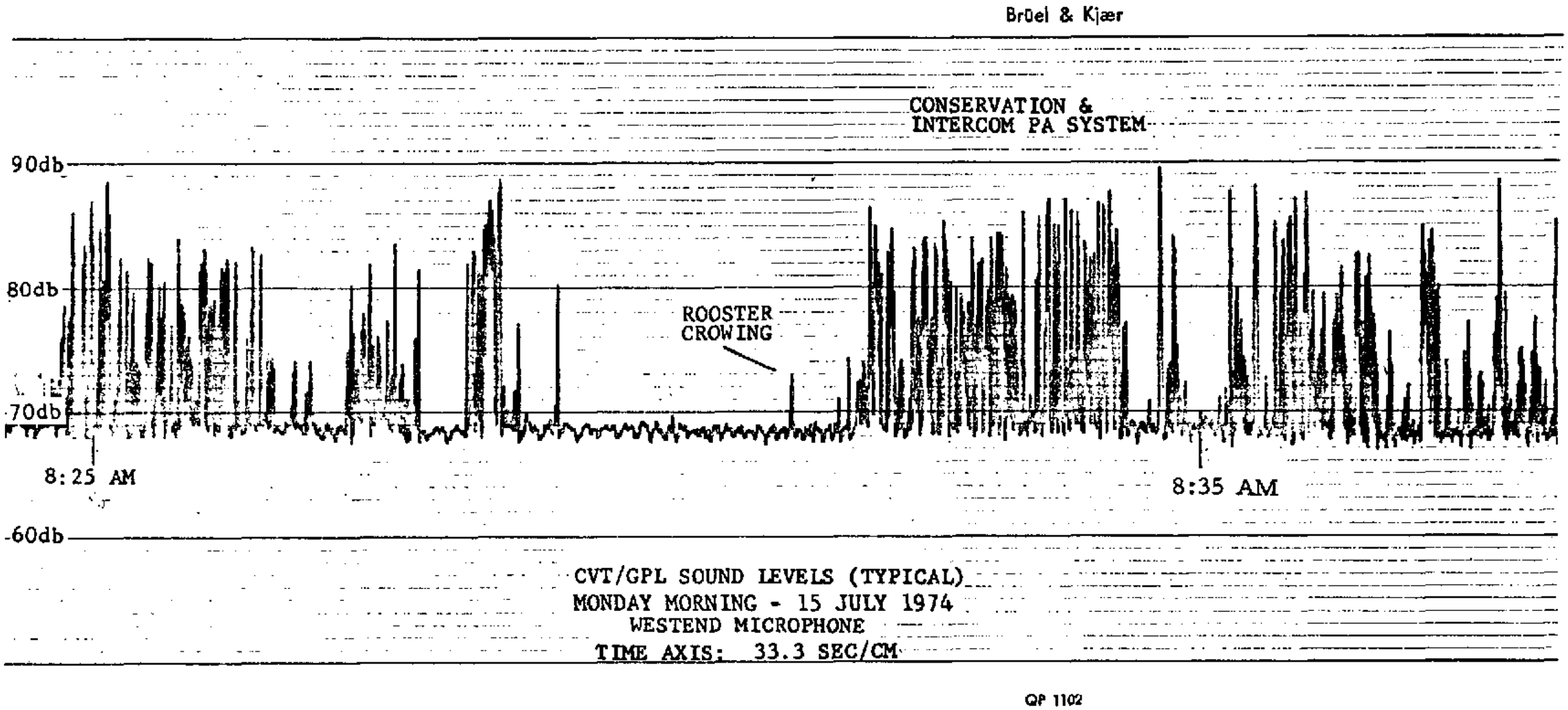


Figure J-1. CVT/GPL sound levels (Monday morning).

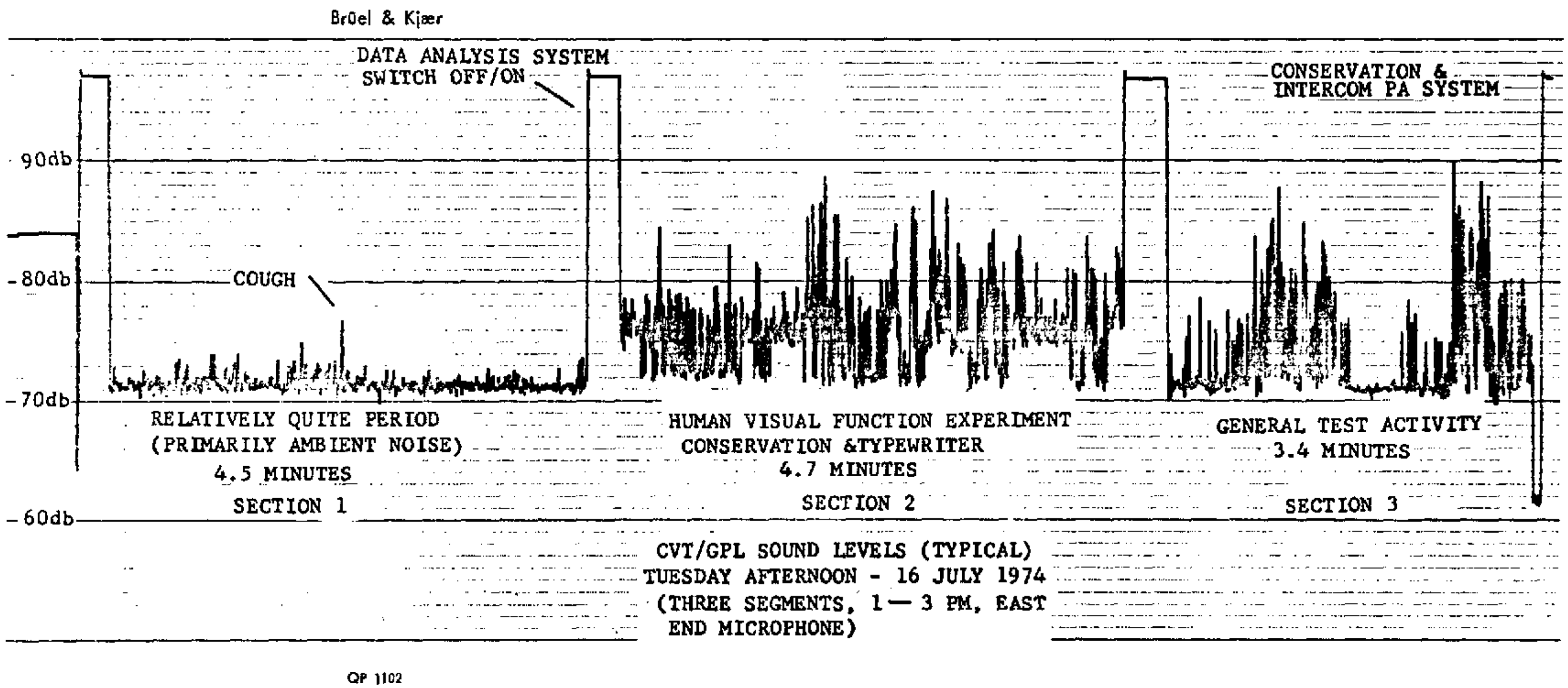


Figure J-2. CVT/GPL sound levels (Tuesday afternoon).

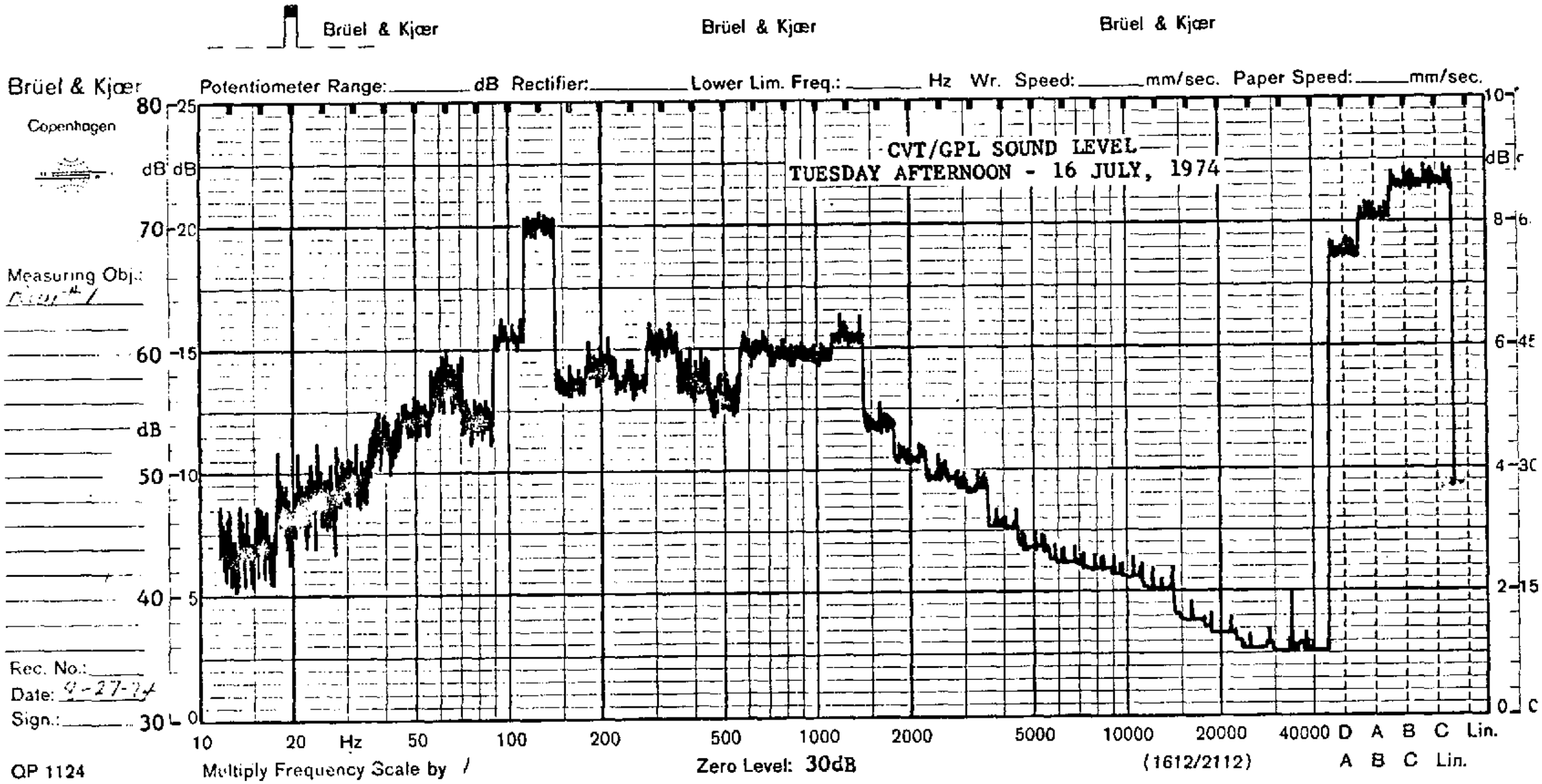


Figure J-3. Spectral analysis of a 31.5 second segment, starting at 2 minutes into section 1 of Figure J-2.

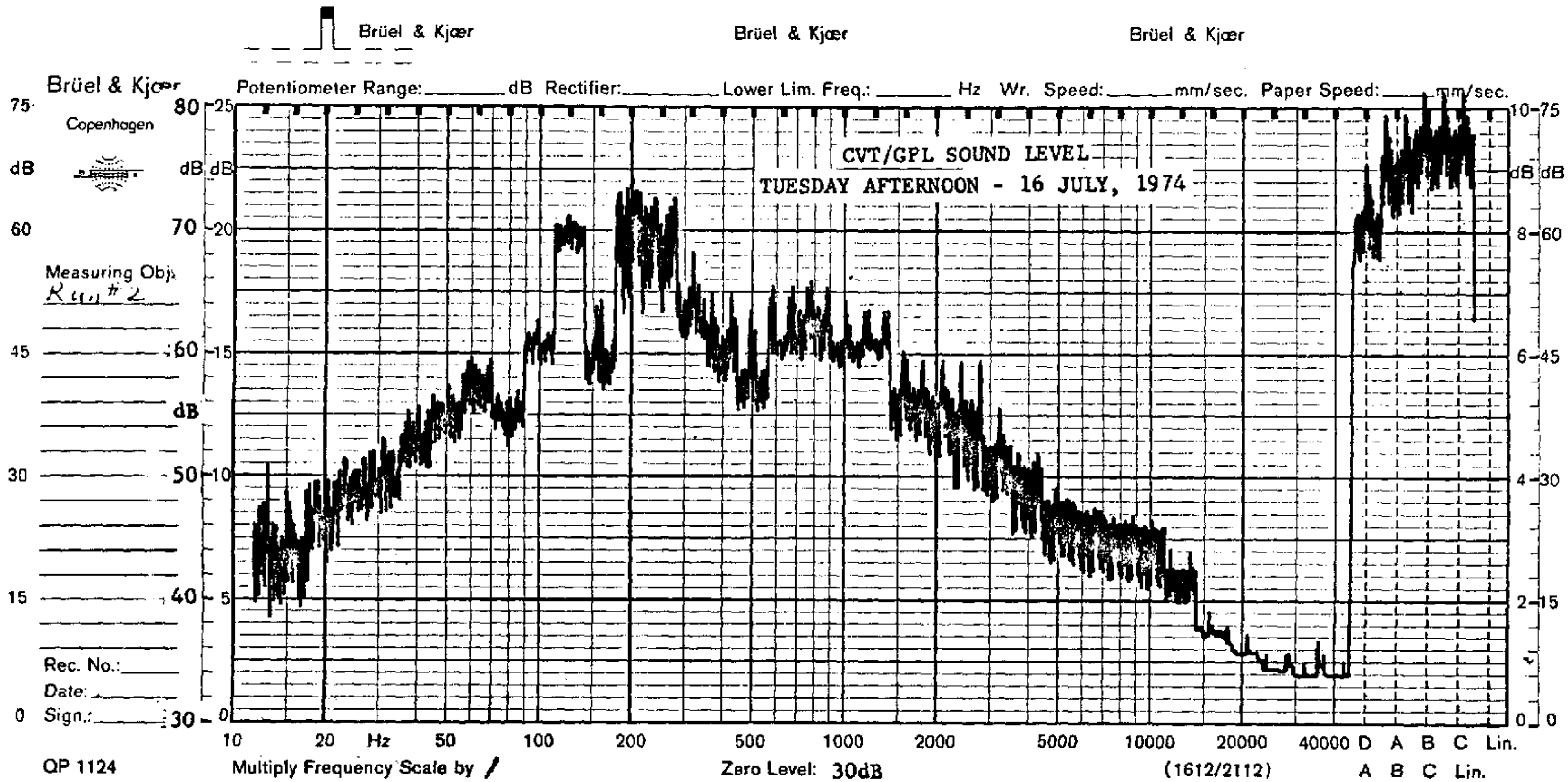


Figure J-4. Spectral analysis of a 31.5 second segment, starting at 2 minutes into section 2 of Figure J-2.

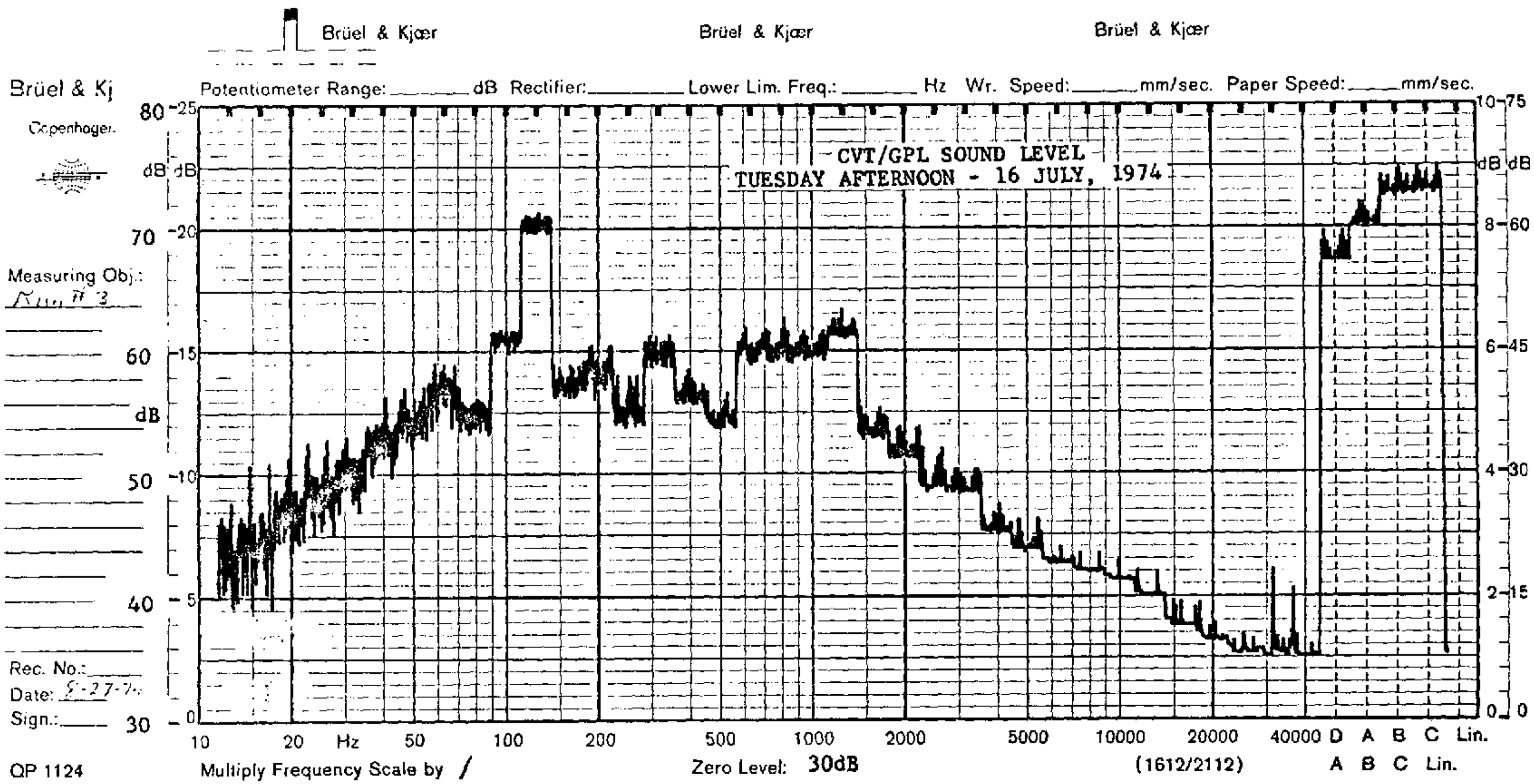


Figure J-5. Spectral analysis of a 31.5 second segment, starting at 2 minutes into section 3 of Figure J-2.

APPENDIX J

BIOCLEAN ROOM TEST RESULTS

Results of testing and monitoring the Bioclean Room are presented in Tables K-1 and K-2. Areas of discrepant performance are discussed below.

Temperature control within the Bioclean Room was satisfactory, provided that its external environment was under control. Failure of the air conditioning system in Building 4612 caused the temperature within the Bioclean Room to increase (see Table K-1). The temperature readings appear to only slightly deviate from the thermostat setting; however, the humidity values are grossly different from the humidity control setting. With the humidity control set for 35 percent, the Bioclean Room was maintained at 46 to 56 percent. Table K-1 also contains temperature and humidity control settings versus the values recorded at stabilized conditions. A complete checkout of the temperature and humidity capabilities was not possible due to the compressed program schedule. It is recommended that the controls be calibrated prior to any further checkouts.

The second discrepancy was that air flow was not laminar within the room and therefore the air velocity could not be accurately verified. Since the particulate count for a Class 100 clean room was met, the requirement for laminar flow was unnecessary.

The third discrepancy was that blower No. 4 would not restart when tested separately. The failure could not be duplicated and the blower performed satisfactorily following the failure.

Upon completion of the test, the Bioclean Room was cleaned and locked. The electrical power was shut off and the power panels were locked. The environmental health personnel discarded the radioactive waste and checked the Bioclean Room to assure that no radioactive condition exists.

When installing the Bioclean Room in Building 4708, electrical outlets should be added to the interior of the room. Two 1/4 inch adaptors should be installed through the wall of the room in order to transfer air or bottled gas to any test device which may be used within the room. It would also be beneficial to obtain another set of prefilters and charcoal filters.

TABLE K-1. TEMPERATURE AND RELATIVE HUMIDITY

		Control Settings			Bioclean Room		Bldg. 4612	
Date	Time	Interlock °C(°F)	Temp.* °C(°F)	Relative Humidity (%)	Temp. °C(°F)	Relative Humidity (%)	Temp. °C(°F)	Relative Humidity (%)
6/25/74	4:30 p.m.	10.0 (50)	25.6 (78)	60	26.7 (80)	49	21.7 (71)	41
6/26/74	8:00 a.m.	10.0 (50)	25.6 (78)	60	26.7 (80)	42	22.2 (72)	38
	11:00 a.m.	-1.1 (30)	22.8 (73)	60	23.9 (75)	47-53	**	43
	2:00 p.m.	-17.7 (0)	22.8 (73)	60	23.9 (75)	45-52	**	43
6/27/74	2:00 a.m.	-17.7 (0)	21.1 (70)	45	22.2 (72)	50-57	**	47
	8:30 a.m.	-17.7 (0)	21.1 (70)	40	22.8 (73)	46-54	22.2 (72)	46
	12:00	-17.7 (0)	21.1 (70)	35	22.2 (72)	46-52	22.2 (72)	47
6/28/74	12:00	-17.7 (0)	21.1 (70)	35	21.7 (71)	44-52	22.8 (73)	49
7/12/74 (Bldg. 4612 A/C failure)	2:00 p.m.	-17.7 (0)	21.1 (70)	35	22.0 (71.5)	46	25.0 (77)	60
	2:30 p.m.	-17.7 (0)	21.1 (70)	35	22.5 (72.5)	50.5	26.4 (79.5)	60
	3:00 p.m.	-17.7 (0)	21.1 (70)	35	23.3 (74)	51	27.2 (81)	55
	3:15 p.m.	-17.7 (0)	21.1 (70)	35	23.9 (75)	52	26.7 (80)	48
	6:00 p.m.	-17.7 (0)	21.1 (70)	35	21.7 (71)	48	24.7 (76.5)	47
	8:00 p.m.	-17.7 (0)	21.1 (70)	35	21.7 (71)	46-56	24.4 (76)	47
	10:00 p.m.	-17.7 (0)	21.1 (70)	35	22.2 (72)	46-56	23.9 (75)	47
7/14/74 (Bldg. 4612 A/C failure)	4:30 p.m.	-17.7 (0)	21.1 (70)	35	21.7 (71)	50	24.2 (75.5)	50
	5:00 p.m.	-17.7 (0)	21.1 (70)	35	22.8 (73)	50	25.6 (78)	64
	6:00 p.m.	-17.7 (0)	21.1 (70)	35	23.9 (75)	50	27.0 (80.5)	64
	6:30 p.m.	-17.7 (0)	21.1 (70)	35	24.4 (76)	47	27.2 (81)	50
	7:00 p.m.	-17.7 (0)	21.1 (70)	35	23.3 (74)	46	26.1 (79)	50
	7:30 p.m.	-17.7 (0)	21.1 (70)	35	22.2 (72)	48-57	25.3 (77.5)	50

*Cooling level setting of the thermostat

**Temperature indicator did not ink (temperature estimated to be approximately 22.2 (72° F)

Note: Continuous Recordings of Temperature and Humidity Data for Building 4612 and the Bioclean Room from 6/25/74 to 7/22/74 are on file.

TABLE K-2. TEST SUMMARY

Date	Test	Results	Requirement
6/18/74	Illumination	1399 lm/m^2 (130 foot candles) at bench height	$\geq$ 753 lm/m^2 ($\geq$ 70 foot candles) at bench height
6/20/74	Delta Pressure Verification	a) 1 ceiling panel raised, flow decreased to ~ 4 $m^3/min/m^2$ (~ 13 cfm/ft^2) b) 3 ceiling panels raised, flow decreased to ~ 0.9 $m^3/min/m^2$ (~ 3 cfm/ft^2)	When ceiling panel raised, flow should decrease to approximately zero.
6/25/74	Prefilter Warning System	61.0 by 15.2, 30.5, 38.1, and 45.7 cm (24 by 6, 12, 15, and 18 in.) prefilter blocking devices used. 61.0 by 45.7 cm (24 by 18 in.) actuated the prefilter warning light. Flow changed from ~ 6.4 to 6.1 $m^3/min/m^2$ (~ 21 to 20 cfm/ft^2).	A blocking device will be used in the prefilter area to assure that the warning light will operate properly.
6/25/74	Possitive Pressure Test	Pressure of Bioclean Room was set at 0.13 cm (0.05 in.) H_2O, which was found to be acceptable.	Measurement will be made to a minimum of 0.25 cm (0.10 in.) H_2O

TABLE K-2. (Continued)

Date	Test	Results	Requirement
6/25/74	Emergency Power Verification	20 second delay between main power interruption and operation on emergency power. 3 sec delay between emergency power deactivation and return to operation on main power. Operation equal with both power sources.	Verify emergency power operation.
6/25/74	Blower Units	One blower disabled at a time. Flow drops from ~ 6.7 to 5.2 $m^3/min/m^2$ (~ 22 to 17 cfm/ft^2). With 2 blowers disabled, flow drops to ~ 3.7 $m^3/min/m^2$ (~ 12 cfm/ft^2). When blower No. 2 and No. 4 were disabled, No. 4 would not restart. Blower No. 4 restarted using system start switch. Failure could not be duplicated.	Blower units shall be disabled individually, one at a time.
6/25/74	Hepa Filters	Downstream side of Hepa filters scanned. Maximum number of particles encountered > 0.5 micron was 4, during a period of 36 seconds. (No leakage).	Scan downstream side of Hepa filter. A leak is indicated by rapid increase of particle counter.

TABLE K-2. (Concluded)

Date	Test	Results	Requirement
6/25-28/74	Temperature and Humidity Test	With the humidity dial set for 34%, the room was maintained at 42 to 50% relative humidity for 11 hours. With the cooling thermostat set at 21.1° C (70° F), the temperature was maintained between 21.1 and 22.2° C (70 and 72° F) during the same period.	To control within the ranges: (68 to 75° F) 40 to 50% relative humidity.
6/26/74	Particulate	When the room is unoccupied, the air is rapidly cleaned of particulate and stabilizes within the requirement of a class 100 clean room at any location.	99.7% of particles 0.5 micron and larger must be removed by the filters.
6/26/74	Air Velocity Scan and Air Flow	Refer to discussion	Scan ceiling, at approximately one foot from the ceiling and at horizon intervals approximately one foot apart. Air velocity shall be between 6.1 and 7.6 $m^3/min/m^2$ (20 and 25 cfm/ft^2).

APPROVAL

CVT/GPL PHASE III INTEGRATED TESTING

By Robert E. Shurney, Eddie Cantrell, George Maybee, and Stan Schmitt

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has been reviewed and approved for technical accuracy.

HARRY H. WATTERS
Chief, Manned Systems Integration Branch

RAYMOND R. HALL
Chief, Electrical Systems Simulation Branch

HERMAN F. KURTZ
Chief, Operations Development Division

PLEASANT M. HUGHES
Chief, Systems & Component Test Division

HERMAN E. THOMASON
Director, Systems Analysis and Integration Laboratory

STANLEY R. REINARTZ
Director, Test Laboratory

☆U.S. GOVERMENT PRINTING OFFICE–640-451/207 REGION NO. 4

DISTRIBUTION

INTERNAL

DA01
Dr. Lucas

PD01
Mr. Marshall (5)

PF04
Mr. Brooksbank (30)

PA01
Mr. Murphy

PS01
Mr. Gierow (2)

PP01
Mr. Sneed

EH01
Mr. Schwinghamer

EH12
Dr. Johnston (2)

EL01
Dr. Thomason
Mr. Isbell

EL11
Mr. Kurtz

EL13
Mr. Nelson
Mr. Sinko (4)

EL14
Mr. Bock
Mr. Vaccaro

EL15
Mr. Watters

EL15
Mr. McBrayer (25)

EL15
Mr. Steadman (5)

AT (6)

CC

EL15
Mr. Shurney (15)

EL15
Mr. Smith (5)

EL22
Mr. Askew

EL32
Mr. Tanner (5)

EL34
Mr. Sells
Mr. McHugh

EL41
Mr. Huff

EL42
Mr. Cobb

EM23B
Mrs. Thompson

EP01
Mr. McCool
Mr. Coldwater
Mr. Kroll

EP21
Mr. Griner

ER01
Mr. Garrett

ES22
Dr. Parnell (2)

ES24
DR. Urban (2)

ES41
Mr. Vaughan (2)

ES42
Mr. West (2)

AS61 (2)

AS61L (8)

ET01
Mr. Reinartz

ET21
Mr. Hill

ET26B
Mr. Henson (2)

ET41
Mr. Hughes

ET43
Mr. Hall
Mr. Cantrell (20)
Mr. Ferrario (20)

NA01
Mr. Lee (10)
Mr. Bush

NA21
Mr. DeSanctis (5)

CC01
Mr. L. D. Wofford, Jr.

EXTERNAL

Scientific and Technical
Information (25)
P. O. Box 33
College Park, Maryland 20740
ATTN: NASA Representative

NASA Headquarters
National Aeronautics and
Space Administration
Washington, D.C. 20546
ATTN: Robert Dunning, MME (10)
Bill Miller, MSFC (20)

Johnson Space Center
Houston, Texas 77058
ATTN: John Lee, EL-3
John Mason, DA (3)

Kennedy Space Center
Cape Kennedy, Fla.
ATTN: Don Bailey, SP-PAY
J. Dickinson, SP-PAY

H. Schwartz
Mail Stop 309-1
Lewis Research Center
Cleveland, Ohio 44135

C. Tynan (3)
Main Stop 418
Langley Research Center
Hampton, Va. 23665

S. Taketa (35)
LS2365
Ames Research Center
Moffett Field, Calif. 94035

George Maybee (20)
Teledyne Brown Engineering
Research Park, M. S.
Huntsville, Alabama 35807

William Weissinger
Hayes International Corp.
P. O. Box 1568
Huntsville, Ala. 35807